KLICKITAT

Subbasin Plan

Prepared for the Northwest Power & Conservation Council

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5/28/2004

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1 Contributors

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1.7 Subbasin Plan Approach and Public Involvement

1.7.1 Description of Board or Planning Unit

Lead entities for this subbasin plan are the Yakama Nation, Klickitat County, Washington Department of Fish and Wildlife. The lead entities are supported by the Northwest Power and Conservation Council.

Public involvement is discussed in the Executive Summary. Citizens of the subbasin who participated in the public meetings are named in Section 1.4. and other contributors are named in Appendix A.

Infrastructure and Organization

Assessment - The subbasin assessment is a technical analysis to determine the biological potential of the subbasin and the opportunities for restoration. It describes the existing and historic resources, conditions and characteristics within the subbasin. The bulk of the assessment work was was done by the Yakama Nation with support and involvement of WDFW and Klickitat County. Separate teams of fish and wildlife scientists developed the assessment.

Inventory - The inventory includes information on fish and wildlife protection, restoration and artificial production activities and management plans within the subbasin. The Inventory work was done by the Yakama Nation and WDFW with support and involvement of Klickitat County.

Management Plan - The management plan is the heart of the subbasin plan-- it includes a vision for the subbasin, biological objectives, and strategies. The management plan embraces a 10-15 year planning horizon. The Yakama Nation, WDFW, Klickitat County and a range of stakeholders were contributors to the management plan.

1.8 Vision Statement

We envision healthy self-sustaining populations of indigenous fish and wildlife that support harvest and other purposes. Decisions and recommendations will be made in a community based, open and cooperative process that respects different points of view, and will adhere to all rights and statutory responsibilities. These efforts will contribute to a robust and sustainable economy.

2 Executive Summary

2.1 Purpose and Scope

The Klickitat Subbasin management plan – along with the supporting assessment and inventory -- is one of nearly 60 management plans currently being developed throughout the Columbia River Basin for the Northwest Power and Conservation Council (NPCC). This subbasin plan was crafted by the same team that is currently working on the Lower Middle Mainstem (including Rock Creek) and Big White Salmon subbasins, and thus has many elements in common with those plans. The plans will be reviewed and adopted as part of the NPCC's Columbia River Basin Fish and Wildlife Program. They will help prioritize the spending of Bonneville Power Administration (BPA) funding for projects that protect, mitigate and enhance fish and wildlife that have been adversely impacted by the development and operation of the Columbia River hydropower system.

The primary goal of subbasin planning in the Columbia Basin is to respond to the Independent Scientific Group's *Return to the River* report to the NPCC. Notable conclusions from that report were:

> "Our review constitutes the first independent scientific review of the Fish and Wildlife Program…"
>
> "The Program's…lack of a process for prioritization provides little guidance for annual implementation…"
>
> "We recommend incorporation of an integrated approach based on an overall, scientifically credible conceptual foundation…"

The NPCC responded to the ISG by creating the subbasin planning process, within the context of the 2000 Fish and Wildlife program. Subbasin plans provide the first basin-wide approach to developing locally informed fish and wildlife protection and restoration priorities.

Another important goal of subbasin planning process is to bring people together in a collaborative setting to improve communication, reduce conflicts, address problems and, whereever possible, reach consensus on biological objectives and strategies that will improve coordinated natural resource management on private and public lands.

The plan could potentially have a great effect on fish and wildlife resources in the subbasins, and could also have a significant economic impact on the communities within the subbasins. For these reasons, public involvement is considered a critical component in the development of the subbasin plans.

An important objective of this subbasin plan is to identify management actions that promote compliance of the federal Endangered Species and the Clean Water acts. None of the recommended management strategies are intended nor envisioned to compromise or violate any federal, state or local laws or regulations. The intent of these management strategies is to provide local solutions that will enhance the intent and benefit of these laws and regulations. The NPCC, BPA, NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) intend to use adopted subbasin plans to help meet requirements of the 2000 Federal Columbia River Power System

Biological Opinion. NOAA Fisheries and the USFWS have stated their intent to use subbasin plans as a foundation for recovery planning for threatened and endangered species.

The purposes of the Klickitat management plan include providing benefits to fish and wildlife where that help is most needed. The broad purposes of the plan and of the NPCC program mesh regarding fish and wildlife species.

From the Columbia River Basin Fish and Wildlife Program (NPPC 1994):

> The development of the hydropower system in the Columbia River Basin has affected many species of wildlife as well as fish. Some floodplain and riparian habitats important to wildlife were inundated when reservoirs were filled. In some cases, fluctuating water levels caused by dam operations have created barren vegetation zones, which expose wildlife to increased predation. In addition to these reservoir-related effects, a number of other activities associated with hydroelectric development have altered land and stream areas in ways that affect wildlife. These activities include construction of roads and facilities, draining and filling of wetlands, stream channelization and shoreline riprapping (using large rocks or boulders to reduce erosion along streambanks). In some cases, the construction and maintenance of power transmission corridors altered vegetation, increased access to and harassment of wildlife, and increased erosion and sedimentation in the Columbia River and its tributaries.
>
> The habitat that was lost because of the hydropower system was not just land, it was home to many different, interdependent species. In responding to the system's impacts, we should respect the importance of natural ecosystems and species diversity."
>
> Some species, such as some waterfowl species, have seemed to benefit from reservoirs and other hydropower development effects, but for many species, these initial population increases have not been sustained.

2.2 Public Involvement

The Klickitat plan could potentially have a great effect on fish and wildlife resources in the subbasin. It could have significant economic impacts on the communities within the subbasin as well. For these reasons, public involvement is considered a critical component in the development of the subbasin plans. Considerable time and effort was spent from the earliest meetings to craft a statement or "vision" of what the participants would like to see in their subbasin as the result of efforts to restore, protect and enhance fish and wildlife populations and their habitat.

Public involvement in the subbasin planning processes for the Klickitat, White Salmon and Lower Middle Mainstem Columbia River (including Rock Creek) included a public mailing, public meetings held at different locations and times throughout the subbasins, regular conference calls, use of a ftp site to store draft documents, posting draft subbasin plans on the NPCC website, and development and use of extensive e-mail lists that were intended to keep members of the public informed regarding the status of the subbasin planning process.

The subbasin planning team, as a part of its public outreach effort, developed a brochure for the public mailing. The brochure was sent as bulk mail and delivered to all postal customers residing in the three subbasins.

There were also a total of seven public meetings held as a part of the subbasin planning effort. These meetings were held on March 9 and May 6 in Goldendale, on March 11 and May 4 in White Salmon, on March 10 and May 5 in Bickleton, and on May 3 in Klickitat. Numerous technical and planning meetings, announced and open to the public, were held in many locations throughout the subbasins to facilitate collaboration, information flow and involvement by as diverse a group as possible. Throughout the subbasin planning process, participants worked on a vision statement that reflects their vision of the subbasin in 10 – 20 years. The vision statement for the Klickitat subbasin is as follows:

2.3 Vision Statement

"We envision healthy self-sustaining populations of indigenous fish and wildlife that support harvest and other purposes. Decisions and recommendations will be made in a community based, open and cooperative process that respects different points of view, and will adhere to all rights and statutory responsibilities. These efforts will contribute to a robust and sustainable economy."

2.4 Subbasin Goals

- Protect or enhance the structural attributes, ecological function, and resiliency of habitats needed to support healthy populations of fish and wildlife.
- To restore and maintain sustainable, naturally producing populations of spring chinook, steelhead that support tribal and non-tribal harvest and cultural and economic practices while protecting the biological integrity and the genetic diversity of the subbasin.

2.5 Biological Objectives

Wildlife and Fish

The larger, long-term objectives for fish and wildlife habitat are to

- Increase reduced populations of native fish and wildlife to sustainable sizes
- Increase quantity and quality of reduced and degraded habitat to amounts that will sustain native fish and wildlife species
- Decrease fragmentation of habitat, to restore connectivity of populations and historic migration routes, within and between subbasins
- Increase presence of native plants in their historical distribution and reduce exotic plant distributions

2.6 Major Findings and Conclusions

There are several expressions of a change in ecosystem processes within the Klickitat Subbasin that have been identified as a part of the subbasin planning process. They will be the target of the plan's strategies to improve conditions for fish and wildlife productivity.

Because of the large number of wildlife species and habitats present in the subbasin, biologists could not provide adequate descriptions and status reports for each. Instead, they chose to select focal habitats on which to focus assessment and management analysis. The focal habitats are montane coniferous wetlands, ponderosa pine/Oregon white oak forests and woodlands, interior grasslands, and interior riparian areas (see Table 5).

Nine wildlife species from the Klickitat subbasin were chosen as focal species -- Western gray squirrel, Rocky Mountain mule deer / Columbian black-tailed deer, grasshopper sparrow, white headed woodpecker, beaver, yellow warbler, greater sandhill crane, Oregon spotted frog, and flammulated owl.

The focal fish species chosen are the steelhead/rainbow, spring chinook salmon and bull trout. Pacific lamprey was chosen as a species of interest.

A number of conditions are present in the subbasin that limit fish and wildlife populations. There has been an increase in fine sediment delivery into the Klickitat River system over historic conditions. There has also been a significant increase in hydroconfinement. Thirdly, large woody debris has decreased in streams, depriving fish of desired hiding and resting places. Riparian function has deteriorated over time. And salmon carcasses have significantly decreased in number due to diminishing run sizes, effectively limiting critical marine derived nutrients from streams and negatively affecting food availability.

Strategies and actions are identified within the management plan to address the change in ecosystem function as well as address limiting factors for production and abundance in the Klickitat subbasin. Where possible geographical priorities are identified within assessment units and ranked as either primary or secondary tier actions.

Positive change is under way. For example, the tunnels at Castile Falls on the Upper Klickitat have been modified to remedy passage impediments, easing access to at least 35 miles of habitat. However, operation and maintenance as well as maintenance and evaluation will be needed -- this is a primary strategy outlined in the subbasin management plan.

Strategies and actions that may be implemented throughout the subbasin include the following: increase floodplain channel and roughness, reconnect side channels, improve floodplain connectivity, relocate floodplain infrastructure and roads, improve maintenance, rehabilitate and decommission roads as appropriate, re-establish and/or enhance native vegetation within floodplain, implement practices that leaves sources of large woody debris in-stream that occur naturally, and/or artificially introduce large woody debris. Building fish populations in the upper Klickitat assessment unit and elsewhere would help provide enough carcasses to restore that missing link in the food web. These strategies will improve the lot of both fish and wildlife.

Of the uncertainties within the subbasin, the following were identified as primary needs for study: the presence of pathogens in juvenile and adult fish, assessments of the relative contributions of various sources to increased fine sediment, the significance of native bird predation on fish populations, the frequency and difficulty of passage at Little Klickitat Falls, the effectiveness and utilization of the Castile Falls tunnels.

Other primary strategies involve evaluation of lamprey habitat needs and the implementation of restoration actions.

A general theme across the subbasin is a reduction in the quantity and quality of all types of wildlife habitat that the focal and other species need to flourish.

Riparian wetlands have been lost, as floodplain habitats have been converted to human uses. That loss of riparian wetland habitat structure and hydrology reduces or ecological function.

This plan's objectives and strategies recommend efforts to restore riparian wetland habitat in order to bring benefit to both fish and wildlife. Those actions involve both restoring habitat by increasing native vegetation and creating adequate hydrological conditions to reconnect habitats in tributary and mainstem floodplain areas.

Primary strategies in both the fish and wildlife portions of this management plans are strategies to restore beaver habitat and, were possible, to prepare for reintroduction of a species whose numbers are greatly reduced from historic levels. The restored habitat would benefit beaver, whose activities would in turn benefit the salmon and steelhead that spend a portion of their life history in the watershed. Beaver dams result in the creation of off channel habitat and increased channel stability, both of which benefit focal fish species.

Among the causes of the diminution and fragmentation of shrub steppe habitat are agriculture and other human development, altered fire frequencies and invasive weed species. Habitat quality can be improved by supplementing the ability to control fires, restoring more natural fire cycles, encouraging appropriate grazing practices, prioritizing weed control areas, and implementing native plant restoration. Restoration and protection of habitats are key strategies.

Habitat quality and ecological function in Ponderosa pine / Oregon white oak habitat has been reduced because of altered forest species composition and age structure. Harvest practices have resulted in removal of late seral stands and large overstory trees across the landscape.

Objectives include retaining any existing late seral stands and large decadent wildlife trees and managing stands to restore functional habitat. Such strategies include identifying areas where thinning and/or prescribed burning would help achieve habitat objectives and thinning appropriate stands to decrease stand density.

The montane coniferous wetland habitat suffers from altered plant species composition due to inappropriate grazing, altered fire frequencies, timber activities and off-road vehicle use. The primary strategies recommended to reverse those limiting factors involve fencing off grazing from sensitive areas, avoiding future road building in sensitive areas and where practical relocating roads, that are causing loss of hydrological function. This management plan also calls for restoring native riparian tree and shrub habitats necessary for fish and wildlife habitat in degraded river and tributary areas. Another primary strategy is to deny off-road vehicle access to sensitive meadows.

Monitoring and evaluation activities within the Klickitat subbasin have invaluably informed and improved habitat projects as well as supplementation efforts. Continued monitoring and evaluation (M & E), along with additional work in targeted areas, is critical to identify successful actions. There are several current actions being taken in the subbasin that have benefited from past M & E efforts. M & E will continue to play an integral role toward understanding what works for fish and wildlife in the subbasin and what does not work, which allows for adaptive management for fish and wildlife projects in the subbasin.

3 Subbasin Overview

This section describes the Klickitat subbasin and its place within the Columbia Plateau Province or eco-region as defined by the Northwest Power and Conservation Council (NPCC). The Subbasin Overview section summarizes the Klickitat subbasin's geological, climatic, biological, and hydrological characteristics; gives an overview of its fish and wildlife resources; and describes the human population and activities that occur in the subbasin.

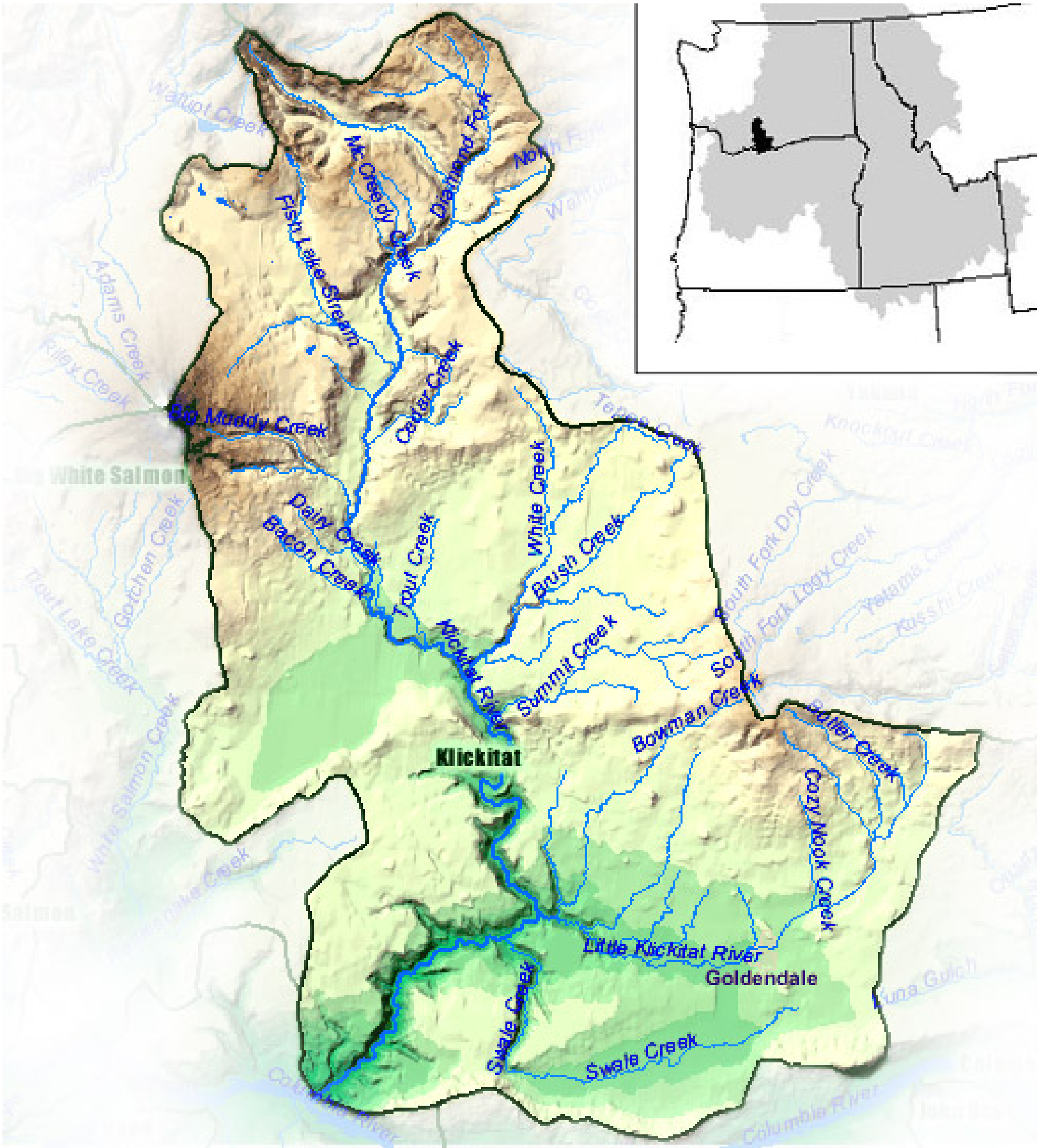

Figure 1 The Klickitat River subbasin

3.1 Subbasin in Regional Context

For planning purposes, the Northwest Power and Conservation Council divided the Columbia River Basin south of the Canadian border and its more than 50 subbasins into 11 eco-regions. NPCC is responsible for implementing the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) and the Fish and Wildlife Program mandated by the Act.

The 11 provinces, beginning at the mouth of the Columbia River and moving inland, are: Columbia Estuary; Lower Columbia; Columbia Gorge; Columbia Plateau; Columbia Cascade; Inter-Mountain; Mountain Columbia; Blue Mountain; Mountain Snake; Middle Snake; Upper Snake. These 11 eco-regions include the entire Columbia River basin in the United States, and together cover approximately 25,000 sq. mi. in Washington, Oregon, Idaho and Montana.

Each of the 11 provinces will develop its own vision, biological objectives, and strategies consistent with those adopted at the subbasin level. NPCC's intent is to adopt these elements into the 2000 Fish and Wildlife Program during later rulemaking. The biological objectives at the province scale will then guide development of the program at the subbasin scale.

The provinces are made up of adjoining groups of ecologically related subbasins, each province distinguished by similar geology, hydrology, and climate. Because physical patterns relate to biological population patterns, fish and wildlife populations within a province are also likely to share life history and other characteristics (NPCC 2000). The Klickitat basin or subbasin is in the Columbia Gorge Province.

3.1.1 Columbia Gorge Province

The Columbia Gorge Province extends over an area of approximately 3,305 sq. mi. It encompasses the Columbia River and associated watersheds between Bonneville Lock and Dam and The Dalles Dam. The Gorge Province includes a small portion of Washington and Oregon, composed of seven subbasins. Five lie within south central Washington: Klickitat, Little White Salmon, Big White Salmon, Wind River, and Columbia Gorge. Two subbasins, Fifteenmile Creek and Hood River, cover portions of Hood River and Wasco Counties in north central Oregon. The cities of Portland, Oregon and Vancouver, Washington are about 40 east of Bonneville Dam.

The province includes the Columbia River Gorge National Scenic Area (Gorge Scenic Area), a spectacular river canyon the Columbia River cut through the Cascade Mountains. The province is a transitional environment between the relatively moist western region and the drier interior portion of the Columbia Basin. The mountainous regions, which form the province's western border, are predominantly coniferous forests, while the arid regions are characterized by sagebrush steppe and grassland. Many of the same fish and wildlife species are found in each of the six subbasins in the Columbia Gorge Province.

Archaelological evidence in the Columbia Gorge suggests human occupation for over 30,000 years. Excavations at Five Mile Rapids, a few miles east of The Dalles, show humans have occupied this ideal salmon fishing site for more than 10,000 years (Gorge Scenic Area 2004). For thousands of years, Indian people throughout western North America traveled to this area to trade for dried, smoked salmon. The people and villages indigenous to the province include the Cascade, White Salmon, Hood River, Klickitat, Wasco, Wishram, Tenino, Wyampum, and Tygh. Other groups such as the Yakima, John Day, Umatilla, Nez Perce, Cayuse and others used the area, particularly for fishing, and figured significantly in trade and marriage with those whose territory this was. The descendants of these native peoples are now members of the Confederated Tribes of the Warm Springs, Confederated Tribes of the Yakama Nation, Confederated Tribes of the Grand Ronde Community of Oregon, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe.

In 1843 about 900 European Americans braved the 2,000 mile Oregon Trail to reach the Willamette Valley. By 1849 approximately 11,500 pioneers had arrived in Oregon, forever changing life in the Columbia Gorge. Today significant urban centers within the Columbia Gorge Province include the incorporated cities of Goldendale, White Salmon, and Stevenson, Washington, and The Dalles, and Hood River, Oregon.

The Columbia Gorge Province is an important recreational, timber, and agricultural area and is a major source of hydroelectric power. Two major hydropower dams are located in the Gorge: The Dalles and Bonneville. Indian and non-fishing also contribute to the local economy. The area has many traditional Indian fishing sites that were reserved for use by the tribes and their members in 1855 treaties between the United States and the Warm Springs, Yakama, Umatilla and Nez Perce tribes.

3.1.2 Terrestrial/Wildlife Relationships

A variety of wildlife including large and small mammals, waterfowl, passerines, raptors, reptiles and amphibians are associated with Gorge's riverine, wetland and upland habitats. While population status varies by area and species, many wildlife species are listed as federal and/or state Threatened, Endangered, Sensitive or At-Risk. Species associated with mature forest and large home ranges such as northern goshawk, spotted owl, pileated woodpecker, wolverine, and pine martin have all been documented in recent years. Harlequin duck are noted as abundant in the Hood River and other Gorge tributaries. Peregrine falcon are known to use c1iffs along the Columbia River for nesting habitat, and riverine and open orchard lands as foraging areas. Locally extirpated species include gray wolf, grizzly bear, California condor and mountain goat. Big game, furbearers, upland birds and waterfowl species are managed by federal, tribal and state wildlife managers. The Province lies along a migratory waterfowl lane of the Pacific flyway.

The loss of the riverine riparian zone along the Columbia River, residential development, timber harvest, development of agricultural land, and species introductions (both invasive and planned) have affected wildlife species abundance and diversity. Development has resulted in some fragmentation of white oak forest in the lower portions of some Columbia River tributaries, which many indigenous wildlife species are dependent upon. The headwater areas of head streams remain in coniferous forests and provide critical habitat for wildlife. The construction of highways and freeways has interrupted natural migrations and limited access to the limited remaining riparian habitat.

Parts of the Klickitat subbasin are important wintering areas for mule / black-tailed deer (*Odocoileus hemionus hemionus* / *Odocoileus hemionus columbianus)*. These deer migrate annually from their summer range in the northern portion of the Klickitat subbasin, within the Yakama Reservation, and even into the Yakima subbasin (figure 1). In the Klickitat subbasin, the oak / shrub steppe fringe provides important food and cover for deer. Here, sagebrush, bitterbrush and acorns make up part of their winter diet. These migrating deer were part of the Klickitat Basin Deer Study (McCorquodale 1999).

The subbasin is also important summer habitat to deer and elk that migrate from their winter range in the Toppenish Creek area (within the Yakima subbasin). Deer and elk generally seek higher, cooler and greener pastures in summer. The elk migration was studied from 1993 to 2000 (McCorquodale 1999). Deer migrations are currently being studied by the Yakama Nation (J. Stephenson, pers. comm.).

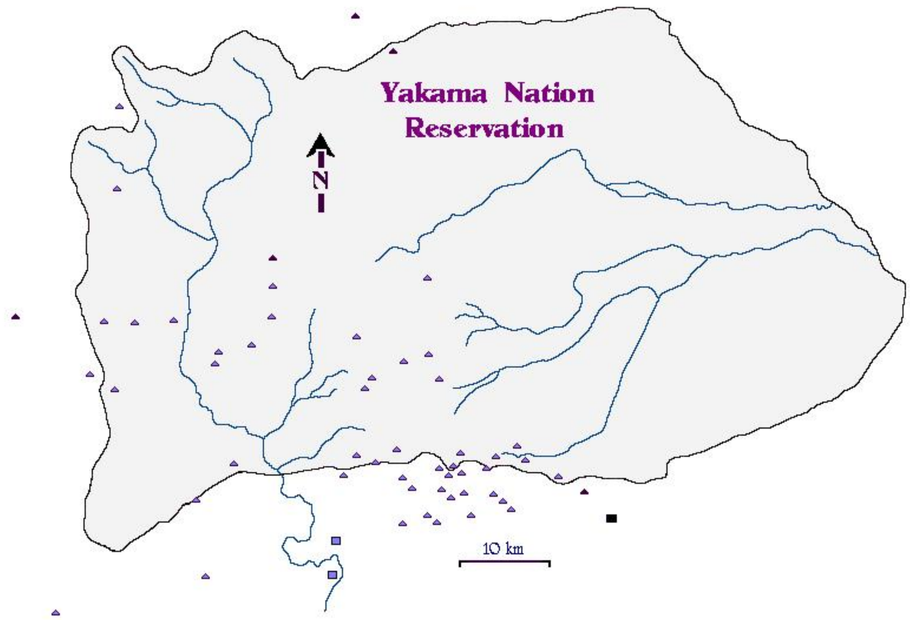

Figure 2 Map showing winter trapping areas (squares) and summer-fall activity centers of radio-collared deer (triangles) (McCorquodale 1999)

Black square represents trapping area in the Rock Creek subbasin, and Blue squares are trapping areas in the Klickitat subbasin.

Klickitat County has the healthiest and most stable population of western gray squirrels (*Sciurus griseus*) in Washington State. This population may play an important role in the recolonization or reintroduction of squirrels into habitats they were formally found but are depleted. Despite some land conversion of oak and pine habitat in Klickitat County, a habitat vital to western gray squirrels, there are still large amounts of suitable and unfragmented habitat available.

Many neotropical migratory birds breed in our subbasin. The flammulated owl (*Otus flammeolus*) is the only neotropical migratory owl in North America, and currently breeds in the Klickitat subbasin. It winters primarily in Mexico but has been recorded as far south as Guatemala. Flammulated owls start migrating north in April and probably arrive in Washington in May. Flammulated owls are presumed to be migratory in the northern part of their range (Balda et al. 1975). Flammulated owls can be found in Washington only during their relatively short breeding period.

3.1.3 Fish & Aquatic / Wildlife & Terrestrial Relationships

Riparian areas connect aquatic and terrestrial ecosystems providing an important link between fish, wildlife and wildlife habitat. Riparian areas perform a number of functions vital to the watershed and water quality. These functions are important to salmon habitat and wildlife that are dependent on salmon for food and nutrients.

Anadromous salmon provide a rich, seasonal food and nutrient resource that directly impacts the ecology of both aquatic and terrestrial consumers and the vegetative landscape. There is also an important indirect affect on the entire food web linking water and land resources (Cederholm et al. 2000). This food web has likely always included this co-evolutionary relationship between salmon, wildlife and habitat in the Pacific Northwest.

The life stages of salmon (i.e., eggs, fry, smolts, adults, and carcasses) all provide direct or indirect foraging opportunities for terrestrial, freshwater, and marine wildlife (Cederholm et al. 2000). The relationship between pacific salmon and wildlife was examined by Johnson et al. (2001). A total of 605 species terrestrial and marine mammals, birds, reptiles, and amphibians currently or historically common to Washington and Oregon were examined for their relationship to pacific salmon. They found a positive relationship between salmon and 137 species of wildlife. See Appendix C, table C.6.A for a full list of the wildlife species in our subbasin identified as having a relationship with salmon.

There are several predators in the Pacific Northwest ecosystem that benefit from the important ecological contribution that pacific salmon make as prey during their anadromous life history. Pacific salmon contribute nutrients during several stages of their life, regardless of whether particular individual salmon complete all life history stages or not (Cederholm et al. 2000). Six wildlife species present in our subbasin are identified as having a strong, consistent relationship with salmon: Common merganser (*Mergus merganser*), harlequin duck (*Histrionicus histrionicus*), osprey (*Pandion haliaethus*), bald eagle (*Haliaeetus leucocephalus*), black bear (*Ursus americanus*) and northern river otter (*Lontra canadensis*).

Fish, and their habitat, also benefit from the presence of particular wildlife species. American beavers (*Castor canadensis*) are extremely important in contributing to large woody debris, which is a critical structural component in Pacific Northwest streams. Large woody debris provides important structural complexity as well as vital nutrients to streams. Large woody debris and beaver dams decreases stream velocity and temperature. It also provides refugia to migrating fish.

3.2 Subbasin Description

Topographic / Physio-geographic Environment

The Klickitat subbasin is located along the east slope of the Cascade Range in south-central Washington. It encompasses an area of 1350 square miles, and includes portions of Klickitat and Yakima counties. The Cascade Mountain crest that forms the western boundary of the subbasin is dominated by Mt. Adams, a 12,000-foot dormant volcano with an extensive glacier system that drains into the Klickitat River. The basalt ridges and plateaus of the Yakama Indian Reservation make up the northern portion of the Klickitat subbasin and separate the Klickitat from other river basins on the north and east. The Columbia River Gorge forms the subbasin southern boundary.

The Klickitat River has its headwaters in the Goat Rocks Wilderness (Tieton Pk. 7,775 ft.) and flows just over 95 miles to the Columbia River at Lyle (RM 180.4), 34 miles upstream of Bonneville Dam. It is one of the longest undammed rivers in the northwest. Major tributaries include Swale Creek, Little Klickitat River, Outlet Creek, Big Muddy Creek, W. Fork Klickitat River, and Diamond Fork.

Median subbasin elevations generally decrease moving downstream through the basin, however, slopes are steeper both in the upper and lower portions. The ground with lower relief is largely located in the Middle Klickitat, Little Klickitat, and Swale Creek subbasins (Watershed Professionals Network and Aspect Consulting, Inc. 2004).

The landscape consists primarily of a plateau of basalt strata having a total thickness of several thousand feet (Cline 1976), dissected by deep (700 to 1500 feet), steep-walled canyons carved by the watershed's network of streams and rivers. In some areas, local variations in erosion resistance of these flows have resulted in the formation of cascades and waterfalls along the mainstem and in many of the tributaries.

Volcanic rocks of four distinct age groups underlie the basin. At the northwest corner of the basin lie the Goat Rocks, the deeply eroded remnants of an extinct volcano that reach to nearly 8,000 feet. The northern boundary is the Klickton Divide, a 7,000-foot ridge of Columbia River Basalt that separates the Klickitat from the watershed of the Tieton River, a tributary to the Yakima. The Lost Horse and Lincoln plateaus, 5,000 - 6,000-foot plateaus underlain by Columbia River basalts, separate the Klickitat from the Ahtanum and Toppenish basins, which drain east to the Yakima River. In the southeast part of the basin, younger volcanic rocks, including many cinder cones, cover the older basalts on the divide separating the Klickitat from the Satus Basin.

The region's general geologic history includes: (1) widespread extrusion of numerous Miocene-age lava flows (Columbia River Basalt Group; CRB) from vents east of the watershed with a combined thickness ranging from zero to several thousand feet; (2) uplift of the Cascade Range immediately to the west, with resulting upwarp and erosion of the lava flows; (3) localized extrusion of lavas and ash from Mount Adams and several smaller volcanic and cinder cones; and (4) glaciation on the higher peaks, resulting in erosion of these peaks and deposition in down slope. The erosion resistant nature of the volcanic strata has resulted in the creation of deep, steep-walled canyons with limited floodplain development over most of the watershed.

Most soils within the subbasin have a Hydrologic Soil Group rating of "B" (0.15-0.30 in/hr), indicating that moderate rates of infiltration and water transmission (NRCS 1996). Infiltration and transmission rates are highest in the Middle Klickitat subbasin, where close to 90% of the soils are in HSG groups A (> 0.30 in/hr) and B, and lowest in the Swale Creek and the Columbia Tributaries subbasins (Watershed Professionals Network and Aspect Consulting, Inc. 2004).

Climate in the watershed can be characterized as a hybrid of that found on the east and west sides of the Cascades, owing to its position at the head of the Columbia Gorge. The watershed is subject to a continental climate, but receives a stronger marine influence than other east side basins. A climatic gradient is noticeable as one moves from the northwest (cooler, wetter) to the southeast (warmer, drier) portions of the watershed. Summers are typically hot and dry (avg. temp. 55°F -70°F) and winters are cold and wet (avg. temp. 25°F - 37°F). Precipitation decreases dramatically from west to east across the subbasin, ranging from 140 inches on Mount Adams to

9 inches on the southeastern plateau. Mean monthly precipitation values are highest in the months of December and January and lowest in July and August (Watershed Professionals Network and Aspect Consulting, Inc. 2004); 75-85% of all precipitation falls between November and May.

In average years, a shallow snow pack is typically present on Jan. 1 in the upper 2/3 of the subbasin and the Little Klickitat watershed and in approximately half in the southern area that drains Dillacort, Swale, Snyder, Wheeler Creeks (Watershed Professionals Network and Aspect Consulting, Inc. 2004). Snow is largely absent in the Columbia Tributaries area on Jan. 1. Snow pack typically increases in depth throughout the winter and spring in the northern part of the subbasin and in the higher elevation areas of the middle mainstem and Little Klickitat watersheds, usually reaching its maximum by April 1 (Watershed Professionals Network and Aspect Consulting, Inc. 2004).

3.2.1 Jurisdictions and Land Ownership

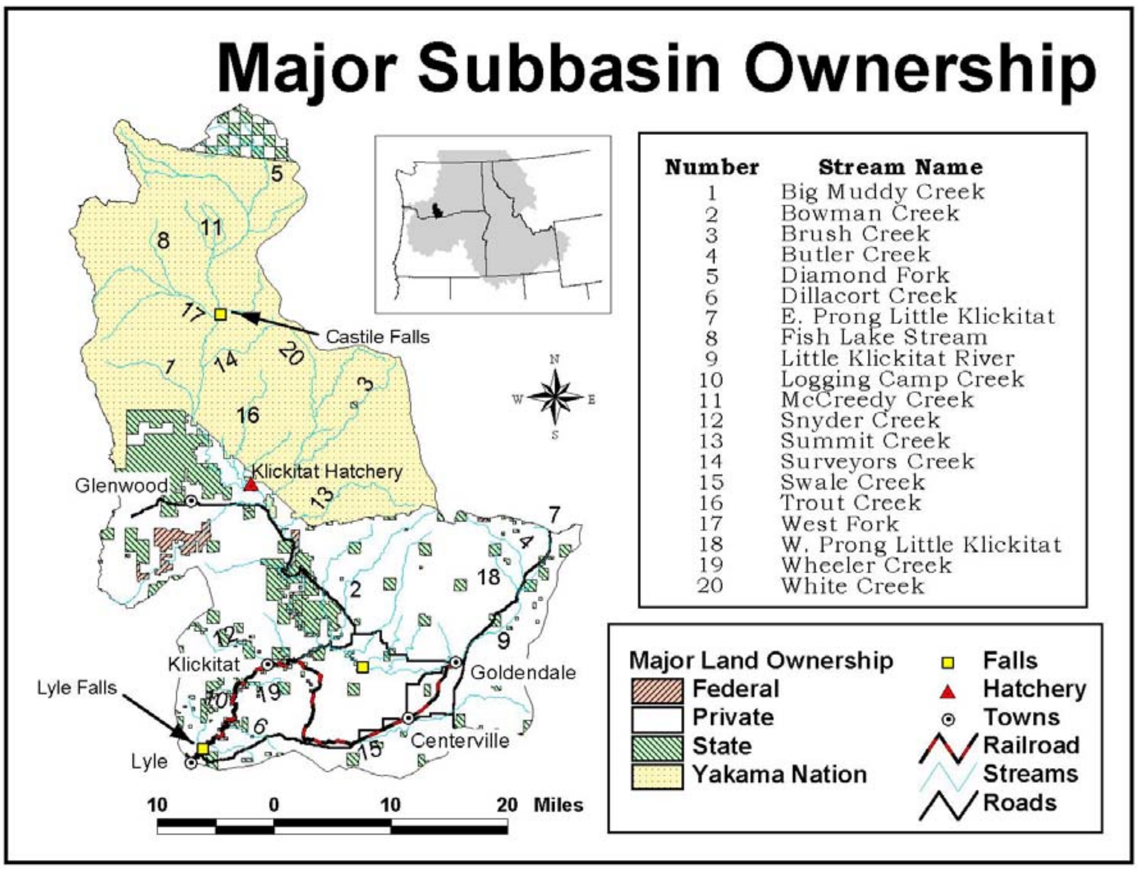

Figure 3 Klickitat subbasin land ownership, towns, and stream locations

The Klickitat watershed is approximately equally divided between Klickitat and Yakima counties. The Yakama Nation Reservation encompasses roughly the northern half of the watershed area. Outside of the reservation, approximately 90% of the land is privately held, 10% of the land is state-owned (Washington Department of Natural Resources [WDNR], Washington Department of Fish and Wildlife [WDFW]) and less than 1% is federally owned (Bureau of Land

Management [BLM], U.S. Fish and Wildlife Service [USFWS]). The City of Goldendale is the Klickitat County seat. The City of Yakima is the Yakima County seat.

Yakama Reservation Land Use Management Areas (LUMAs)

The current (1993-2002) Yakama Nation Forest Management Plan (FMP) has designated Land Use Management Areas (LUMAs) for special management emphasis within the closed area (closed to non-tribal members) of the reservation (Figure 3). Table1 lists the LUMAs within the Klickitat subbasin, as well as the acreage and goal of each LUMA.

Table 1 Land Use Management Areas (LUMAs) within the Klickitat subbasin

LUMA	Acres	Goal of LUMA
Alpine	37,021	To protect & enhance watershed values and other non-timber resource uses
General Forest	186,982	To provide optimum timber production consistent with tribal objectives, cultural and environmental considerations, and economic efficiency
Old Growth	6,081	To provide for well-distributed old growth habitat across the Yakama Reservation Forest
Primitive	35,864	To maintain the designated Primitive Area in a natural state for the use and enjoyment of enrolled Yakama Tribal members
Riparian	5,629	To protect and enhance riparian habitat
Special Use & Ranger Stations	2,398	To maintain or enhance designated sites of cultural, historical, and educational importance
Tract D Recreation	16,954	To maintain or enhance the natural ecosystems present and provide opportunities to visit and appreciate this unique ecological area
Visual Resource	2,670	To provide for visually satisfactory forest appearances from selected scenic travel routes
Watershed	34,764	To maintain the vegetative and drainage characteristics needed for water quality protection
Wildlife Winter Habitat	140	To provide for optimum deer and elk winter range and growth of foods and medicines

(USDI Bureau of Indian Affairs 1993)

Columbia River Gorge National Scenic Area

"The National Scenic Area was created to protect and enhance the scenic, natural, cultural and recreational resources of the Columbia River Gorge while encouraging economic development", (www.fs.fed.us/r6/columbia/). Part of the NSA has been designated along the southernmost portion of the Klickitat subbasin, adjacent to the Columbia River.

Klickitat Wildlife Area

The Klickitat Wildlife Area is owned and managed by WDFW. The area covers approximately 14,000 acres in the western portion of Klickitat County. It lies on the east slope of the Cascade Mountains about halfway between the Columbia River Gorge to the south and Mt. Adams to the north. The Klickitat River forms a deep, twisting canyon on its way south to the Columbia River. This twisting characteristic has created juxtaposing areas of forage on south slopes and thermal cover on north slopes. General vegetation types include the forest riparian zone along the Klickitat River, south-facing hillsides of open grasslands, north-facing hillsides forested with conifers, and the flatter plateau covered by mixed forests of oak and pine interspersed with small grassland openings, (www.wa.gov/wdfw/lands/r5klick.htm).

Conboy Lake National Wildlife Refuge

The Conboy Lake National Wildlife Refuge (NWR) is managed by USFWS. The refuge is located approximately 10 miles east of Trout Lake and 7 miles southwest of Glenwood, in the Glenwood Valley/Camas Prairie area. The NWR contains 5,184 acres of marsh, meadows, grasslands, and forest. The former mountain lake is now present only in winter and early spring. The area provides a spring migration area for Canada geese and ducks, (mainly mallards and pintails) and wintering use for tundra swans, Canada geese, ducks, and bald eagles. Additionally, one of three known nesting areas for sandhill cranes in Washington is located on the NWR, as is one of two known populations of Oregon spotted frogs, www.r1.fws.gov/visitor/washington.html).

Wild and Scenic Rivers

The Wild and Scenic Rivers Act was created to preserve in a free-flowing condition selected rivers of the nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. On Nov. 17, 1986, the lower 10 miles of the Klickitat River were designated recreational under this legislation. The segment river is administered by the Secretary of Agriculture, (www.nps.gov/rivers/klickitat).

3.2.2 Land Use and Demographics

Land use is well correlated with climate, vegetation, and topography. Approximately 75% of the watershed is forested; these areas are generally characterized by steep topography considered unsuitable for agriculture. Most of this forestland is managed for commercial timber production. The Yakama Nation is the primary timberland landowner; collectively, the State of Washington and numerous private parties own the remaining forested lands in the subbasin. These lands are also considered suitable for grazing, and most currently have active grazing allotments.

Fire was historically a common disturbance in the subbasin. However, 100 years of fire suppression have altered the fire disturbance regime, resulting in changes in vegetative species composition. Many areas that were historically dominated by fire-dependent communities have been altered through succession to more dense vegetation that is prone to catastrophic fire.

Most of the remaining 25% of the watershed is agricultural land, dedicated primarily to pasture, dry-land farming and livestock grazing. Agricultural use is concentrated in the Glenwood/Camas Prairie area in the western part of the watershed and on the southeastern plateau, where climatic conditions do not support commercial timber species outside of riparian areas. Approximately 8,600 acres within the subbasin are irrigated, primarily in the Glenwood/Camas Prairie area (Outlet Creek drainage), along the Little Klickitat River near Goldendale, and in the upper Swale Creek drainage.

Total human population within the subbasin is approximately 11,000. Urban development is limited to the city of Goldendale, which has the highest population (3,760), and the unincorporated towns of Klickitat, Lyle, and Glenwood. Rural residential use is found primarily along the main thoroughfares (SR 142 and US 97). In total, these areas constitute less than one-half of one percent of the total watershed area.

Table 2 Population of major Klickitat Subbasin Counties, 1980-2000

County	1990 Population	2000 Population	Area (sq. mi.)	People/sq. mi.
Klickitat	16,616	19,161	1,904	10.2
Yakima	188,823	222,581	4,296	51.8

(U.S. Census Bureau, 1990, 2000)

3.2.3 Hydrology

The mainstem Klickitat River arises from the Cascades below Cispus Pass at approximately 5,000 feet elevation and flows 95 miles to the Bonneville Pool (elevation 74 feet) on the Columbia River. Channel gradients along the mainstem vary from 0.4 to 0.8 percent between the mouth and the Klickitat Hatchery (RM 42.4), between 1 and 2 percent upstream of the hatchery to just beyond Diamond Fork (RM 78), and to 0.5 percent or less from Diamond Fork to just above McCormick Meadow (RM 85). Here, channel gradient abruptly increases to 8 percent or greater to the headwaters. Two notable gradient "discontinuities" on the mainstem are Lyle Falls (RM 2.2), which is a series of five falls ranging from 4 to 12 feet in height, and Castile Falls (RM 64.0 to 64.5), which is a series of 11 falls having a total elevation change of approximately 80 feet.

Major tributaries to the mainstem include Swale Creek (RM 17.2), Little Klickitat River (RM 19.8), Outlet Creek (RM 39.7), Big Muddy Creek (RM 53.8), West Fork Klickitat River (RM 63.1), and Diamond Fork (RM 76.8). Below Castile Falls (RM 64.0 to 64.5), most tributaries have short- to medium-length (less than 100 feet to several miles) low-gradient reaches along the valley floor. These low-gradient reaches are followed by a falls and/or a moderate- to high-gradient (greater than 4%) reach that continues until the tributary attains the plateau, where gradients typically decrease to less than 0.5%.

No flow regulation occurs within the watershed. All flows in the watershed occur within a natural flow regimen, with the exception of portions of Outlet Creek, Hellroaring Creek, Swale Creek, and the Little Klickitat River, where diversions for water supply and irrigation occur.

The combination of topography, soils, geology, precipitation, and land use in the subbasin affects local hydrologic conditions. The volcanic rocks on the Mt Adams side of the Klickitat River contain both permeable volcanic debris and lava tubes. The Columbia River Basalt that underlies most of the Klickitat River basin is highly permeable, and represents the largest source for groundwater supply within the subbasin (Watershed Professionals Network and Aspect Consulting, Inc. 2004). Cline (1976) estimates that about 60% of the average annual stream flow leaving the Yakama Reservation in the Klickitat River is groundwater discharge, with individual springs discharging up to 40 cfs. In many areas of the subbasin the volcanic bedrock is overlain by unconsolidated sedimentary deposits comprised of gravels, sands, and silts of glacial or fluvial origin (collectively referred to as alluvium). Where the surficial alluvium is extensive, such as in the Swale Creek valley south of Goldendale and in the Camas Prairie area surrounding Glenwood, it can provide a groundwater source for domestic supplies.

Due to the pattern of precipitation and snow accumulation in the subbasin, tributaries within the upper to mid-portion of the subbasin and the mainstem Klickitat River are likely to have a snowmelt-dominated hydrograph, with the highest flows occurring in the late spring months (Watershed Professionals Network and Aspect Consulting, Inc. 2004). Mt. Adam's persistent snowpack feeds high summer base flows and contributes runoff to the mainstem and some tributaries far into the drier portion of the year. In the mid-elevation ranges, streams are likely to have rain-on-snow dominated hydrographs, with the highest flows occurring in the winter months during relatively warm winter storms.

Areas in the Simcoe Range along the eastern watershed divide between four and six thousand feet in elevation receive between 30 and 50 inches of precipitation, and snow melt occurs earlier. In the lowest elevation areas streams are unlikely to be significantly influenced by rain-on-snow events, and are likely to have a rainfall driven hydrograph, with the highest flows occurring in response to high-intensity rainfall events (Watershed Professionals Network and Aspect Consulting, Inc. 2004). Consequently, 7-day low flows are on the order of a hundred times less in streams draining the southeastern Klickitat subbasin that for streams draining Mt. Adams. Due to the smaller water budget and earlier runoff, the east side tributaries are more dependent on meadow complexes for storing water and releasing flow from springs to sustain base flow.

In summary, the variations in the elevation ranges of the drainages found within the Klickitat subbasin result in variable expected runoff patterns. The gentle relief of a large portion of the lower area likely limits the potential energy available to move water through the system, resulting in relatively low stream velocities and erosion potential, and allowing for precipitation to percolate to aquifers (Watershed Professionals Network and Aspect Consulting, Inc. 2004). Conversely, areas of steeper relief, found primarily in the upper part of the subbasin, and within steep canyon areas, have greater erosion potential, and a greater propensity for moving water out of the system (Watershed Professionals Network and Aspect Consulting, Inc. 2004).

Mt. Adams has a distinct influence on both water quantity and water quality in the Klickitat River. The primary source of sediment is naturally generated silt from Rusk Glacier on the eastern flank of Mount Adams. The glacier is prone to occasional outburst floods that deliver torrents of water, volcanic debris, and fine sediment via snowmelt to Big Muddy and Little Muddy Creeks, and the West Fork Klickitat. This results in high mainstem suspended sediment during summer months that colors the Klickitat River from the West Fork to the Columbia River 63 miles downstream. Other sources of excess sediment, both natural and anthropogenic, are likely to be miniscule at the watershed scale compared to this source, though they may have adverse effects on fish and fish habitat at the local scale.

No systematic, watershed evaluation of sediment sources and impacts has been conducted in the watershed. Generally speaking, land-use related sediment sources in this watershed occur as a result of forest practices (e.g. harvesting, skidding, and road building across or adjacent to a stream), agricultural practices (e.g. rill irrigation, streamside grazing), or residential or commercial construction (land clearing and excavation in the vicinity of a stream). Problem areas identified include damaged meadows and riparian areas along the mainstem above Castile Falls and eroded/compacted streambanks and riparian areas along portions of the Little Klickitat River (above RM 12) and Swale Creek (RM 0 to RM 14).

Additional water quality problems have been noted in the subbasin. An instream flow study conducted in 1991 identified Swale Creek and the Little Klickitat River and many of its tributaries as having insufficient flows to support fish populations (anadromous and resident). Six reaches on the Little Klickitat (2), Blockhouse, Bloodgood, Bowman, and Mill creek were considered placed on the 1998 state "water quality impaired" 303 (d) list for instream flows (Brock and Stohr 2000). It is not known to what extent insufficient flows are land-use related.

The East Prong, West Prong, and mainstem Little Klickitat River; Swale Creek; and Butler Creek, a major tributary the Little Klickitat River, were listed on the 1998 303 (d) list for temperature. Eight reaches on these water bodies violated thermal water quality criteria. Temperatures exceeding state water quality criteria have been recorded in these streams primarily during low flow periods during the summer months; it is presumed that these exceedences are attributable, in part, to lack of stream shading due to degraded or non-existent riparian areas and low summer flows. Additionally, natural water temperatures in some water bodies may exceed state water quality criteria.

The state's 303 (d) listing process was altered in September 2002. The new listing process uses five unique assessment categories (Tables 3 and 4):

Table 3 2002 303 (d) list assessment categories and definitions

Assessment Category	Definition
Category 1	Waters that meet tested standards
Category 2	Waters of concern
Category 3	Waters with no data available
Category 4	Impaired waters but one of the following conditions exist: Category 4a. Water has a TMDL Category 4b. Water has a pollution control plan Category 4c. Water is impaired by a non-pollutant
Category 5	The 303 (d) list

Streams and proposed category listings for 2002/2004 are summarized below:

Table 4 Proposed 2002/2004 Assessment Category

Stream Name	2002/2004 Category	Parameter	Medium
Columbia River	5 4C 4A	Temperature Invasive exotic species Dioxin, total dissolved gas	Water Habitat Water
Blockhouse Creek	4C	Instream Flow	Habitat
Bloodgood Creek	4C	Instream Flow	Habitat
Bowman Creek	4C		
Butler Creek	4C 4A	Instream Flow, Fish Passage barrier Temperature	Habitat Water
Horsethief Lake	4C	Invasive exotic species	Habitat
Jenkins Creek	4C	Fish Passage barrier	Habitat

Stream Name	2002/2004 Category	Parameter	Medium
Klickitat River	4C	Fish habitat	Habitat
Lower Klickitat River, West Prong	4C	Fish passage barrier	Habitat
Little Klickitat River	4C 4A	Fish habitat, Instream Flow Temperature	Habitat Water
Little Klickitat River, East Prong	4C 4A	Fish Passage barrier Temperature	Habitat Water
Little Klickitat River, West Prong	4A	Temperature	Water
Mill Creek	4C	Fish passage barrier, Instream Flow	Habitat
Snyder Canyon Creek	4C	Fish passage barrier	Habitat
Swale Creek	5 4C	Temperature Instream Flow	Water Habitat
Unnamed Creek	4C	Fish passage barrier	Habitat

Riparian condition in the Klickitat watershed is influenced by geology and topography. Habitat is often characterized by relatively dense understory and overstory vegetation, with cottonwood, alder and willow commonly the dominant tree species. Riparian areas in the canyon reaches of the subbasin appear to be more or less intact; however, past and, in some areas, current timber harvest practices, poor road construction and crossings, off-season use of wet roads, and cattle access to riparian areas have all resulted in erosion and impacts to riparian corridors, especially in the upper forested portions of the watershed. On the plateau reaches where agricultural and urban land uses occur, the riparian forest has been almost entirely removed, or is in a condition such that in some area only minimal amounts of necessary ecological functions can be provided. The McCormick Meadow area of the upper Klickitat River in the tribally designated Primitive Area has been heavily grazed for approximately 60 years.

Creation of the Bonneville pool on the mainstem Columbia River effectively inundated the lower reaches of the subbasin and resulted in the loss of critical riparian habitat that linked riparian to rich upland areas that included mixed conifer and oak. Travel corridors between the Klickitat River and the Columbia River, and connectivity to essential habitats (e.g., breeding, feeding, seasonal ranges) between and along the Columbia River to other subbasins drainages was lost for a number of species (i.e., blacktail deer, western gray squirrels, neotropical birds).

Development of floodplains and wetlands is naturally limited over a large portion of the watershed. Deeply incised canyons with narrow valley floors that comprise most of the mainstem, as well as substantial portion of most fish bearing tributaries, severely constrained alluvial floodplain development over most of the watershed. On the plateau, unrestrained channels are able to develop natural meander patterns and create floodplains and wetlands. Climate (i.e. low rainfall) as well as topography is a constraint to wetland development in some portions of the watershed.

The inundation of wetlands from hydropower development has resulted in the loss of this habitat type. For example, recent review of pre-hydro aerial photographs from the Columbia River indicate a significant loss of wetland habitat considered important to healthy populations of the western pond turtle. These connected wetland habitats would have provided for more widely distributed populations of western pond turtle along the Columbia River than now exist.

The reduced number of beaver in the subbasin is believed to have resulted in the drying and loss of many wetland and riparian habitats. Other wetlands, such as in Glenwood Valley, have been drained for agricultural use. Loss of wetlands in tributary headwaters, possibly in conjunction with groundwater withdrawals by agricultural and domestic wells, has diminished storage capacity and recharge capability.

Though no data exist, some subbasin planners believe that local hydrology has been altered, generating a “flashier” hydrograph with higher peaks and lower base flows.

The deeply incised lower Klickitat River has remained relatively isolated from direct shoreline development over most of its length. A review of County Assessor’s data shows no residential dwelling development along the SR 142 corridor (on either side of the road, not just shorline) between miles 0 and 19 for the years 2000, 2001, 2002, and 2003 and first quarter of 2004. Only about 12 tax parcels along SR 142 had any development (including garages, sheds, pole barns, etc.) during those years.

However, floodplain roads, both abandoned and active, have led to channelization and constriction problems in some of these reaches. An abandoned paved floodplain road hugs the west bank of the Klicktiat River from RM 14 to 31. The abandoned log haul road experienced considerable damage from the 1996 flood. However, the road even now cuts off side channels and river meanders at many key locations. In the upper subbasin, an unpaved major haul road follows the upper Klickitat River from RM 66 to RM 78. Within this section, the road is directly in the floodplain for 40 percent of its length, cutting off side channels and river meanders.

3.2.4 Terrestrial / Wildlife Resources

A large variety of wildlife species are associated with the Klickitat subbasin because of its diverse vegetative and geologic features. Big game include black bear (*Ursus americanus*), black-tailed deer (*Odocoileus hemionus columbianus*), Rocky Mountain elk (*Cervus elaphus*), and cougar (*Felis concolor*). Mountain goats are associated with the Goat Rocks and are also seen using the breaks of the Klickitat canyon on the Yakama Nation Reservation. Bighorn sheep (*Ovis canadensis*) have been extirpated from the Klickitat subbasin. Small mammals also inhabit the various habitats (beaver, *Castor Canadensis*; western gray squirrel, *Sciurus griseus*). In recent years, wolverines (*Gulo gulo*) sightings have been reported in the upper portions of the subbasin, as have unconfirmed sightings of gray wolves (*Canis lupus*).

Passerine birds, raptors (peregrine falcon, *Falco peregrinus*; bald eagle, *Haliaeetus leucocephalus*; northern spotted owl, *Strix occidentalis caurina*), waterfowl (sandhill crane, *Grus canadensis*) and uplands birds are found in various habitats across the subbasin. A great number of bird species are associated with or require riparian habitats in the Klickitat River subbasin. As a subset of this guild, the neotropical migrants (e.g., willow flycatcher [*Empidonax traillii*], yellow warbler [*Dendroica petechia*], yellow-breasted chat [*Icteria virens*], red-eyed vireo [*Vireo olivaceus*], and Vaux’s swift [*Chaetura vauxi*]) continually exhibit declining population trends in this region. Other species that are marsh obligates include the Virginia rail, sora rail and marsh wren. Merriam’s turkeys were introduced to the subbasin by WDFW to provide hunting opportunities and are quite prevalent in the middle portions of the subbasin that contain open mixed conifer/ oak woodlands. Some bird species are year-round residents, while others are migratory.

Little is known of the distribution, abundance and life histories of amphibians in the Klickitat subbasin. Two populations of Oregon spotted frog (*Rana pretiosa*) currently exist in the state of Washington, one of which is at Conboy National Wildlife Refuge in the Klickitat drainage. WDFW is working on western pond turtle (*Clemmys marmorata*) recovery in habitat near the mouth of the Klickitat River.

3.2.5 Fish Resources

The Klickitat River subbasin supports two species of Pacific salmon, chinook (*Oncorhynchus mykiss*) and coho (*Oncorynhcus kisutchi*), as well as steelhead (*Oncorhynchus tshawytscha*). These three species of anadramous fish are composed of six stocks: three chinook (spring, early run fall [tule], late run fall [upriver bright]); two steelhead (summer, winter); and one coho stock.

Spring chinook and summer steelhead are known to have existed historically in the watershed; winter steelhead ("discovered" in the early 1980s) are presumed to have existed historically. Steelhead are part of the Mid-Columbia Evolutionarily Significant Unit (ESU), which has been listed as "threatened" under the Endangered Species Act.

Tule fall chinook and coho are not native to the Klickitat. They were introduced in the late 1940s and early 1950s, with the Washington Department of Fisheries Hatchery (1950), and construction of the fishway at Lyle Falls (1952). Upriver bright fall chinook were "discovered" in 1989, and are also considered an introduced stock.

All salmon stocks, except possibly winter steelhead, have been supplemented or even sustained by the Klickitat Hatchery. Completed in 1952, the hatchery is located on the Klickitat River at RM 42.4. The hatchery was constructed and is operated by Washington State Fish and Wildlife for hydropower mitigation under the Mitchell Act of 1936. The *U.S. v. Oregon* Columbia River Fish Management Plan (1998) governs fish production at this facility.

Hatchery production dominates natural production for chinook and coho. Four million eyed eggs of fall "upriver bright" (URB) chinook stock are delivered annually to the Klickitat Hatchery from Priest and Lyons Ferry hatcheries for final rearing and on-station release into the Klickitat River. The purpose of the URB release is to provide a terminal fishery for Tribal and other fishers. A total of 3.85 million coho smolts are also released into the Klickitat River. Approximately 1.35 million are reared at the Klickitat Hatchery for an on-station release. The remaining 2.5 million are released directly into the river at several locations downstream of the Klickitat Hatchery. Recent attempts have been made to develop and test coho acclimation sites in the lower basin. To date acclimation sites have been developed for 600,000 of the direct-released coho, which also provide for a late fall terminal fishery (CTWSR et al. 1988).

Hatchery releases have resulted in some hybridization of the native spring chinook stock. Escapements for these species have been managed to provide for hatchery requirements, with no allowance for natural production (Hymer, et al. 1992).

Pacific lamprey (*Entosphenus tridentatus*) is another anadromous species of interest in the Klickitat subbasin, although historic and present distribution and status are relatively unknown.

Fine sediment delivery from the Klickitat Glacier provides required rearing conditions during the ammocoete life stage of the species.

Resident fish in the Klickitat include rainbow, westslope cutthroat, brook and bull trout. Naturally reproducing populations of rainbow trout are found within the mainstem from the Columbia River confluence to RM 85, and in virtually all tributaries. Cutthroat was observed in limited numbers within McCreedy and Summit creeks during the1980s; however, none were observed during a late 1990s reinvestigation of known locations The historic and present distribution and status are relatively unknown. Brook trout were introduced into the Klickitat subbasin in the late 1970s and early 1980s, primarily in high mountain lakes. Currently, natural reproducing populations are found throughout the upper Klickitat mainstem and in major tributaries upstream of Big Muddy Creek (RM 53.8).

Bull trout are listed as threatened under the Endangered Species Act (ESA). The presence of both brook trout and bull trout in Fish Lake Stream and the West Fork below its confluence with Fish Lake Stream could potentially result in hybridization and competitive interactions and are of concern to fisheries managers in this area.

4 Assessment

Introduction

The subbasin assessment is a technical analysis to determine the biological potential of the subbasin and the opportunities for restoration. It describes the existing and historic resources, conditions and characteristics within the subbasin with the emphasis on designated focal fish and wildlife species and focal habitat types. The bulk of the assessment work was was done by the Yakama Nation with support and involvement of WDFW and Klickitat County. Separate teams of fish and wildlife scientists developed the assessment.

A focal species has special ecological, cultural, or legal status and is used to evaluate the health of the ecosystem and the effectiveness of management actions. Criteria used in selecting the focal species include a) designation as Federal or State endangered or threatened species, b) cultural significance, c) local significance and d) ecological significance, or ability to serve as indicators of environmental health for other species. Each of the focal species for the Klickitat subbasin is described below.

4.1 Wildlife Assessment

Introduction

Because of the large number of wildlife species and habitats present in the subbasin, biologists could not provide adequate descriptions and status reports for each. Instead, they chose to select focal habitats on which to focus assessment discussions. The focal habitats are montane coniferous wetlands, ponderosa pine/Oregon white oak forests and woodlands, interior grasslands, and interior riparian areas (see Table 5).

For each focal habitat, a small group of focal species was chosen. Nine wildlife species from the Klickitat subbasin have been chosen as focal species for this planning effort: Western gray squirrel (*sciurus griseus*), Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) / Columbian black-tailed deer (*Odocoileus hemionus columbianus*), grasshopper sparrow (*Ammodramus savannarum*), white headed woodpecker, beaver (*Castor canadensis*), yellow warbler (*Dendroica petechia*), greater sandhill crane (*Grus canadensis tabida*), Oregon spotted frog (*Rana pretioso*), and flammulated owl (*Otus flammeolus*), see Table 5. In this assessment, the rationale behind the selection of the focal habitats and species is discussed, followed by a more thorough discussion of each focal habitat with its representative species.

Table 5 Wildlife focal species and their distribution in the subbasin's focal habitats

Wildlife Focal Species	Focal Habitats
Greater Sandhill Crane	Montane Coniferous Wetlands
Oregon Spotted Frog	Montane Coniferous Wetlands
Western Gray Squirrel	Ponderosa Pine / Oregon White Oak
Flammulated Owl	Ponderosa Pine / Oregon White Oak
White-Headed Woodpecker	Ponderosa Pine / Oregon White Oak
Mule / Black-Tailed Deer	Shrub Steppe / Interior Grasslands

Wildlife Focal Species	Focal Habitats
Grasshopper Sparrow	Shrub Steppe / Interior Grasslands
Yellow Warbler	Interior Riparian Wetlands
American Beaver	Interior Riparian Wetlands

Assessment Methodology

This section briefly describes the framework used to develop subbasin wildlife assessment for the Klickitat subbasin plan. Appropriate federal, state, and local wildlife/land management entities have partnered with the Yakama Nation Wildlife Department to complete the subbasin plan. The Yakama Nation Wildlife Department is the lead wildlife agency in the Klickitat subbasin compiling wildlife assessment, inventory, and management information for the subbasin, in cooperation with the Washington Department of Fish and Wildlife (WDFW), Klickitat County and other interested parties.

The wildlife assessment was developed from a variety of “tools” including the Klickitat Subbasin Summary (NPPC 2001), the Interactive Biodiversity Information System (IBIS), the WDFW Priority Habitats and Species (PHS) database, the Washington Gap Analysis Program (GAP) Analysis database, Partners in Flight (PIF) information, National Wetland Inventory maps, and input from local, state, federal, and tribal wildlife managers. Specific information about these data sources is located in Appendix B. Overall information on many species and habitats in the Klickitat Subbasin is inadequate.

Although IBIS is a useful assessment tool, it should be noted that IBIS-generated historic habitat maps have a minimum polygon size of 1 km2 while current IBIS habitat type maps have a minimum polygon size of 100 ha or 250 acres (T. O’Neil, pers. comm.). In either case, linear aquatic, riparian, wetland, subalpine, and alpine habitats are under represented, as are small patchy habitats that occur at or near the canopy edge of forested habitats. It is also likely that microhabitats located in small patches or narrow corridors were not mapped at all. Another limitation of IBIS data is that they do not specifically rate habitat quality nor do they associate key ecological correlates (KEC) with specific areas. As a result, a given habitat type may be accurately depicted on IBIS maps, but may be lacking in functionality and quality. For example, IBIS data do not distinguish between shrub steppe habitat dominated by introduced weed species and pristine shrub steppe habitat.

Washington State GAP data was also used extensively throughout the wildlife assessment. The GAP generated acreage figures may differ from IBIS acreage figures as an artifact of using two different data sources. The differences, however, are relatively small (less than 5 percent) and will not impact planning and/or management decisions.

The WDFW has created the PHS list, which is a catalog of species and habitat types that were identified as priorities for management and preservation. For many of these species and habitat types, documents have been created that include, in the case of species, habitat need and use descriptions, basic life history information, population status and trends, and in the case of both species and habitats, provide factors limiting presence and make management recommendations. Available documents were used for species and habitat write-ups as well as for the creation of key findings, limiting factors and working hypotheses to be used in the creation of a management plan.

4.1.1 Wildlife Habitats and Species in the Klickitat Subbasin

Wildlife Habitats and Features

The Klickitat subbasin consists of 15 wildlife habitat types as identified by IBIS (2003). These are briefly described in table 6. Historic and current wildlife habitat distribution is illustrated in figures 2 and 3.

Table 6 Wildlife habitat types within the Klickitat subbsasin, Washington

Habitat Type	Brief Description
Mesic Lowlands Conifer-Hardwood Forest	One or more of the following are dominant: Douglas-fir, western hemlock, western redcedar (Thuja plicata), Sitka spruce (Picea sitchensis), red alder (Alnus rubra).
Montane Mixed Conifer Forest	Coniferous forest of mid-to upper montane sites with persistent snowpack; several species of conifer; understory typically shrub-dominated.
Interior Mixed Conifer Forest	Coniferous forests and woodlands; Douglas-fir commonly present, up to 8 other conifer species present; understory shrub and grass/forb layers typical; mid-montane.
Lodgepole Pine Forest and Woodlands	Lodgepole pine dominated woodlands and forests; understory various; mid- to high elevations.
Ponderosa Pine and Interior White Oak Forest and Woodland	Ponderosa pine dominated woodland or savannah, often with Douglas-fir; shrub, forb, or grass understory; lower elevation forest above steppe, shrub steppe.
Subalpine Parkland	Whitebark pine is found primarily in the eastern Cascade mountains Okanogan Highlands, and Blue Mountains.
Alpine Grasslands and Shrubland	Grassland, dwarf-shrubland, or forb dominated, occasionally with patches of dwarfed trees.
Interior Grasslands	Dominated by short to medium height native bunchgrass with forbs, cryptogam crust.
Shrub Steppe	Sagebrush and/or bitterbrush dominated; bunchgrass understory with forbs, cryptogam crust.
Agriculture, Pasture	Cropland, orchards, vineyards, nurseries, pastures, and grasslands modified by heavy grazing; associated structures.
Urban	High, medium, and low (10-29 percent impervious ground) density development.
Lakes, Rivers, Ponds, and Reservoirs	Natural and human-made open water habitats.
Herbaceous Wetlands	Emergent herbaceous wetlands with grasses, sedges, bulrushes, or forbs; aquatic beds with pondweeds, pond lily, other aquatic plant species; sea level to upper montane.
Montane Coniferous Wetlands	Forest or woodland dominated by evergreen conifers; deciduous trees may be co-dominant; understory dominated by shrubs, forbs, or graminoids; mid- to upper montane.
Interior Riparian Wetlands	Shrublands, woodlands and forest, less commonly grasslands; often multilayered canopy with shrubs, graminoids, forbs below.

IBIS 2003

Changes in Wildlife Habitat

Dramatic changaes in wildlife habitat have occurred throughout the subbasin since pre-European settlement (circa 1850). The most significant habitat changes are both the loss of ponderosa pine and Oregon white oak forests and woodlands and the loss of interior grasslands. (See Table 7 and Figure 4 and Figure 5).

Table 7 Changes in wildlife habitat types in the Klickitat subbasin from circa 1850 (historic) to 1999 (current)

	STATUS (acres)			
HABITAT TYPE	**Historic**	**Current**	**Change**	**Change (%)**
Mesic Lowlands Conifer-Hardwood Forest	1,977	24,595	22,618	92
Montane Mixed Conifer Forest	46,655	135,978	89,323	66
Interior Mixed Conifer Forest	128,226	284,609	156,383	55
Lodgepole Pine Forest and Woodlands	75,836	1,084	-74,752	-99
Ponderosa Pine & Oregon White Oak Forest and Woodlands	431,479	227,871	-203,608	-47
Subalpine Parkland	12,848	5,984	-6,864	-53
Alpine Grasslands and Shrublands	2,190	15,763	13,573	86
Eastside (Interior) Grasslands	163,592	9,863	-153,729	-94
Shrub Steppe	0	105,460	105,460	999
Agriculture, Pastures	unknown	34,269	N/A	N/A
Urban	unknown	1,056	1,056	N/A
Open Water - Lakes, Rivers, and Streams	303	978	675	70
Herbaceous Wetlands	unknown	75	N/A	N/A
Montane Coniferous Wetlands	unknown	15,167	N/A	N/A
Interior Riparian Wetlands	unknown	324	N/A	N/A

Note: Values of 999 indicate a positive change from historically 0 (habitat not believed to be present historically), N/A indicates change is unknown due to lack of historical data.

IBIS 2003

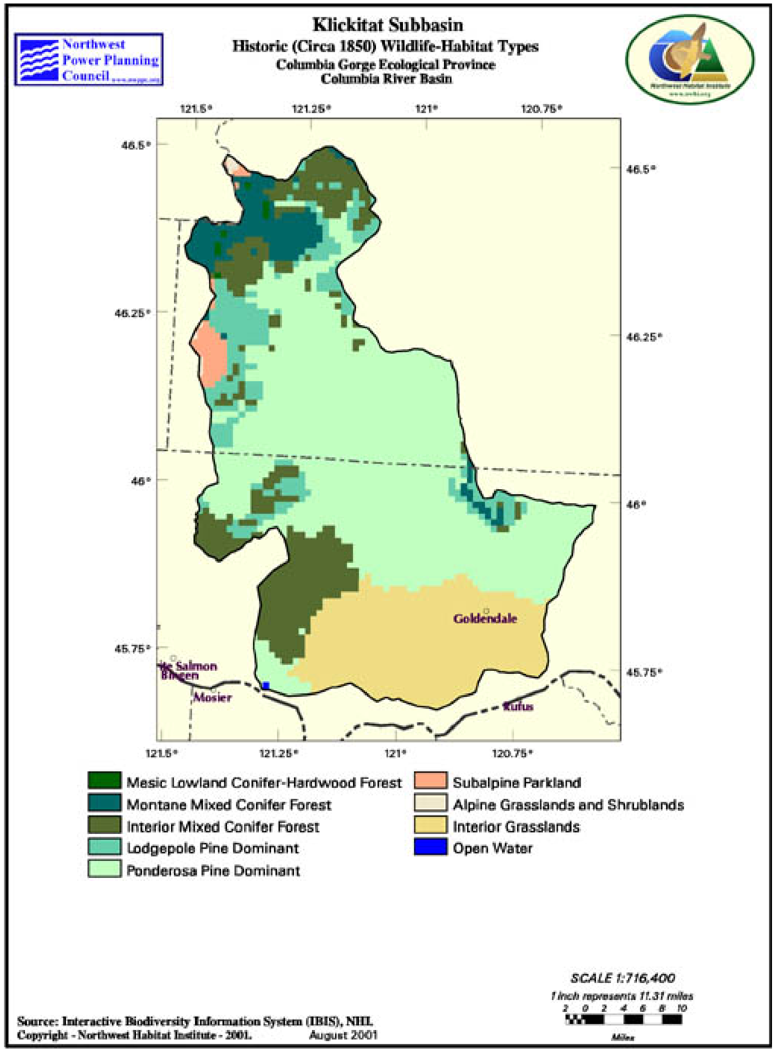

Figure 4 Historic wildlife habitat types of the Klickitat subbasin, Washington (IBIS 2003)

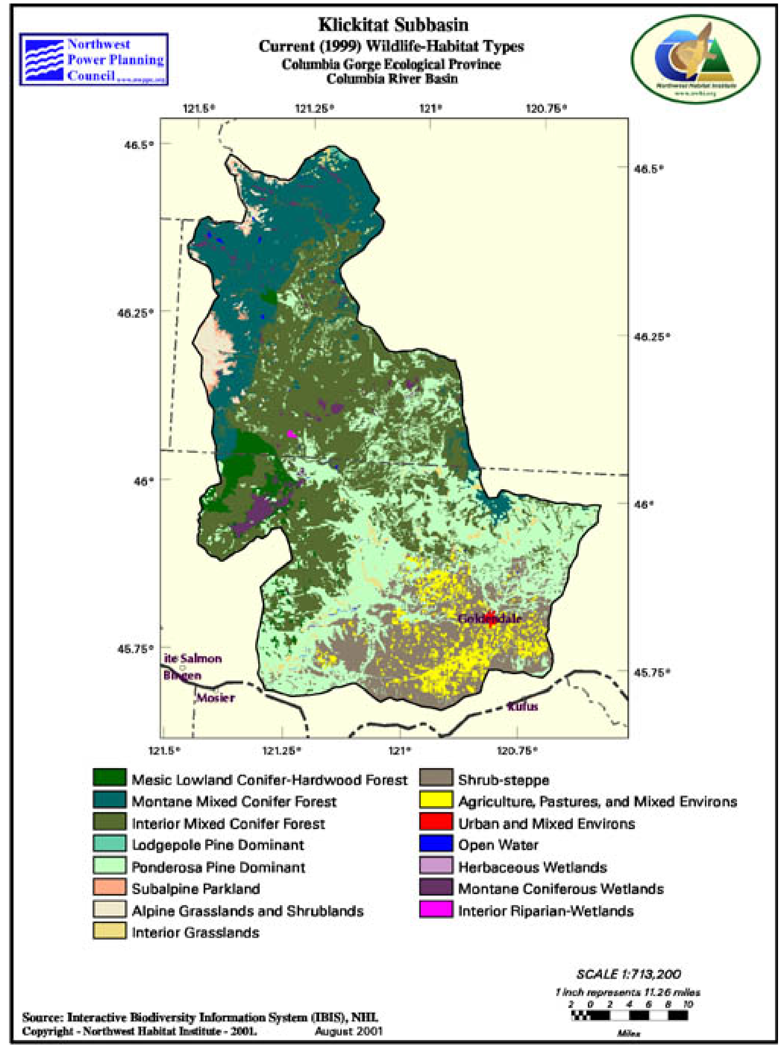

Figure 5 Current wildlife habitat types of the Klickitat subbasin, Washington(IBIS 2003)

Rare Plants and Plant Communities

Klickitat and Yakima counties, part of which are contained within the Klickitat subbasin, contains 76 rare plants and 46 rare or high-quality plant communities, identified by the Washington Natural Heritage Program (2003). Complete listings are in Appendix D, tables D.1.A and D.2.

Priority Habitat and Species (PHS)

The PHS List is a catalog of habitats and species considered to be priorities for conservation and management. Priority habitats are those habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type or dominant plant species, a described successional stage, or a specific structural element.

In the subbasin there are 17 habitats or habitat elements listed within the PHS list for southwest Washington (Region 5) (see Appendix D, table D.3). Internet access to the PHS list is available via the World Wide Web at: http://www.wa.gov/wdfw/hab/phslist.htm.

Plant Species of Importance to Native American Cultural

There are many species of native plants that have traditional and modern cultural importance to the Yakama Nation. When looking for focal habitats, habitats that supported culturally important, and often imperiled, plants were considered. For a short list of some of these plant species that have already been published in other literature, refer to Appendix D, table D.5.

Noxious Weeds

To help protect the state's resources, the Washington State Noxious Weed Control Board has in the past adopted a State Noxious Weed List each year (WS NWCB 2004). The list categorizes weeds into three major classes – A, B & C - according to the seriousness of the threat they pose to the state or a region of the state. Klickitat subbasin has 29 classified weed species. Two are in Class A, 23 are in Class B, and four are in Class C.

Noxious weeds have one of the most degrading impacts on the native wetland and terrestrial habitats. They often out-compete native plant species and provide a decreased value of wildlife habitat. They can also decrease the recreational and economic value of land. The focal habitats chosen all have noxious weeds that have already degraded or currently threaten what remains of these habitats. See Appendix D, table D.4.A and D.4.B for a complete list of weeds and Class definitions.

Wildlife in the Klickitat Subbasin

Using IBIS (2003), 365 wildlife species have been identified to currently occur within the Klickitat subbasin. For a full list of species and breeding status in the subbasin, see Appendix C, table C.1.

Species richness for the Klickitat subbasin is given in table 8. Differences in species richness between subbasins can partially be explained as variation in biological potential and quality of habitats, amount / type and juxtaposition of remaining habitats, and robustness of databases used to establish the species lists.

Table 8 Species richness of the Klickitat subbasin, Washington

Class	Number
Amphibians	23
Birds	232
Mammals	88
Reptiles	22
Total	365

IBIS 2003

Many of the wildlife species found in the subbasin can be listed in several different categories. These categories include: federal and state listed species, game species, Washington State Partners In Flight species, species used in the Habitat Evaluation Procedure (HEP), and species that have documented relationships with salmon. These groups were compiled by IBIS (2003) and are discussed next. These categories were some of the criteria used in choosing focal species later.

Federal and State Listed Species

Of the 365 wildlife species listed above, 61 are either federally (threatened, candidate or concern) or state (endangered, threatened, sensitive or candidate) listed. See Appendix C, table C.2.A for a full list, and table C.2.B for definitions of listings.

Game Species

Of the 365 wildlife species identified in the subbasin, 69 species are listed in IBIS (2003) as being game animals. Of these, 1 is an amphibian, 45 are birds and 23 are mammals. For a detailed list of game species in the subbasin, see Appendix C, table C.3.

Washington State Partners in Flight

The goal of Partners in Flight (PIF) is to focus resources on the improvement of monitoring and inventory, research, management, and education programs involving birds and their habitats. The PIF strategy is to stimulate cooperative public and private sector efforts in North America and the Neotropics to meet these goals. Of the 365 wildlife species in the subbasin, there are 232 bird species. Of these, 99 are listed in Partners in Flight for the state. See Appendix C, table C.4 for a full list of species.

Habitat Evaluation Procedure

The wildlife species listed under the Habitat Evaluation Procedure (HEP) are used to assess habitat losses associated with federal hydroelectric facilities on the Lower Snake and Columbia Rivers. Of the 365 wildlife species in the subbasin, 24 are used under HEP, 18 birds and 6 mammals (IBIS 2003). See Appendix C, table C.5 for a full list.

Salmonid Associations

Anadramous salmon provide a rich, seasonal food resource that directly affects the ecology of both aquatic and terrestrial consumers, and indirectly affects the entire food web that knits the water and land together. Wildlife species and salmon have likely had a very long, and co-evolutionary relationship with salmon in the Pacific Northwest. Of the 365 species in the subbasin, 76 are classified as having a routine relationship with salmon (combination of species with Strong and Consistent, Recurrent, Indirect and Rare relationships, see Appendix C, table C.6.B for definitions). See Appendix C, table C.6.A for entire list (IBIS 2003).

Priority Habitat and Species (PHS)

Under the PHS list, priority species may warrant management for their perpetuation at target population levels due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance. Priority species include State Endangered, Threatened, Sensitive, and Candidate species; animal aggregations considered vulnerable; and those species of recreational, commercial, or tribal importance that are vulnerable. In the subbasin there are 74 wildlife species listed on the PHS list for Washington State.

4.1.2 Rationale for Focal Terrestrial Habitat Selection

Subbasin wildlife planners emphasize an ecosystem approach to management 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 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 (see table 7). According to Haufler, 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 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 (see figure 4 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 (table 7)
- 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 including cultural, economical, ecological and special factors

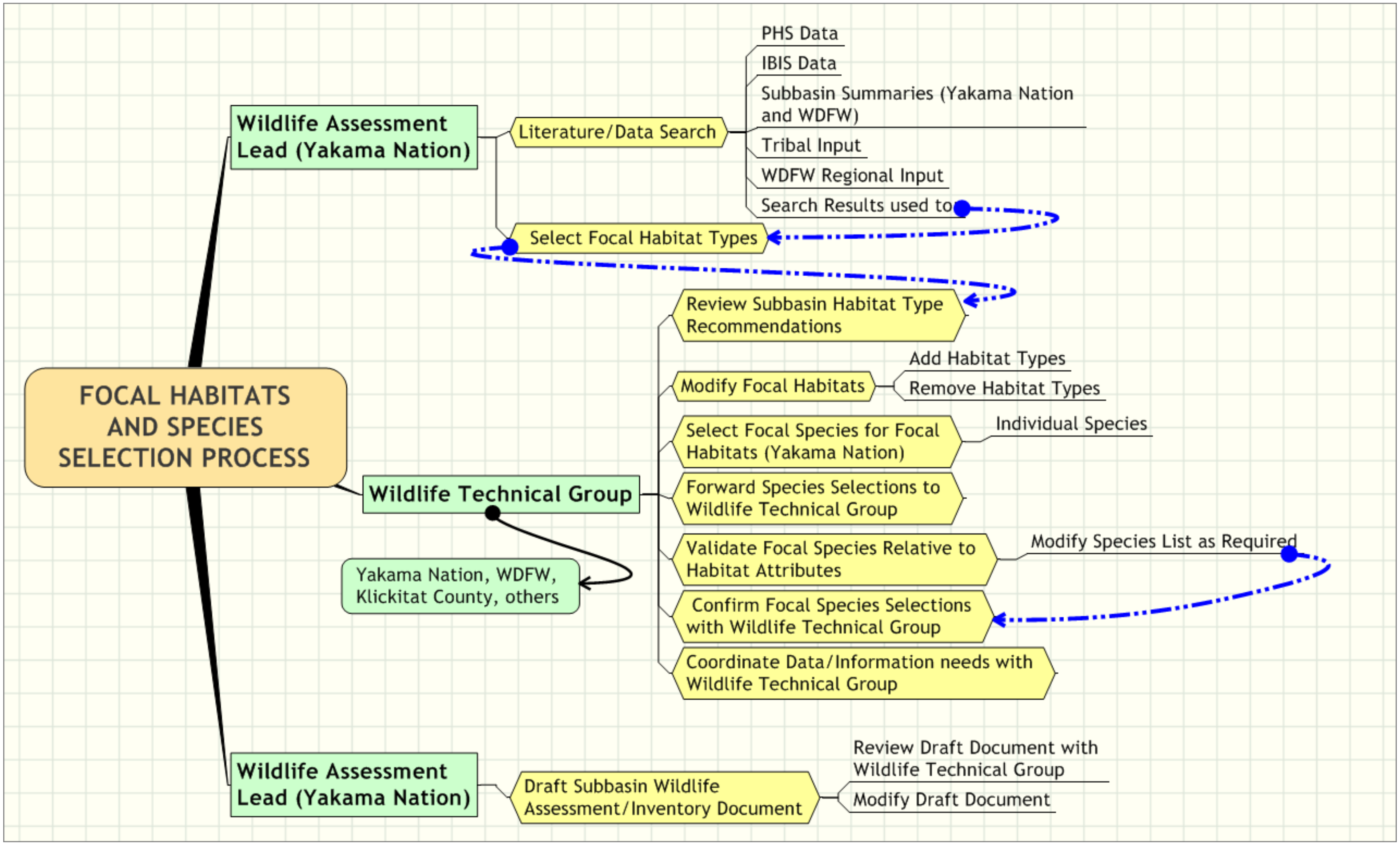

Figure 6 Focal habitat and species selection process summary

(prepared by Paul Ashley, 2004)

Focal Terrestrial Habitats Selected

Subbasin planners selected four focal wildlife habitat types of the 15 identified by Interactive Biodiversity Information System (IBIS) in table 7 for the subbasin (see figure 9 for coverage of three of these focal habitats). Subbasin focal habitats include: Interior Riparian Wetlands, Shrub Steppe / Interior Grasslands, Ponderosa Pine / Oregon White Oak and Montane Coniferous Wetlands. For a summary of some of the criteria considered during selection, see table 9.

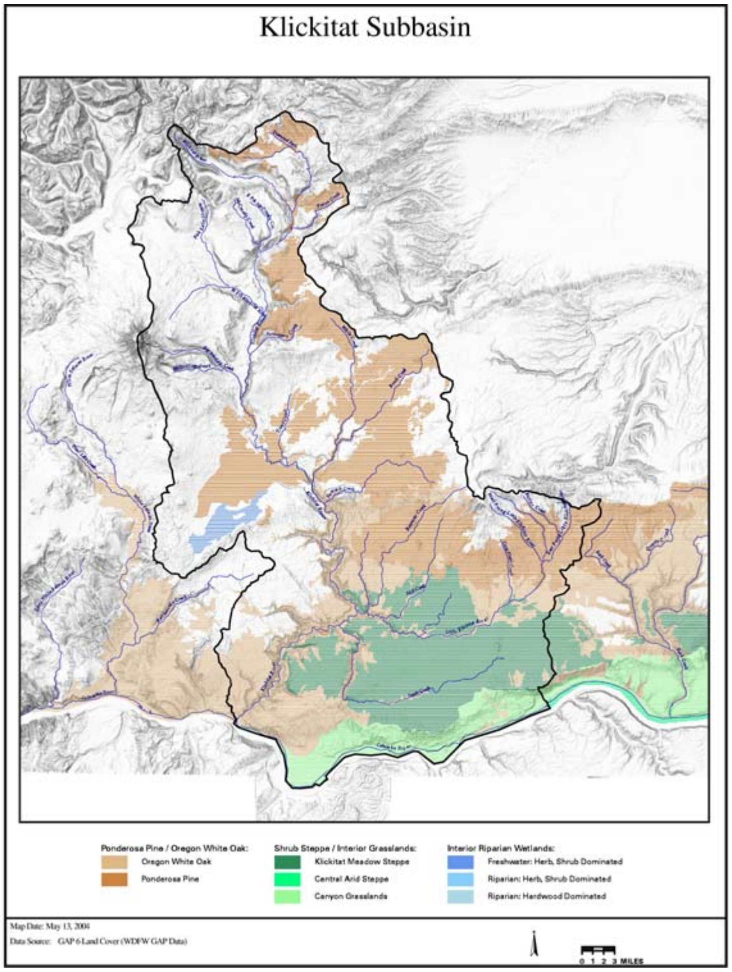

Figure 7 Range of three focal habitat (Ponderosa Pine / Oregon White Oak, Shrub Steppe / Interior Grasslands and Interior Riparian Wetlands) in the Klickitat subbasin (Cassidy 1997).

Table 9 Focal habitat selection matrix for the Klickitat subbasin, Washington

Habitat Type	Criteria						
	PHS Data	ECA Data	IBIS Data	Considerable loss in quantity	Considerable loss in quality	Listed in subbasin summary	Historically present in macro quantities1
Interior Riparian Wetlands	Yes	Yes	Yes	Likely, not mapped well	Yes	Yes	No
Shrub Steppe / Interior Grasslands	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ponderosa Pine / Oak White Oak	Yes	No	Yes	Yes	Yes	Yes	No
Montane Coniferous Wetlands	No	No	Yes	Likely, not mapped well	Yes	No	No
Agriculture2	No	No	Yes	-	-	Yes	No

1 Habitat types historically comprising more than 5 percent of the subbasin land base. This does not diminish the importance of various microhabitats.

2 Agriculture is not a focal habitat; it is a habitat of concern. Focal species were not selected to represent this habitat type.

Changes in Focal Wildlife Habitat Quantity and Distribution

Changes in focal habitat quantity at the subbasin level are depicted in table 10. Forest succession, logging, and development account for the 47 percent change (loss) in ponderosa pine / Oregon white oak habitat (IBIS 2003). Similarly, agricultural conversion accounts for most of the 94 percent decline in Interior Grasslands habitat (IBIS 2003). The IBIS data shows that little is known historically about montane coniferous wetlands. The changes in this habitat have gone largely unrecorded. Historical presence of Interior Riparian Wetlands has also been largely undocumented by IBIS. This habitat type has likely undergone a decrease in acreage, but without better data, the amount is unknown.

Table 10 Changes in focal wildlife habitat types in the Klickitat subbasin from circa 1850 (historic) to 1999 (current)

	STATUS (acres)			
FOCAL HABITAT TYPE	Historic	Current	Change	Change (%)
Interior Riparian Wetlands	unknown	324	N/A	N/A
Interior Grasslands	163,592	9,863	-153,729	-94
Shrub steppe	2,162,965	1,518,558	644,407	30

	STATUS (acres)			
FOCAL HABITAT TYPE	Historic	Current	Change	Change (%)
Ponderosa Pine & Oregon White Oak	431,479	227,871	-203,608	-47
Montane Coniferous Wetlands	unknown	15,167	N/A	N/A
Agriculture (Habitat of Concern)	0	34,269	34,269	999

Note: Values of 999 indicate a positive change from historically 0 (habitat not believed to be present historically), N/A indicates change is unknown due to lack of historical data.

(IBIS 2003)

The IBIS and GAP riparian habitat data are incomplete. Therefore, riparian floodplain habitats are not well represented on IBIS maps (accurate habitat type maps, especially those detailing riparian wetland habitats, are needed to improve assessment quality and support management strategies/actions). Subbasin wildlife managers, however, believe that physical and functional losses have occurred to these important riparian habitats from hydroelectric facility construction and inundation, agricultural development, historical forest practices, and inappropriate livestock grazing.

Rationale for Focal Wildlife Species Selection

The term focal species was defined by Lambeck (1997) as a suite of species whose requirements for persistence define the habitat attributes that must be present if a landscape is to meet the requirements for all species that occur there. The key characteristic of a focal species is that its status and trend provide insights to the integrity of the larger ecological system to which it belongs (USDA Forest Service 2000).

Subbasin planners refer to these species as “focal species” because they are the focus for describing desired habitat conditions, attributes and needed management strategies and/or actions. The rationale for using focal species is to draw immediate attention to habitat features and conditions most in need of conservation or most important in a functioning ecosystem. The corollary is those factors, which affect habitat quality and integrity within the subbasin, also impact the species, hence, the decision to focus on habitat with focal species in a supporting role.

Subbasin planners consider focal species’ life requirements representative of wildlife habitat conditions or features that are important within a properly functioning focal habitat type.

Subbasin planners selected focal species using a combination of several factors including:

- primary association with riparian or wildlife habitats for breeding
- specialist species that are obligate or highly associated with key habitat elements / conditions important in functioning ecosystems
- declining population trends or reduction in their historic breeding range (may include extirpated species)
- cultural significance of the species, from a tribal and non-tribal perspective
- special management concern or conservation status such as threatened, endangered, species of concern, management indicator species, etc.

- professional knowledge on species of local interest

Subbasin planners identified a focal species assemblage and combined life requisite habitat attributes for each species assemblage to form a recommended "range of management conditions." Fisheries and wildlife habitat managers will use the recommended range of riparian and wildlife habitat conditions to identify and prioritize future habitat restoration and protection strategies and to develop specific habitat management actions/measures for focal habitats.

Focal species can also serve as performance measures to evaluate ecological sustainability and processes, species / ecosystem diversity, and results of management actions (USDA Forest Service 2000). Monitoring of habitat attributes and focal species will provide a means of tracking progress towards conservation. Monitoring will provide essential feedback for demonstrating adequacy of conservation efforts on the ground, and guide the adaptive management component that is inherent in this approach.

Focal Wildlife Species Selected

A total of five bird species, three mammalian species and one amphibian species were chosen as focal or indicator species to represent four focal habitats in the Klickitat subbasin (table 11), also see Appendix C, table C.7 for an entire list of species associated with the focal habitats. Focal species selection rationale and important habitat attributes for each species are described in further detail in table 12.

Table 11 Focal species selection matrix for the Klickitat subbasin, Washington.

Focal Species (Common Name)	Focal Habitat	Priority Habitat Species	Partners in Flight	Game Species	Status1	
					Federal	State
Yellow Warbler	Interior Riparian Wetland	No	No	No	-	-
American Beaver		No	No	Yes	-	-
Mule / Black Tailed Deer	Shrub Steppe / Interior Grasslands	Yes	No	Yes	-	-
Grasshopper Sparrow		No	Yes	No	-	-
Western Gray Squirrel	Ponderosa Pine / Oregon White Oak	Yes	No	No	-	ST
Flammulated Owl		Yes	Yes	No	-	-
White-headed Woodpecker		Yes	Yes	No	-	-
Greater Sandhill Crane	Montane Coniferous Wetlands	Yes	No	No	-	SE
Oregon Spotted Frog		Yes	No	No	FC	SE

1FC = Federal Candidate; ST = State Threatened; SE = State Endangered

Table 12 Focal species selection rationale and habitat attributes for the Klickitat subbasin, Washington

Focal Species	Focal Habitat	Life / Habitat Requisite	Conservation Focus	Habitat Attribute (Vegetative Structure)	Comments	Habitat Criteria for Selection
Yellow Warbler	Interior Riparian Wetlands	Reproduction	Subcanopy foliage, riparian habitat	> 70% cover in shrub and subcanopy w/ subcanopy > 40% of that, > 70% cover native species	Highly vulnerable to cowbird parasitism; grazing reduces understory structure	Riparian obligate, reproduces in riparian shrub habitat and makes extensive use of adjacent wetlands
American Beaver		Food	Canopy closure	40-60% tree/shrub canopy closure trees, < 6" dbh; shrub height 6.6 ft.	Wetland and riparian shrub/forest habitat	Indicator of healthy regenerating cottonwood stands; important habitat manipulator
		Water (cover for food and reproductive requirements)	Permanent water	Stream channel gradient 6% with little to no fluctuation	Keystone species creating pools and standing water used by many species	
		Food	Shoreline development	Woody vegetation 328 ft. from water	Important tool in watershed and wetland restoration	
Mule / Black-tailed deer	Shrub Steppe / Interior Grasslands	Winter forage	Ceanothus, Big sagebrush, antelope bitterbrush	30-60% canopy cover of preferred shrubs < 5 ft., number of preferred shrub species > 3, mean height of shrubs > 3 ft., 30-70% canopy cover of all shrubs < 5 ft.	Deer are important food source for predators and scavengers, agric. important suppl. food source	South facing slopes important in winter
Grasshopper Sparrow		Breeding	Vegetative complexity, large unbroken patches	Bunchgrass cover > 15% and > 25 cm tall, > 60% total grass cover and shrub cover < 10%	Vegetation type not as important as percent cover, require some bare ground	Indicator of complex grassland structure, CRP lands important
Western Gray Squirrel	Ponderosa Pine / Oak Woodlands	All life stages, non migratory	Oak and ponderosa pine forests	Acorns and other mast producing plants, important in winter, pine cones and seeds in summer	The core population of the western gray squirrel is currently found in the lower Klickitat drainage	Obligate for oak pine woodlands habitat. Mixed stands of oak and ponderosa pine preferred for nesting
Flammulated Owl		Breeding	Large dead ponderosa pines	Late seral forests needed, snags should be >20" dbh, > 16' high. 10-80% brush cover, core areas should contain 2-10 acres optimal habitat	Obligate secondary cavity nesters. Eat insects from bark of trees	Mature ponderosa pine forest obligate

Focal Species	Focal Habitat	Life / Habitat Requisite	Conservation Focus	Habitat Attribute (Vegetative Structure)	Comments	Habitat Criteria for Selection
White-Headed Woodpecker		All life stages, non migratory	Large patches of late seral forest with large trees and snags	> 10 trees/ac, > 21" dbh w/ > 2 trees > 31" dbh, 10-40% canopy closure, > 1.4 snags/ac > 8" dbh w/ > 50% > 25", 250-500 acres suitable, unfragmented habitat	Weak primary excavator, needs well decayed snags for nesting. Needs open stand, canopy closure 30-50%	Obligate for large patches of healthy late seral ponderosa pine forest
Greater Sandhill Crane	Montane Coniferous Wetlands	Breeding and migration	Large montane wetlands with limited human disturbance	Needs security from disturbance, trees and shrub presence good, but not when encroaching, water depth approx. 10", vegetation approximately 15" height	Currently only known to breed in Klickitat and Yakima counties, potential for others	Dependent on large montane wetlands for critical life stages
Oregon Spotted Frog		Breeding	Intact and functional montane wetland	Needs shallow water, 2-12" deep, needs clear, oxygenated water and emergent vegetation, needs warm summer water temps (>68º F)	In Washington state, Bullfrog threatens remaining populations	Dependent on montane wetlands for critical life stages

Discussion of Focal Habitats and their Representative Focal Species

4.2 Interior Riparian Wetlands

Description of Habitat

Rationale For Selection

The Interior Riparian Wetlands wildlife habitat type was selected as a focal habitat because its protection, compared to other habitat types, may yield the greatest gains for fish and wildlife while involving the least amount of area (Knutson and Naef 1997). Riparian habitat covers a relatively small area yet it supports a higher diversity and abundance of fish and wildlife than any other habitat; it provides important fish and wildlife breeding habitat, seasonal ranges, and movement corridors; it is highly vulnerable to alteration; it has important social values, including water purification, flood control, recreation, and aesthetics; and, many species that primarily dwell in other habitat types, such as shrub steppe, depend on riparian areas during key portions of their life history. Interior Riparian Wetlands have suffered degradation and losses to hydrological function as well as fragmentation of habitat, which also fragments movement corridors for wildlife.

Historic

Since the arrival of settlers in the early 1800s, 50 to 90% of riparian wetland habitat in Washington State has been lost or extensively modified (Buss 1965). Prior to 1850, riparian habitats were found at all elevations and on all stream gradients; they were the lifeblood for most wildlife species with up to 80 percent of all wildlife species dependent upon these areas at some time in their lifecycle (Thomas 1979).

These habitats are strongly influenced by stream dynamics and hydrology. Riparian forests require various flooding regimes and specific substrate conditions for reestablishment. Annual flood cycles occurred in most riparian wetland areas, although flood regimes varied among stream types. Hyporheic hydrology supported riparian wetland conditions considerable distances from perennial creek and river channels. Upwelling and downwelling groundwater dynamics created thermal conditions in wetland and spring brook areas conducive to wildlife use throughout the seasons. Fire typically influenced habitat structure in most areas, but was nearly absent in colder regions or on topographically protected streams. River meander patterns, ice and log jams, sediment dynamics and flood debris deposits provided spatial and temporal changes in habitat condition. Abundant beaver activity cropped younger cottonwoods (Black cottonwood, *Populus balsamifera ssp. trichocarpa*) and willows (*Salix* spp.), damming side channels. This activity influenced the vegetative, sediment, hyporheic and surface water dynamics creating diverse and complex habitat interactions.

In the Klickitat Subbasin, the density and diversity of wildlife in riparian wetland areas is also high relative to other habitat types. Riparian forest habitats are critical to the structure and function of rivers and to the fish and wildlife populations dependent upon them (Rood and Mahoney 1990). Healthy forested riparian wetland habitat has an abundance of snags and downed logs that are critical to many cavity nesting birds, mammals, reptiles and amphibians. Cottonwood, alder (*Alnus* spp.) and willow are commonly dominant tree species in riparian wetland areas from the Cascades down through the valley portion of the sub basin. This habitat is often characterized by relatively dense understory and overstory vegetation. Riparian wetland habitats also function as travel corridors between, and provide connectivity to, other essential habitats (e.g., breeding, feeding, seasonal ranges).

Though riparian wetland habitats are often forested, they also contain important sub-components such as marshes and ponds that provide critical habitat for a number of wildlife species. Broad floodplain mosaics consisting of cottonwood gallery forests, shrub lands, marshes, side channels, and upland grass areas contain diverse wildlife assemblages. The importance of riparian wetland habitats is increased when adjacent habitats are of sufficient quality and quantity to provide cover for nesting, roosting, and foraging.

Riparian vegetation was restricted in the arid Intermountain West, but was nonetheless diverse. It was characterized by a mosaic of plant communities occurring at irregular intervals along streams and dominated singularly or in some combination by marshes, side channels, grass-forb associations, shrub thickets, and mature forests with tall deciduous trees. Common shrubs and trees in riparian zones included several species of willows, red-osier dogwood (*Cornus stolonifera*), alder, Wood's rose (*Rosa woodsii*), snowberry (*Symphoricarpos* spp.), currant (*Ribes* spp.), black cottonwood, water birch (*Betula occidentalis*), trembling aspen (*Populus tremuloides*), and peach-leaf willow (*Salix amygdaloides*). Herbaceous understories were very diverse, but typically included several species of sedges (*Carex* spp.) along with many dicot species. Marsh habitats contained tule (*Scirpus* spp.), common cattail (*Typha latifolia*), narrow-leaved bur-reed (Sparganium angustifolium), wapato (*Sagittaria latifolia*), water-plantain (*Alisma plantago-aquatica*), many species of submersed macrophytes including sago pondweed (*Potamogeton pectinatus*), common hornwort (*Ceratophyllum demersum*), and greater bladderwort (*Utricularia vulgaris*), yellow waterlily (*Nuphar polysepalum*), and common watercress (*Nasturtium officinale*). Lower elevation wet meadows contained much of the vegetation found in their montane counterparts; including sedges, smartweeds (*Polygonum* spp.), spike rushes (*Scirpus* sp.), common camas (*Camassia quamash*), and wild onion (*Allium* spp.). Floodplain grasslands were dominated by great basin wild rye (*Leymus cinereus*), greasewood (*Sarcobatus vermiculatus*), and dogbane (*Apocnum* spp.).

Riparian areas have been extensively impacted within the Columbia Basin such that undisturbed riparian systems are rare (Knutson and Naef 1997). Losses in lower elevations include large areas once dominated by cottonwoods that contributed considerable structure to riparian habitats. In higher elevations, stream degradation occurred with the trapping of beaver in the early 1800s, which began the gradual unraveling of stream function that was greatly accelerated with the introduction of livestock grazing. Woody vegetation has been extensively suppressed by grazing in some areas, many of which continue to be grazed. The implications of riparian area degradation and alteration are wide ranging for bird populations, which utilize these habitats for nesting, foraging and resting. Secondary effects that have affected insect fauna have reduced or altered potential foods for birds as well.

Historic wetland acreage in our subbasin is difficult to measure. The IBIS riparian habitat data are incomplete; therefore riparian floodplain habitats are not well represented on IBIS maps. Evidence of historic riparian wetland location and extent in the subbasin can be found by examining hydric soil acreages, which could not be obtained in the timeframe of this planning process. Landscape information such as that contained in floodplain maps can also be consulted, which also could not be obtain in the timeframe.

Current

Quigley and Arbelbide (1997) concluded that the cottonwood-willow cover type covers significantly less in area now than before 1900 in the Inland Pacific Northwest. The authors concluded that although riparian shrub land occupied only 2 percent of the landscape, they estimated it to have declined to 0.5 percent of the landscape. Approximately 40 percent of riparian shrublands occurred above 3,280 ft. in elevation pre-1900; now nearly 80 percent is found above that elevation.

Riparian and wetland conditions in the subbasin range from severely degraded to high quality. Roadway and development have constricted floodplains in some areas of the subbasin and reduced riparian wetland habitats. Riparian habitats are degraded in some places because of historical timber practices, and inappropriate livestock grazing.

Within the past 100 years, a large amount of the subbasin riparian wetland habitat has been altered, degraded, or destroyed. As in other areas of the Columbia Basin, impacts have been greatest at low elevations and in valleys where agricultural conversion, levee and road development, altered stream channel morphology, and water withdrawal have played significant roles in changing the character of streams and associated riparian areas.

Stresses

Natural systems evolve and become adapted to a particular rate of natural disturbances over long periods. Land uses alter stream channel processes and disturbance regimes that affect aquatic and riparian habitat (Montgomery and Buffington 1993). Anthropogenic-induced disturbances are often of greater magnitude and/or frequency compared to natural disturbances. These higher rates may reduce the ability of riparian and stream systems and the fish and wildlife populations to sustain themselves at the same productive level as in areas with natural rates of disturbance.

Other characteristics also make riparian wetland habitats vulnerable to degradation by human-induced disturbances. Their small size, topographic location, and linear shape make them prone to disturbances when adjacent uplands are altered. The unique microclimate of riparian and associated aquatic areas supports some vegetation, fish, and wildlife that have relatively narrow environmental tolerances. This microclimate is easily affected by vegetation removal within or adjacent to the riparian area, thereby changing the habitat suitability for sensitive species (Thomas et al. 1979, O'Connell et al. 1993).

Factors affecting riparian wetlands in the subbasin are summarized in the paragraphs below, as well as in table 13 at end of chapter. Riparian wetland habitat conditions throughout the subbasin have been influenced by one or all of these factors in different ways depending on their location. Restoration plans for these habitats must take in to consideration the location of the habitats, the historic conditions under which they operated, the alterations that have occurred to impact their function, and the possibilities that currently exist to adequately address the stresses in a cost-effective manner.

Alteration of the Hydrograph

The hydrograph is altered in the Little Klickitat drainage where water diversions affect summer flows. Agricultural drains have altered the hyporheic flows in some areas of the subbasin.

Exclusion of the River from its Floodplain

Transportation ways (road and railroad) and levee development has restricted the floodplain in some areas. Land conversion from riparian wetland habitat to agricultural, residential, or recreational uses has also occurred behind the levees and roads. Riparian wetland restoration must take in to consideration the effects of restoration on lands that have been converted away from flooded habitats. Restoration priority should be given to protecting those areas that have not experienced floodplain exclusion and to areas within which floodplain reconnection is economically and culturally possible.

Alteration of Sediment Dynamics

Riparian wetland habitats are spatially and temporally dynamic. Floodplain processes creating and altering these habitats are largely dependent on cut and fill alluviation. The activities creating the altered hydrograph, the floodplain restrictions, the agricultural drainage of sediment-laden water into the waterways, the loss of green vegetation, and the reduction in woody debris have disrupted the sediment processes necessary for healthy riparian wetland conditions. Certain watersheds are experiencing increased sedimentation. Management actions often can correct alterations in sediment dynamics in localized areas. Priority should be given to projects that include the restoration of sediment processes.

Loss or Alteration of Riparian Wetland Vegetation

Vegetation loss and alteration is caused by multiple factors. All of the impacts listed above result in loss and alteration of riparian wetland vegetation communities. In areas unaffected or receiving little alteration by the factors listed above, vegetation alteration can also occur through heavy grazing or clearing. In areas that have experienced little hydrologic and landscape alteration, vegetation restoration may be as simple as reducing the grazing or vegetation removal practices. In situations where the hydrology or landscape has been altered in a significant manner, these impacts must be addressed if vegetation restoration is to be successful. Many riparian wetland vegetation reintroduction projects fail because the hydrologic impacts have not adequately been addressed. Priority should be given to projects that adequately address the reasons for vegetation loss or alteration.

Reduction in Large Woody Debris

Healthy riparian wetland habitats create large amounts of dead woody materials. Cottonwood gallery forests are famous for their ability to provide standing and downed snags. The processes mentioned above interact with this dead woody material to supply nesting and feeding opportunities for many fish and wildlife species. This material is responsible, as well, for influencing the floodplain dynamics, especially cut and fill alluviation, necessary for riparian wetland and cottonwood forest health. As cottonwood stands age, the large dead material produced will collect sediment, block side channels, and force the establishment of new channels. The new channels will create exposed gravel and sediment conditions upon which new cottonwood trees will become established. The result is a diverse mosaic of cottonwood stands of different ages within a floodplain area. Restoration of large woody debris, then, is dependent on the restoration of healthy cottonwood stands. This activity requires floodplain areas large enough to provide space for cottonwood stands of various ages. Restoration areas too small may experience declines in the health of the cottonwood forests as they age and are not replaced with new stands. Restoration priority should be given to projects large enough to provide sufficient floodplain conditions conducive to the continued development of healthy cottonwood forests.

Reduction of Beaver Activity

Beaver were central to the maintenance of healthy riparian wetland habitats. Their abundant activity created flooded conditions throughout the subbasin. A testimony to their abundance is reflected in the fact that the Pacific Northwest was revered for its fur trade. Extensive trapping is routinely listed as a major factor in their decline. Healthy beaver populations, however, are returning to many restoration areas in the lower portions of the subbasin. Beaver damage complaints often will increase in areas adjacent to restoration projects. Restoration managers must be prepared to address these affects if projects are to succeed in the long term. Priority should be given to projects that address the factors necessary to support healthy populations of beavers and to address the unintended impacts to adjacent lands.

Increase in Invasive Non-Native Vegetation

The Klickitat Subbasin is in no means an isolated area. Global markets and economies cause human interactions unheard of a century ago. Because of this, the introduction of vegetation from exotic locals increases every year. Habitat conversion in the intensively developed irrigated agricultural portions of the subbasin compounds the effects of these introductions. Weed management is becoming an increasingly important component of riparian wetland restoration and management. A list of noxious weed species occurring in the subbasin is included in Appendix D, table D.4.A. To combat these invasive species, techniques must be used that fit the situation within which they are arising. A comprehensive, integrated approach to pest management involves many tools. An important tool is in the restoration of conditions as close as possible to those that existed historically. The re-creation of native conditions conducive to the needs of the native plants which evolved in these conditions will often allow the best defense against infestation by exotic vegetation. Intensive weed control, however, may be necessary to reestablish these native communities in the first place. Many times, the removal of grazing on a heavily disturbed area will result in large weed infestations. Weed issues are much more important in the lower portions of the subbasin, but are increasing in the upper basin as well. Restoration projects must include plans to address weed infestations. Priority should be given to projects that include credible, integrated plans to address exotic vegetation issues.

Human Disturbance

As the subbasin becomes increasingly populated, human disturbance issues will also increase. Fish and wildlife populations need habitats relatively free of human activity. The best habitat will not provide the needs of wildlife if the level of human disturbance is high. Restoration areas must balance the needs of the fish and wildlife with the needs of the local communities. Restoration projects away from population centers will require less effort to minimize human disturbance than projects near or adjacent to urban areas. Priority should be given to projects adequately addressing human disturbance issues.

Reduction in Anadromous Fish Populations

Many native wildlife species and habitats in the subbasin were dependent on the constant energy sources brought up from the ocean by the large anadromous fish runs. The loss of these fish runs caused a large reduction in energy entering the system, altering wildlife population dynamics.

Priority should be given to riparian wetland restoration activities that emphasize anadromous fish as well as wildlife benefits that promote an increase in the inter-specific interactions.

Table 13 Summary of potential effects of various land uses on riparian wetland habitat elements needed by fish and wildlife

Potential Changes in Riparian Elements Needed by Fish and Wildlife	Land Use						
	Forest Practices	Agriculture	Unmanaged Grazing	Urban-ization	Dams	Recreation	Roads
Riparian Habitat							
Altered microclimate	X	X	X	X		X	X
Reduction of large woody debris	X	X	X	X	X	X	X
Habitat loss/fragmentation	X	X	X	X	X	X	X
Removal of riparian vegetation	X	X	X	X	X	X	X
Reduction of vegetation regeneration	X	X	X	X	X	X	X
Soil compaction/ deformation	X	X	X	X		X	X
Loss of habitat connectivity	X	X	X	X		X	X
Reduction of structural and functional diversity	X	X	X	X		X	X
Stream Banks and Channel							
Stream channel scouring	X	X	X	X		X	X
Increased stream bank erosion	X	X	X	X	X	X	X
Stream channel changes (e.g., width and depth)	X	X	X	X	X	X	X
Stream channelization (straightening)	X	X		X			
Loss of fish passage	X	X	X	X	X		X
Loss of large woody debris	X	X	X	X	X	X	X
Reduction of structural and functional diversity	X	X	X	X	X		X
Hydrology and Water Quality							
Changes in basin hydrology	X	X		X	X		X
Reduced water velocity	X	X	X	X	X		
Increased surface water flows	X	X	X	X		X	X
Reduction of water storage capacity	X	X	X	X			X
Water withdrawal		X		X	X	X	
Increased sedimentation	X	X	X	X	X	X	X

Potential Changes in Riparian Elements Needed by Fish and Wildlife	Land Use						
	Forest Practices	Agriculture	Unmanaged Grazing	Urban-ization	Dams	Recreation	Roads
Increased stream temperatures	X	X	X	X	X	X	X
Water contamination	X	X	X	X		X	X

(Knutson and Naef 1997)

4.2.1 Yellow Warbler (*Dendroica petechia*)

Rationale for Selection

The yellow warbler is a common native species strongly associated with riparian and wet deciduous habitats. The yellow warbler is a good indicator of functional subcanopy / shrub habitats in riparian areas. It is a locally common breeder along rivers and creeks in the Columbia Basin, where it is declining in some areas. For these reasons, they were chosen as a focal species for the Interior Riparian Wetlands wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Partners in Flight (PIF) established the following biological objectives for this species in the lowlands of eastern Oregon and eastern Washington (Altman 2001):

- >70 percent cover in total cover {shrub (<3 m) and subcanopy (>3m) layers};
- Subcanopy layer contributing >40 percent of the total cover;
- Shrub layer cover 30-60 percent of total cover (includes shrubs and small saplings), height > 2m;
- >70% cover should be native species; and
- Edge and small patch size (heterogeneity).

General

The yellow warbler is a riparian obligate species most strongly associated with wetland habitats and deciduous tree cover and is a good indicator of functional subcanopy / shrub habitats in riparian areas.

Yellow warbler abundance is positively associated with deciduous tree basal area, and bare ground; abundance is negatively associated with mean canopy cover of Douglas-fir (*Pseudotsuga menziesii*), Oregon grape (*Berberis nervosa*), swordfern (*Polystuchum munitum*), blackberry (*Rubus discolor*), hazel (*Corylus cornuta*), and oceanspray (*Holodiscus discolor*) (Rolph 1998). Altman (2001) reported that, at the landscape level, yellow warbler habitat should include a high degree of deciduous riparian heterogeneity within or among wetland, shrub, and woodland patches and a low percentage of agricultural land use.

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). 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).

Nesting

They are a common breeder in hardwood trees throughout Washington State at lower elevations. Breeding yellow warblers are closely associated with riparian trees, specifically willows, alders, or cottonwoods. In Klickitat County, they are mostly confined to relatively dense riparian vegetation (Manuwal 1989). Optimal nesting habitat for the yellow warbler is provided in wet areas with dense, moderately tall stand of hydrophytic deciduous shrubs (Schroeder 1982).

Population Status and Trend

Core zones of distribution in Washington are the forested zones below the subalpine fir (*Abies lasiocarpa*) and mountain hemlock (*Tsuga mertensiana*) zones, plus steppe zones other than the central arid steppe and canyon grassland zones, which are peripheral.

Within the Washington State, yellow warblers are apparently secure and are not of conservation concern (Altman 1999, see figure 5). Information from Breeding Bird Surveys indicates that the population is stable in most areas. However, yellow warblers have shown population declines in various regions during well-defined time periods. Because the Breeding Bird Survey dates back only about 30 years, population declines in Washington resulting from habitat loss prior to the survey would not be accounted for by that effort.

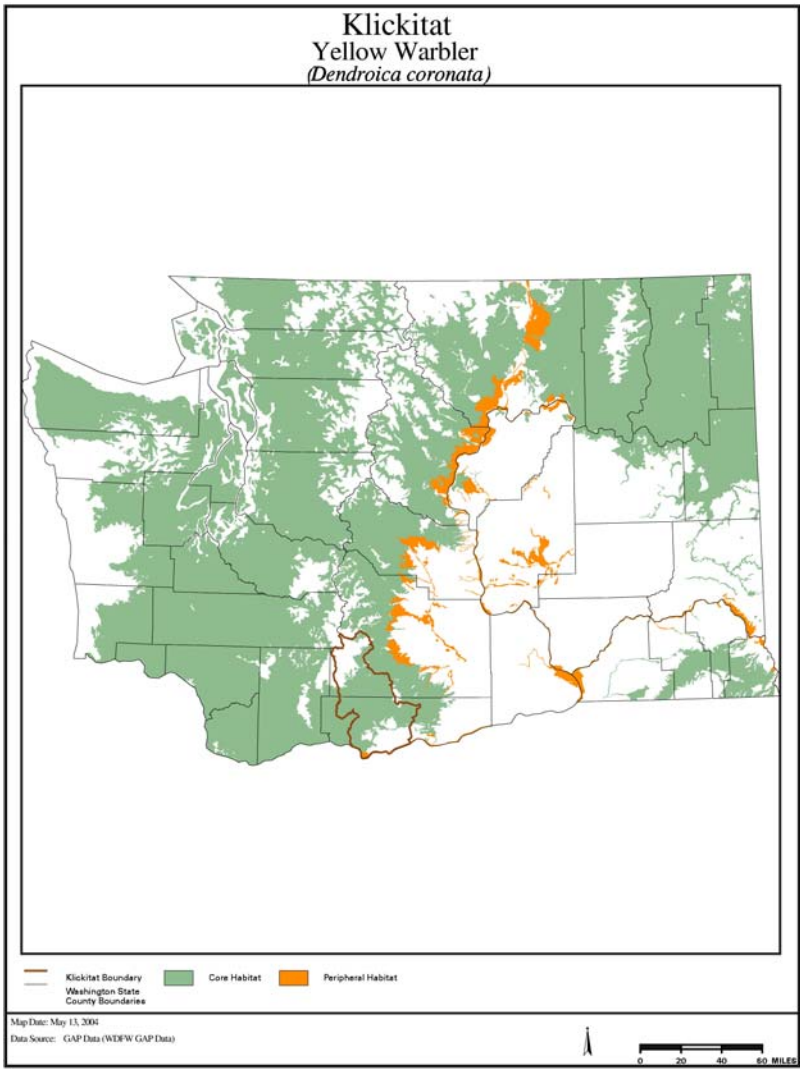

Figure 8 Potential habitat for yellow warblers in the Klickitat subbasin and Washington State (Smith et al. 1997)

They are most abundant in riparian areas in the lowlands of eastern Washington. Numbers decline in the center of the Columbia Basin, but this species can be found commonly along most rivers and creeks at the margins of the Basin.

Management Issues

No specific management issues were identified in the subbasin.

Out-of-Subbasin Effects and Assumptions

The peak of spring migration in Washington and the Columbia Basin 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).

Fall migration is somewhat inconspicuous for the yellow warbler. It most probably begins to leave Washington by the first of August and has generally left the state by the end of September.

The yellow warbler winters from the Bahamas and northern Mexico south to Peru, Bolivia and Brazil.

The yellow warbler is a long-distance neotropical migrant. Spring migrants begin to arrive in the Columbia River Basin in April; dates of 2 April and 10 April have been reported from Oregon and British Columbia, respectively (Gilligan et al. 1994, Campbell et al. in press).

In Yakima County, earliest arrival dates are in late April with most breeders present by mid- to late-May; by late July/early August numbers begin to decline and by early September most yellow warblers have migrated out of the county (Stepniewski 1998).

Relationship with Riparian / Fisheries Issues

Healthy riparian vegetation is important to yellow warbler, and to other terrestrial and aquatic species as well. Riparian vegetation helps stabilize stream banks, reducing sedimentation input in the stream. Riparian vegetation also shades the stream keeping stream temperatures stable. The trees that yellow warbler need for nesting provide large woody debris when they die, increasing refugia for fish and other aquatic vertebrates and invertebrates. Riparian restoration that improves habitat for yellow warblers will also improve riparian aquatic and terrestrial habitat for other species including fish.

Factors Affecting Population

Habitat loss

Hydrological diversions and control of natural flooding regimes (e.g., dams), inundation from impoundments, cutting and spraying riparian woody vegetation for water access, gravel mining, and urban development have negatively affected yellow warblers in the subbasin.

Vegetation and habitat degradation

Degradation of riparian habitat includes: loss of vertical stratification of riparian vegetation, lack of recruitment of young cottonwoods, ash (*Sorbus* spp.), willows, and other subcanopy species; stream bank stabilization which narrows stream channels, reduces the flood zone, and reduces extent of riparian vegetation; invasion of exotic species such as reed canary grass (*Phalaris arundinacea*) and Himalayan blackberry (*Rubus discolor)*; inappropriate grazing which can reduce understory cover; reductions in riparian corridor widths which may decrease suitability of the habitat and may increase encroachment of nest predators and nest parasites.

Presence of Development

Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird, *Molothrus ater*) and domestic predators (cats), and be subject to high levels of human disturbance.

Recreational Disturbance

Recreational disturbances during nesting season, particularly in high-use recreation areas, may contribute towards nest abandonment.

Pesticide and Herbicide Use

The use of pesticides and herbicides associated with agricultural practices may reduce the warbler's insect food base.

4.2.2 American Beaver (*Castor canadensis*)

Rationale for Selection

American beavers are an indicator of healthy riparian systems. Beavers are dependent on permanent riparian systems with consistent year round stream flow rates, adequate stream-side an in-stream vegetation and presence of in-stream downed woody debris. Beavers are also an important tool in maintaining and repairing properly functioning riparian systems. Because of their strong relationship with healthy riparian systems, they were chosen as a focal species for the Interior Riparian Wetland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following:

- Permanent source of water (Slough and Sadleir 1977)
- Ability to build lodges
- Mild or no annual or seasonal water level fluctuations (Slough and Sadleir 1977) (Murray 1961, Slough and Sadleir 1977)
- Slow water flow (Collins 1976b)
- Low stream channel gradient (Slough and Sadleir 1977, Williams 1965)
- Stream channel gradients of 6 percent or less have optimum value as beaver habitat; streams of 15 percent or more are uninhabitable (Retzer et al. 1956)
- Presence of food and building source
- Herbaceous plants include aspen, willow, cottonwood, alder) (Denney 1952) and aquatic vegetation (Collins 1976a)
- Woody stems cut by beavers are usually less than 7.6 to 10.1 cm (3 to 4 inches) dbh (Bradt 1947, Hodgdon and Hunt 1953, Longley and Moyle 1963, Nixon and Ely 1969)

General

All wetland cover types (e.g., herbaceous wetland and deciduous forested wetland) must have a permanent source of surface water with little or no fluctuation in order to provide suitable beaver habitat (Slough and Sadleir 1977). Water provides cover for the feeding and reproductive activities of the beaver.

Lodge and Dam Building

Beavers build lodges and / or burrows for cover (Rue 1964). Lodges may be surrounded by water or constructed against a bank or over the entrance to a bank burrow. Water protects the lodges from predators and provides concealment for the beaver when traveling to and from food gathering areas and caches.

The lodge is the major source of escape, resting, thermal, and reproductive cover (Jenkins and Busher 1979). Mud and debarked tree stems and limbs are the major materials used in lodge construction although lesser amounts of other woody, as well as herbaceous vegetation, may be used (Rue 1964). On lakes and ponds, lodges are frequently situated in areas that provide shelter from wind, wave, and ice action.

For beavers to build dams, there must be a low seasonal and annual water level fluctuations, slow water flow and a low stream channel gradient.

Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level will be unsuitable habitat for beaver. Similarly, intermittent streams, or streams that have major fluctuations in discharge (e.g., high spring runoff) or a stream channel gradient of 14 percent or more, will have little year-round value as beaver habitat.

Diet and Foraging

Assuming that there is an adequate food source available, small lakes [< 8 ha (20 acres) in surface area] are assumed to provide suitable habitat. Large lakes and reservoirs [> 8 ha (20 acres) in surface area] must have irregular shorelines (e.g., bays, coves, and inlets) in order to provide optimum habitat for beaver.

Various factors, including the poor placement, construction and maintenance of road systems in the subbasin, have contributed to changes in stream channel morphology. Stream channels have become incised, secondary channels have been lost, and beaver access to floodplains has been reduced. These factors contribute and relate to a decline in the recruitment of aspen and cottonwood, both food sources for beaver. The loss of wetlands is an additional factor limiting beaver populations.

An adequate and accessible supply of food must be present for the establishment of a beaver colony (Slough and Sadleir 1977). The actual biomass of herbaceous vegetation will probably not limit the potential of an area to support a beaver colony (Boyce 1981). However, total biomass of winter food cache plants (woody plants) may be limiting. Low marshy areas and streams flowing in and out of lakes allow the channelization and damming of water, allowing access to, and transportation of, food materials. Steep topography prevents the establishment of a food transportation system (Williams 1965, Slough and Sadleir 1977).

Population Status and Trend

Because of the high commercial value of their pelts, beavers figured importantly in the early exploration and settlement of western North America. Thousands of their pelts were harvested annually, and it was not many years before beavers were either exterminated entirely or reduced to very low populations over a considerable part of their former range. By 1910 their populations were so low everywhere in the United States that strict regulation of the harvest or complete protection became imperative. In the 1930s live trapping and restocking of depleted areas became a widespread practice which, when coupled with adequate protection, has made it possible for the animals to make a remarkable comeback in many sections (see map of current habitat and locations, figure 6).

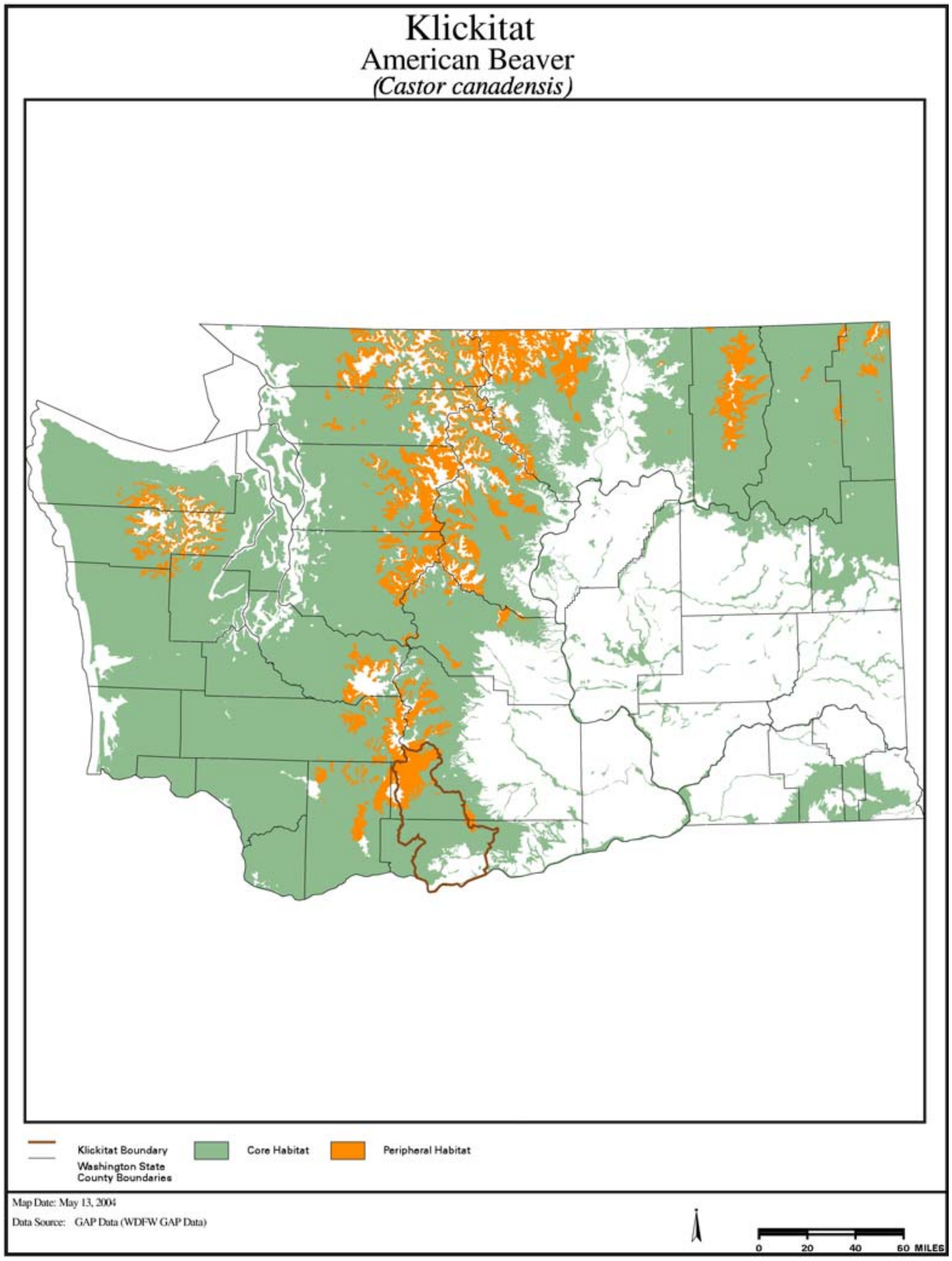

Figure 9 Potential habitat for American Beaver in the Klickitat subbasin and Washington State (Johnson and Cassidy 1997).

Management Issues

Trapping removed almost all of the beaver from the subbasin. Once this happened, they were no longer available to provide activities necessary to maintain the early-successional habitats on which they depend. Without beaver, a cycle is broken and important ecosystem and riparian / wetland functions are lost. In upland riparian habitats, beavers are unable to re-colonize the area with restoration and management efforts.

Transplants do occur of “problem” beaver from lower elevation riparian areas to higher elevation riparian areas. Little documentation is available on when this occurs and whether transplanted beaver have been successful in living in their new locations. Research and organization of these transplants would be valuable. Transplanting beaver could also be used to assess the quality of riparian restoration efforts, as well as act as a tool in speeding up restoration efforts.

There are many other human activities that have implications to both beavers and their habitat (Cederholm et al. 2000). Some examples include timber activities, presence of roads and cattle grazing. Timber activities can fragment wildlife habitat. It can also decrease woody debris available to streams and increase sedimentation. High amounts of sediment can increase water temperature, making streams unsuitable for fish, amphibian and aquatic macroinvertebrate species. Roads fragment habitat and creating barriers to migrating species. Roads can also cause sediment increase and edge degradation. Inappropriate grazing both degrades terrestrial and aquatic vegetation, impacting both wildlife and fish.

Relationship with Riparian / Fisheries Issues

Beavers have long co-existed with salmon (*Oncorhynchus* spp.) in the Pacific Northwest, and have had an important ecological relationship with salmon populations (Cederholm et al. 2000). The beaver created and maintained a series of beneficial aquatic conditions in many headwater streams, wetland, and riparian systems, which serves as juvenile salmon rearing habitat. Beavers have multiple effects on water bodies and riparian ecosystems that include altering hydrology, channel morphology, biochemical pathways, and stream productivity. This function, however, has been severely altered by people. It is difficult to imagine the amount of influence beavers have had on the landscapes, most Pacific Northwest streams had been void of beaver activity for many decades before ecologists had the opportunity to study them.

Beavers are extremely important in contributing to large woody debris, which is a critical structural component in streams. Large woody debris provides important structural complexity as well as vital nutrients to streams. Large woody debris and beaver dams decreases stream velocity and temperature. They also provide refugia to migrating fish.

Beaver dams can obstruct channels and redirect channel flow and the flooding of stream banks and side channels (Cederholm et al. 2000). By ponding water, beaver dams create enhanced rearing and over-wintering habitat that protect juvenile salmon during high flow conditions. Beaver dams are often found associated with riverine ponds called “wall-base channels” along main river flood plains, and these habitats are used heavily by juvenile coho salmon (Oncorhynchus kisutch) and cutthroat trout (*Oncorhynchus clarki*) during the winter.

Factors Limiting Populations

Habitat loss and fragmentation

The lack of habitat and the loss of proper ecosystem and riparian functioning have hindered the natural re-colonization of beaver in this subbasin. Multiple factors have influenced the loss of habitat and riparian processes. The poor placement, construction and maintenance of road systems in the subbasin, have contributed to changes in stream channel morphology. Stream channels have become incised, secondary channels have been lost, and beaver access to floodplains has been reduced.

Food availability

Availability of food is a limiting factor. Degradation of streams contributes and relates to a decline in the recruitment of aspen and cottonwood. In winter, the amount of available winter food cache plants (woody plants) may be limiting (Boyce 1981). At lower elevations, riparian habitat along some waterways has been removed to plant agricultural crops, which removes important habitat and food sources for beaver.

Dam removal

Beavers create dams that restrict fish passage, and are removed in order to restore fish passage.

Trapping

Historically, trapping removed beavers from the subbasin, resulting in the alteration of their riparian / wetland habitats.

4.2.3 Interior Riparian Wetlands Key Findings, Limiting Factors, and Working Hypotheses

Table 14 Key findings, limiting factors and working hypotheses for the Interior Riparian Wetlands focal habitat and its representative focal species

INTERIOR RIPARIAN WETLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat has suffered degradation and loss of hydrological function.	Overall Loss of Riparian Vegetation	Properly managed grazing in riparian areas will help reduce the damage to riparian understory vegetation, which will in turn avoid the narrowing of stream channels and reverse increases in water temperature.
	Reduction in Floodplain Acreage	In riparian habitat, restoring habitat on abandoned roads or railroads and relocating problematic roads would allow for wider floodplain zones, decrease stream bank erosion, decrease sediment, and decrease disturbance to nesting species.
	Displacement of Native Riparian Vegetation by 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.
	Incised Stream Reaches	Restoring stream channels in selected reaches will allow for hydrologic reconnection into wetland habitats.
	Upper Watershed Hydrologic Alteration	Appropriate silvicultural practices that maintain and enhance riparian habitat will decrease sediment discharge,
	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 loss and fragmentation, removing corridors necessary for wildlife movement.	Loss of Riparian Habitat and Function	Restoring and maintaining riparian habitat will provide corridors used by wildlife as well as habitat and forage. This will also retain water storage availability of riparian terrestrial habitat for release in drier seasons.
	Fragmentation of Habitat	
INTERIOR RIPARIAN WETLANDS - FOCAL SPECIES		
Yellow Warbler		
Habitat loss and degradation has negatively affected yellow warblers in the subbasin.	Reduction in Floodplain Acreage	Identifying critical habitat, inventorying habitat remaining, and monitoring habitat changes, both locally and at a landscape level, will increase the effectiveness future management

INTERIOR RIPARIAN WETLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
	Overall Habitat Loss	and protection of yellow warblers and reduce loss of habitat due to limiting factors.
	Fragmentation of Habitat	
	Reduced Food Base	Decrease misuse of herbicides and pesticides in riparian areas will decrease mortality of food base needed by key species.
American Beaver		
American Beavers are unable to reestablish in historical locations due to habitat fragmentation, loss and degradation.	Overall Loss of Riparian Vegetation	Restoration of riparian vegetation would increase food availability and quality for beaver, increasing survivorship and reestablishment efforts.
	Fragmentation of Habitat	Reestablishing corridors of movement would help enable beaver to reestablish themselves in historical locations.
	Reduction in Mean Annual Floodplain Acreage	Increasing beaver presence to historic level would help restore hydrological function to floodplains.

4.3 Shrub Steppe/Interior Grasslands

Rationale for Selection

Shrub Steppe

Shrub steppe was selected as a focal habitat because changes in land use over the past century have resulted in the loss of over half of this once expansive habitat type in eastern Washington (Dobler et al. 1996). Shrub steppe communities support a wide diversity of wildlife. The loss of once extensive shrub steppe communities has reduced substantially the habitat available to a wide range of shrub steppe-associated wildlife, including several birds found only in this community type (Quigley and Arbelbide 1997, Saab and Rich 1997). More than 100 bird species forage and nest in sagebrush communities, and at least one of them (Brewer's sparrow, *Spizella breweri*) is an obligate in the subbasin (Braun et al. 1976). In a recent analysis of birds at risk within the interior Columbia Basin, the majority of species identified as of high management concern were shrub steppe species (Vander Haegen et al. 1999). Moreover, over half these species have experienced long-term population declines according to the Breeding Bird Survey (Saab and Rich 1997).

Interior Grasslands

Interior Grasslands were selected as a focal habitat type because land use practices in the past 100 years have reduced this habitat type by 97 percent. Within the subbasin, this habitat type historically occurred at the transition zone between shrub steppe and forest and where fires killed shrubs within the shrub steppe. Despite its importance as a wildlife habitat it was limited in distribution within the subbasin historically. Modern altered fire intervals and conversion into agriculture have converted large portions of remaining shrub steppe into grassland habitat. Adequate mapping data illustrating where these two types exist within the subbasin does not exist. Therefore, the interior grassland habitat type was combined with the shrub steppe habitat type into the Shrub Steppe / Interior Grassland wildlife habitat for this plan.

Description of Habitat

Historic

Historic vegetation patterns can only be inferred from sites thought to resemble historic conditions. Several shrub and grass associations were commonly interspersed with one another forming a diverse floral mosaic. The combination of elevation, aspect, soil type, and proximity to surface and/or ground water contributed to the vegetation potential of a site. Fire was likely the primary disturbance factor with intervals ranging between 50 and 100 years (Stinson et al. 2004); large mammals such as Rocky Mountain elk (*Cervus elaphus nelsoni*), small mammals such as ground squirrels (*Spermophilus* sp.), mass wasting and flooding in perennial and ephemeral streams probably contributed secondary localized disturbance roles. Shrubs and perennial bunchgrasses co-dominated with a micro-biotic crust of lichens, mosses, green algae, and micro-fungi on the surface of the soil (Belnap et al. 2001). Biotic crusts are critical for binding soil particles together protecting the soil from wind and water erosion, fixing nitrogen, accumulating nutrients used by vascular plants, and out competing invasive species (Stinson et al. 2004). Estimates for historic shrub cover at undisturbed sites vary between 5 and 30% (Daubenmire 1970, Dobler et al. 1996, Crawford and Kagan 2001). Perennial bunchgrass cover was estimated to vary between 69-100% (Daubenmire 1970).

The dominant shrub-grass association was Antelope bitterbrush (*Purshia tridentata*) and bluebunch wheatgrass (*Agropyron spicata*) (Daubenmire 1970). Scattered throughout this dominant cover type were many other bunchgrasses including Sandberg's bluegrass (Poa secunda), needle and thread (*Stipa comata*), Thurber's needle grass (*Stipa thurberina*), Idaho fescue (*Festuca idahoensis*), Indian rice grass (Achnatherum hymenoides), squirreltail (*Elymus elymoides*) and Cusick's bluegrass (*Poa cusickii*). Scattered shrubs also included two rabbitbrush species (*Chrysothamnus viscidiflorus* and *Chrysothamnus nauseosa*), short-spine horsebrush (*Tetradymia spinosa*), spiny hopsage (*Grayia spinosa*), rigid sagebrush (*Artemesia rigida*), basin sagebrush (*A. tridentata tridentata*) and three-tip sagebrush (*A. tripartita*) (Crawford and Kagan 2001).

Most of these shrub species had their own unique association with one or more bunchgrasses and dominated a portion of the landscape. For example, at higher elevations and north facing slopes three-tip sagebrush and Idaho fescue was the dominant association. On ridge tops where shallow soils (i.e., basaltic lithosols) were common, rigid sagebrush and Sandberg's bluegrass and/or bluebunch wheatgrass dominated. Rabbitbrush was common in areas where fires had recently burned. Within the shrub steppe landscape there also were alkaline adapted community types, usually associated with drainage bottoms, perennial and ephemeral streams, or seeps and springs.

A diversity of flowering herbaceous plants, known as forbs, were present with these shrub-bunch grass associations. Perennial forb species included several balsamroots (e.g., *Balsamorrhiza careyana, B. hookeri, B. sagitata*), milkvetches (e.g., *Astragalus columbianus, A. spaldingii*), desert parsleys (e.g., *Lomatium triternatum, L. gormanii, L. canbyi*) and burrow weed (*Hyplopopus bloomer*)(Daubenmire 1970).

Sagebrush / bunchgrass obligates within the subbasin included Brewer's sparrow (*Spizella breweri*) and the sagebrush vole (*Lemmiscus curtatus*). Other shrub steppe species include Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) / Columbian black-tailed deer (*Odocoileus hemionus columbianus*), short-eared owl (*Asio flammeus*), loggerhead shrike (*Lanius ludovicianus*), lark sparrow (*Chondetes grammacus*), grasshopper sparrow (*Ammodramus leconteii*), western rattlesnake (*Crotalus viridis*), short-horned lizard (*Phrynosoma douglasii*), and the great basin spadefoot (*Scaphiopus intermontanus*).

A decade or more is required for big sagebrush to recolonize depending on fire severity and season, seed, rain, postfire moisture, and plant competition; whereas three-tip sagebrush is a late seral species that reestablishes (from seeds or commonly from sprouts) within 5-10 years following a disturbance (Crawford and Kagan 2001).

Current

An estimated 10.4 million acres of shrub-steppe existed in Washington prior to the 1800s of which approximately 40% remains (Dobler et al. 1996). We were unable to obtain the number of acres of shrub steppe that remain within the subbasin. Approximately 8,608 acres of irrigated agriculture exists in the subbasin (Watershed Professionals Network and Aspect Consulting, Inc. 2004. The National Biological Division of the U.S. Geological Service has identified native shrub and grassland steppe in Washington as an endangered ecosystem (Noss et al. 1995). The most significant direct cause of shrub steppe loss in the subbasin was creation of dryland agriculture. The pattern of agricultural conversion has resulted in a disproportionate loss of deep soil communities not reflected in typical measures given for habitat loss (Vander Haegen et al.

2000). On highly disturbed sites, i.e. gravel pits, housing developments, road constructions, etc, invasive alien species have gained the opportunity to compete with and replace natives. Past mismanagement of certain areas has also allowed invasive species to predominate.

The predominate ownerships of the shrub steppe in Klickitat County are agricultural producers and livestock ranchers, cropland farms with incidental shrub steppe holdings. The state of Washington owns and manages several smaller but key parcels as well.

Most shrub steppe habitat in the subbasin is in fair to good ecological condition.

Shrub steppe included in cropped private land tends to be fragmented into relatively small patches (Dobler et al. 1996). There are a few exceptions where relatively large (<12,000 acres) shrub steppe parcels exist in close proximity to public land. They are usually associated with steep topography such as on ridges that were historically not productive for cultivation. A redeeming quality is they remain mostly intact and, at a minimum, act, as wildlife (e.g., elk, mule deer) corridors for dispersal between public lands with a mixed quality of management. For example, wildife originating on the Klickitat Wildife Area, owned by WDFW, must cross private land to access the Simcoe Mountains and Grayback wildlife area to the North.

Stresses

Altered fire regimes

Fire alone can set back to a seral stage many sagebrush-steppe dependent species from the subbasin. Not only does wildfire kill sagebrush it may open the community to expansion of invasive alien species such as cheatgrass (Bromus tectorum), and knapweeds, especially on south facing slopes. North facing slopes of ridges appear to be more resilient to invasion following fire probably because of cooler microclimates. Cheatgrass can germinate when some native bunchgrasses are dormant during the cold season. Native bunchgrasses, including Sandberg and Big Bluegrass compete effectively with Mediterranean annuals. South facing slopes tend to be warmer with less snow accumulation. Warmer soil temperatures permit cheatgrass to germinate. As a result, many remaining shrub steppe areas in the subbasin have significant cheatgrass problems on south facing slopes. Techniques for restoring shrub steppe into healthy bunchgrass stands need further development. However, conservation agencies have observed significant voluntary efforts at restoring shrub steppe habitat communities.

Inappropriate Grazing

Of the 894,000 acres of privately owned land used for grazing in Klickitat County, 47% is rangeland. Open native grassland used for grazing by livestock and wildlife is mainly on river breaks and in mountainous areas, including east of the Klickitat River, from south of the Simcoe Mountains to the Columbia River, and east of Bingen, Wash., along the Columbia River.

Rangeland in the best ecological condition usually is interspersed with areas of small grain cropland. Because a cropping system of winter wheat-summer fallow is used in the area, these areas of rangeland are rested from grazing during alternate growing seasons.

Generally, the range of plants in the survey area is suited to grazing in fall and winter or early spring. Grazing should be deferred from year to year. The plants are not suited to continuous grazing early in the growing season. Use of practical grazing methods, a high level of management, and range improvements to speed up ecological processes are beneficial to the areas of rangeland.

Very shallow areas of rangeland generally are in good or excellent condition because the short period of plant growth generally does not correspond with the periods of livestock grazing. Areas that are over used and in poor condition generally are those where the periods of livestock grazing overlap with the critical periods of use by wildlife in the spring.

To maintain the condition of the rangeland, livestock should be moved to irrigated pastures or to areas of grazeable woodland in summer. Range plants can be grazed intensively for a brief period, and then they should be allowed to recover for the remainder of the growing season (Guenther 1997).

Development and Land Conversion

Many sources contribute to increased fragmentation. Collectively, these comprise a significant threat to the ecological integrity of shrub steppe biota. Agriculture and residential development are the two most significant sources of fragmentation across the subbasin. The construction of roads and other infrastructure completely change the nature of the landscape. Many of these lands were formerly under cultivation and have potential for restoration under farm conservation programs (such as the Conservation Resource Program). Restoring native vegetation to agricultural land in key areas may offer valuable opportunities for reducing fragmentation in important habitats.

Ephemeral wetlands have historically been an important feature of shrub steppe. There is very little literature on this landscape feature, but many bird species have been observed using these wetlands (D. Lichtenwald, pers. comm.) and arid species such as the great basin spadefoot are known to breed in these temporary pools (Leonard et al. 1993). Further study of these wetlands is needed to determine their importance to our subbasin.

Invasive Non-Native Plant Species

While linked in many areas to inappropriate grazing practices, other sources also exacerbate this stress, including recreational use, residential development, and frequent fire. As with habitat fragmentation, we cannot point to a single highly ranked source for this limiting factor across the site. However, in selected locales throughout the subbasin, invasive non-native species pose a serious threat to biotic integrity of the shrub steppe. The abundance of such locations, the diversity of sources, and the continued or increasing nature of this threat, combines to yield a medium-high rank for this limiting factor.

Off Road Vehicles

Off Road Vehicle (ORV) use can cause damage to shrub steppe and grassland vegetation, especially the fragile microbiotic crust layers. This type of activity is often unregulated and unmanaged in the subbasin (J. Hill pers. comm.). Limiting ORV traffic to specific marked areas, or eliminating it completely, will protect shrub steppe/grassland habitat, reduce stream sedimentation from snowmelt, rain fall runoff from tire tracks, dirt roads. By not degrading shrub steppe and grassland habitat with vehicles off of designated roads, better quality feed will result for wildlife and livestock and the overall quality of wildlife habitat will be improved.

4.3.1 Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) / Columbian black-tailed deer (*Odocoileus hemionus columbianus*)

The Washington Department of Fish and Wildlife (WDFW) identifies deer east of US-97 as Rocky Mountain mule deer and deer west of US-97 as Columbian black-tailed deer. In reality, throughout the east slopes of the Cascades, there is a hybrid zone, where the deer are a mix of both subspecies' genotypes. Phenotypically, these deer look like black-tails, albeit large black-tails until you get out of the coniferous forest associated with the Cascade foothills. Once you get into the open country, the deer quickly become Rocky Mountain deer phenotypes (S. McCorquodale, pers. comm.) For simplicity, in this writing both subspecies will be referred to as deer, unless information is specific to only one subspecies. This writing will cover general information on both subspecies as well as regional information on both subspecies and their hybrids.

Rationale for Selection

Deer are an important member of Washington State's landscape. Deer historically have been, and remain today, important to the people and ecology of Washington State. Deer serve as a food and clothing source for Native Americans. Additionally, they provide recreational opportunities for hunters and wildlife watchers, and contribute economic benefits to local communities and the state of Washington. Furthermore, deer are the most widely distributed and numerous native species of ungulate in Washington. As such, deer occupy an important ecological niche, converting tremendous volumes of plant matter into animal protein, providing prey for a wide variety of predators and scavengers and generally contributing to the cycling of nutrients (E. Holman, pers. comm.). Shrub steppe and grasslands provide important deer habitat, especially during winter months, in the subbasin and therefore mule / black-tailed deer have been chosen for the Shrub Steppe / Interior Grassland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

The most important habitat factors affecting deer in the subbasin are:

- The availability suitable cover and forage to survive harsh winter conditions. Large sagebrush is an important source of both cover and forage, and
- The availability of forage year round. Fire can destroy shrub steppe sagebrush, an important food in winter.

General

Habitat requirements vary with vegetative and landscape components contained within each herd range. Deer occupying mountain-foothill habitats live within a broad range of elevations, climates, and topography, which includes a wide range of vegetation; many of the deer using these habitats are migratory. Deer occupy a wide variety of habitats in Washington, including but not limited to: canyon complexes along the major rivers, the channeled scablands of eastern Washington, the grasslands of southeastern Washington, the conifer-dominated forests of western Washington, various mountainous habitats in the Cascade, Blue and Selkirk ranges, etc.

Some of these areas are dominated by native bunch grasses or shrub steppe vegetation. Deer also occupy agricultural areas, which were once shrub steppe or native grassland.

Diet and Foraging

During the fall season, high quality forage should be available to allow does to recover from the rigors of nursing fawns and prepare for the leaner winter months. In the subbasin late summer/fall rains may create a green-up that is very important for deer. The fall green-up provides the nutrition necessary to maintain body condition for the coming winter, and maintain the fertility of does that breed in late fall. Good spring range conditions are important because they provide the first opportunity for deer to reverse the energy deficits created by low quality forage and winter weather. Winter can be a difficult time for deer; forage quality and availability may be limited. Energy demands elevate at the end of gestation and jump dramatically when does start supporting their young after parturition (S. McCorquodale, pers. comm.). Ideally, deer winter range should be free of disturbance and contain abundant, high quality forage. Poor winter range conditions and severe winter weather in the form of deep snow and cold temperatures can result in high mortality, especially among the old and young. Severe winters, particularly winters with deep and/or hardpacked snow, would likely be the major weather-related cause of death among adults (S. McCorquodale, pers. comm.).

Woody browse that is known to be highly palatable and nutritious, such as antelope bitterbrush, is an important component of quality deer winter range. Deer generally do not do well on strict grass diets, as these tend to have low digestibility when mature. Deer need a high digestibility diet, which is typically of a higher quality diet than elk. They do not need as much food as elk, but they do need high quality foods (S. McCorquodale pers. comm.).

McCorquodale (1999) found that during the growing season, deer in the Klickitat subbasin ate a lot of forbs, some grasses, and quite a few shrub leaves (e.g. currant). In winter, deer ate grasses, shrubs such as antelope bitterbrush, snowberry, and ceanothus (*Ceanothus* spp.). The absence or presence of highly digestible shrubs, such as bitterbrush, is essential to survival (Hobbs 1989).

Food habitats for deer in more grassland-dominated habitats also are dependent upon time of year. In a report published on the ecology of mule deer on the Yakima Training Center, Yakima County (1995), deer were found to avoid a bunchgrass cover type in spring and summer but favored that habitat during winter months (Raedeke et al 1995). A diet analysis from this study showed that 47 percent of the deer diets were forbs, 39 percent were shrubs, and only 13 percent were grasses. Preferred forbs were balsamroots (*Balsamorhiza* spp.), buckwheat (*Eriogonum* spp.), and lupine (*Lupinus* spp.). Shrubs included antelope bitterbrush and willow while cheatgrass and steppe bluegrass (*Poa secunda*) were important grasses. Deer were more dependant on browse during the summer months when energetic needs are at their highest (Raedeke et al. 1995).

Wintering

In the Klickitat subbasin, deer winter range is associated with south facing breaks and uplands of the lower Klickitat River Canyon, which is south of the Yakama Nation Reservation (McCorquodale 1999). In the Klickitat subbasin, the WDFW owns and manages the Klickitat Wildlife Area. For wintering deer, habitat with an oak component is very important in this region.

Population Status and Trend

Status

Historically, deer where generally thought to have occupied much of what is known as eastern Washington. Today, deer can be found in every county within eastern Washington (figure 10). In the Klickitat subbasin, deer winter range extends along south-facing slopes and associated uplands (McCorquodale 1999).

As is commonly the case in many western big game populations, the Klickitat deer herd has an abundance of summer range but winter range is limited. The last three decades have marked considerable conversion of deer winter habitat to land uses that are less favorable to deer. Current habitat conditions likely are not able to support high wintering deer populations. Further development or habitat loss will continue to reduce the capacity of the landscape to support deer. Managers should continue to make winter habitat maintenance, enhancement and acquisition a priority (McCorquodale 1999).

Additionally, the importance of habitat conditions on summer range has recently been shown to be of significance to ungulate populations such as deer. Specifically, adequate quantities of high-quality forage must be available during spring and summer months to allow for recovery from winter food shortages, successfully recruit young, assure pregnancy in females, secure nutritional reserves prior to the coming winter, etc. (E. Holman pers. comm.) In addition to the aforementioned management priority of winter range, habitat maintenance and enhancements on summer range should be conducted as well.

Figure 10 Potential habitat for mule / black-tailed deer in the Klickitat subbasin and Washington State (Johnson and Cassidy 1997).

Trends

Historic population levels are unknown but are generally thought to be higher than current deer numbers (McCorquodale 1999). In a comparative deer harvest report from 1948 to 1986, harvest numbers rose from 814 in 1948, reached its peak in 1964 with 6,530, and dropped consistently ending with 1,391 animals in 1986 (Oliver 1986). In its best year, Klickitat County contributed only 9.9 percent of the total statewide harvest.

In 1959, a retired Wildlife Agent, Dick Thompson, claimed that “deer were as thick as rabbits” (Oliver 1986) but landowners soon took to large kills of deer to control damage to crops. Record harvests in the mid 1960’s coupled with severe winter conditions drastically reduced deer populations. Deer have never fully recovered in Klickitat County (Oliver 1986). Deer population numbers continue to fluctuate drastically due to weather, hunting of “problem deer” and other factors.

Harvest data may not always be a reliable source for population trends. For example, in the Rock Creek watershed, located immediately east of the Klickitat subbasin, number of deer harvested has likely dropped due to the decrease in hunters over the past 50 years. This decrease is, in part, the result of an increase in private hunting clubs formed by local landowners.

There are various hypotheses as to why historical deer populations were maintained. One theory is that periods of high population levels were also associated with infrequent severe winters; perhaps the large-scale conversion of historical winter range to agricultural and residential development reduced deer numbers. An additional possibility is that in lieu of the increased agricultural production deer use of crop forage led to higher population levels. The Rock Creek drainage east of the Klickitat is approximately 95,000 ha and has habitats similar to the Klickitat (McCorquodale 1999). Historically, it was thought that deer summering in the Klickitat possibly winters in the Rock Creek subbasin.

According to McCorquodale (1999), deer populations largely reflect the recent history of winter severity. Populations increase during mild winters while severe winters can cause a crash in the population. Most deer herds are currently thought to be stable or declining across much of eastern Washington. There are exceptions to the current, widespread decline, most notably, herds in southeastern Washington and portions of Grant, Douglas, Spokane, and Whitman Counties.

Management Issues

The management of deer in the Klickitat subbasin is the responsibility of the Yakama Nation, WDFW, two large forest landowners; Boise Cascades and Campbell Group, as well as many smaller-scale forestland owners, along with agricultural landowners and residential landowners.

Rocky Mountain elk were historically uncommon in the Klickitat subbasin but during the last 10 years, the number of wintering elk has increased (McCorquodale 1999). Deer have been shown to be sensitive to elk and it is thought that deer will avoid areas where there are elk. In Oregon at the Starkey project, radio collared deer actually moved into areas where roads were recently built to avoid the elk that had moved out of that area (J. Stephenson pers. comm.). Additionally, ongoing research efforts at the Starkey Experimental Forest suggest that the presence of cattle leads to an increase of interspecific competition among elk and deer (E. Holman pers. comm.). Specifically, in the absence of cattle, deer and elk tend to select different foods, with elk making much more extensive use of grass than deer. With the introduction of cattle, the supply of grass available to elk is reduced causing them to browse more extensively on shrubs and forbs. Elk are generally more adaptable, capable of utilizing a wider variety of foods, require more food and are better able to cope with severe winter conditions than are deer (E. Holman pers. comm.).

Approximately 59,321 acres of CRP have been created in the farmlands of Klickitat County by converting cropland to grassland. This has resulted in an improvement in habitat conditions for deer. The CRP lands provide both food and cover in agricultural areas where little existed after post settlement and development and before CRP was created.

Deer populations in Game Management Unit's (GMU's) 588 and 382 in Klickitat County persist at a level where landowners sometimes complain about too many deer on their winter wheat, and in their gardens or landscaping. Partially in response to these concerns, the WDFW establishes hunting seasons designed to result in limited antlerless deer harvest and a relatively stable overall deer population. In some limited cases, WDFW has authorized "hotspot" hunts to reduce damage and complaints from landowners (McCorquodale 1999).

Relationship with Riparian / Fisheries Issues

The presence of streams is an important water supply in the arid environments of Klickitat County. Healthy and abundant riparian areas can serve as buffers against extreme weather/environmental conditions such as drought or severe winters. Healthy and abundant riparian areas may also serve to provide habitat for deer that is more attractive than agricultural or residential habitats, thereby partially reducing the undesirable effects of a robust deer population i.e. damage claims (E. Holman pers. comm.).

Out-of-Subbasin Effects and Assumptions

Mule deer populations are either non-migratory or migrate to avoid deep snows (Severson and carter 1978, Eberhardt et al. 1984), or to find more nutritious forage (Garrott et al. 1987) and drinking water (Rautenstrauch and Krausman 1989). McCorquodale (1999) noted that although deer wintering in the lower Klickitat were both migratory and resident, most individuals were migratory and exhibited strong fidelity to their seasonal home ranges. He found that wintering radio collared deer from the Klickitat Wildlife Area and Rock Creek dispersed widely during the spring through fall period. Rock Creek migrants summered northwest through west of their home range while Klickitat deer migrated north or east of their winter home ranges (figure 11). Spring migrations started around the end of March and concluded during the second week of May. Peak activity for deer movement was recorded in April. Summer ranges, for the most part, were snowfree by mid-April. Summer to winter home range migrations were found to generally occur between late September and early December.

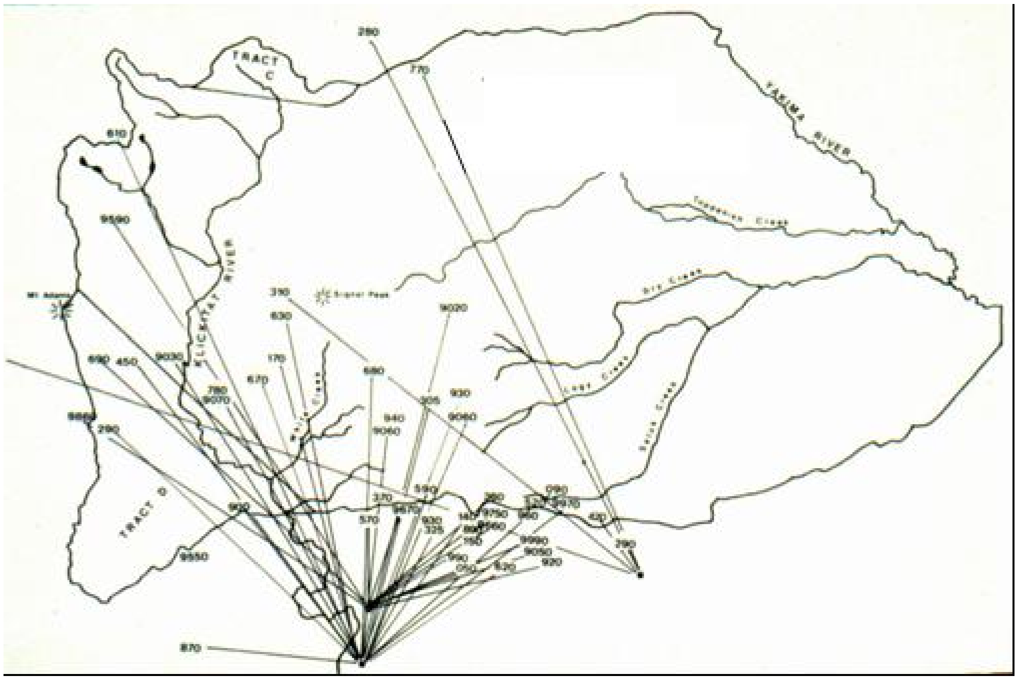

Figure 11 Movements of radio-collared deer from the Klickitat River Basin (Klickitat subbasin) study, boundary shows Yakama Reservation (McCorquodale 1999).

Factors Affecting Population

A multitude of factors limit the ability of landscapes to support populations of deer. These factors are both human-caused and climactic in nature. These factors may work independently or in concert to suppress deer populations i.e. loss of suitable forage to weeds may cause deer to concentrate on habitats near highways where accidental deaths and disturbance may be higher than desirable. Deer populations are primarily a function of the availability of high-quality habitat. Logically, when habitat conditions are compromised, deer populations are suppressed. In contrast, deer are very reproductively fit and when conditions are favorable, they readily increase in number and occupy available habitats. Populations existing under high-quality habitat conditions generally increase to the point of carrying capacity at which point, some limiting factor suppresses the population. WDFW attempts to manage deer populations at a level where large-scale winter mortality does not become the primary source of this population suppression (E. Holman pers. comm.).

Some of the factors that collectively limit deer populations are listed below.

Land Conversion

The conversion of shrub steppe and grassland habitat to agricultural croplands has resulted in the alteration of hundreds of thousands of acres of deer habitat in eastern Washington. This has been mitigated to some degree by the implementation of the Conservation Reserve Program (CRP). Approximately 400,000 acres have been converted to CRP in southeast Washington. Furthermore, agricultural areas may provide an extensive supply of food for deer such as winter green-up in harvested wheat fields or standing alfalfa. However, large numbers of deer may not be tolerated by landowners in agricultural areas and WDFW is legally mandated to address damage caused by wildlife (E. Holman pers. comm.).

Land Conversion to residential, commercial or industrial uses: These activities generally result in the direct loss or severe degradation of habitat for deer. Specifically, establishment of impervious surfaces, fencing, removal of vegetation, etc. all reduce the ability of a given landscape to support populations of deer.

Fire suppression

This has resulted in a decline of habitat conditions in the mountain and foothills of the Blue Mountains, as well as other portions of Washington State. Browse species need to be regenerated by fire in order to maintain availability and nutritional value to big game. Lack of fire has allowed many browse species to grow out of reach for deer (Young and Robinette 1939, Leege 1968; 1969).

Hunting

Mortality in one study (McCorquodale 1999) was mainly associated with hunting except for the period of 1992-1993. Most hunting mortalities occurred in off-reservation areas, although deer made considerable use of reservation lands (McCorquodale 1999). Illegal take of female deer was quite common during the study period of 1988-1995. The majority of the does were killed during the branch-antlered male deer season. WDFW uses recreational hunting to manage deer within the biological capacity of the species to support an annual harvest and provide recreation. WDFW's deer population objectives and therefore seasons are partially established in response to the impact of deer on private landowners, primarily agricultural (E. Holman pers. comm.).

Deer often cause problems for landowners. In the past landowners often took matters into their own hands. In the early 1960s, the Klickitat County Farmers Wildlife Control Association was formed among landowners in Goldendale, White Salmon, Glenwood and elsewhere (Oliver 1986). Hundreds of deer were killed in the Goldendale and White Salmon River Valley. Today deer populations are considerably smaller, problems with deer are smaller and more sporadic, and the killing of "problem" deer is much more closely managed. Landowners still influence the methods and harvest of deer in Klickitat County, but views have changed.

Weather

Weather conditions can play a major role in the productivity and abundance of deer. Drought conditions can have a severe impact on deer because forage does not replenish itself on summer or winter range, and nutritional quality is low. Drought conditions during the summer and fall can result in low fecundity in does, and poor physical condition going into the winter months. Winter weather can result in high mortality of all age classes, but the young, old, and mature bucks usually sustain the highest mortality depending on the severity. In McCorquodale's 1999 study, the dominant form of non-hunting mortality resulted from winterkill. If deer are subjected to drought conditions in the summer and fall, followed by a severe winter, the result can be high mortality rates and low productivity the following year. The 1992-1993 period marked the greatest loss of deer of all ages from winterkill because that was also a period of high snow depths.

Deer populations in central and eastern Washington are reported to be growing in some locations in response to recent mild winters (WDFW 2003).

Invasive non-native plants

Establishment of invasive plants such as yellow star thistle and cheat grass have reduced the capacity of the landscape to support deer.

Roads

The construction of roads and railways are detrimental to deer. These activities result in the direct loss of habitat due to the establishment of hardened surfaces, vegetation removal, etc. Additionally, roads and railways fragment habitats, facilitate human access to remote areas (as in forest roads), interrupt migration corridors, increase disturbance and may cause direct mortality due to deer-vehicle collisions.

Disturbance

Deer are sensitive to a variety of primarily human-caused sources of disturbance. Such activities as ATV use, snowmobile use, the driving of forest roads, hiking, mountain-biking, uncontrolled pets, etc., all disturb deer. Deer are especially sensitive to such disturbance during winter when energy reserves are low. During such times, deer conserve energy by reducing their metabolic rate and attempting to move as little as needed. Disturbances during this time can cause the loss of important energy reserves and therefore reduce the ability of given habitats to support deer (E. Holman pers. comm.).

Energy Development

The impacts of energy development are varied. In the Klickitat subbasin these impacts currently consist primarily of the inundation of reservoirs in former deer habitat, the establishment of transmission lines with the associated roads, weed dispersal, disturbance, etc. (E. Holman pers. comm.). The potential for future energy related limiting factors exists as well. Such future developments likely include oil and gas exploration and wind power.

Klickitat County is in the process of developing a county-wide Environmental Impact Statement (EIS) that considers the cumulative environmental and fish and wildlife impacts of potential emergy development in the county. The EIS will guide the development of an “energy overlay” in county zoning ordinances that will direct future energy development away from environmentally/fish and wildlife sensitive areas.

Interspecific competition

As previously mentioned, deer compete with many other species for available forage and other habitat components. The most significant of these competitive relationships occur among deer, elk and livestock.

Herbicide

The use of herbicide to treat forest plantations following timber harvest is commonplace. The use of these chemical treatments greatly reduces the available forage that would be expected to occur following forest cover removal. Chemical treatments tremendously shorten and reduce the vigor of the period of early succession following timber harvest. These activities reduce the ability of the landscape to support populations of deer.

Disease

Diseases among deer have the potential to reduce population. Deer that are unusually concentrated especially in winter or deer that suffer compromised health due to nutritional deficiencies are more likely to succumb to disease. The establishment of programs to feed deer during winter would increase the likelihood of large-scale outbreaks (E. Holman pers. comm.).

4.3.2 Grasshopper Sparrow (*Ammodramus savannarum*)

Rationale for Selection

Throughout the United States this sparrow has experienced population declines throughout most of its breeding range (Brauning 1992, Brewer et al. 1991, Garrett and Dunn 1981). BBS data (Robbins et al. 1986) have shown a decreasing long-term trend for the grasshopper sparrow (1966-1998) (Sauer et al. 1999). In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the U.S. since the late 1960's. Grasshopper sparrows rely on healthy grasslands and prefer undisturbed, native bunchgrasses communities, a habitat that is being replaced by non-native grassland communities such as cheatgrass. Grasshopper sparrows are listed as a state candidate species in Washington State. Due to their association with healthy grassland habitats, they have been chosen as a focal species for the Interior Grassland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

- Recommended habitat objectives include the following:
- Vegetative composition dominated by native bunchgrasses (Altman and Holmes 2000)
- Vegetation complexity (Altman and Holmes 2000) that includes Bunchgrass cover >15% and >60% total grass cover
- Bunchgrass >25 cm tall
- Shrub cover <10%
- Large unbroken patches >40 ha (100 ac) (Altman and Holmes 2000)
- Undisturbed patches (exotic grass detrimental; vulnerable in agricultural habitats from mowing, spraying, etc.)
- Moderately deep litter and sparse coverage of woody vegetation (Smith 1963, Bent 1968, Wiens 1969, 1970, Kahl et al. 1985, Arnold and Higgins 1986)

General

Grasshopper sparrows use most types of grassland, especially tallgrass and midgrass, but also shortgrass where shrubs or tall forbs are present. In addition to native grasslands, they will nest in CRP lands planted to taller grasses and may be heavily reliant on these in the shortgrass region.

Abundance of grasshopper sparrows seems to be positively correlated with percent grass cover, percent litter cover, total number of vertical vegetation hits, effective vegetation height, and litter depth; abundance was negatively correlated with percent bare ground, amount of variation in litter depth, amount of variation in forb or shrub height, and the amount of variation in forb and shrub heights (Rotenberry and Wiens 1980).

They are highly territorial, and require the presence of tall forbs, scattered trees, or shrubs for singing perches. Grasshopper sparrows prefer grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground (Bent 1968, Blankespoor 1980, Vickery 1996).

Vander Haegen et al. (2000) found no significant relationship with vegetation type (i.e., shrubs, perennial grasses, or annual grasses), but did find one with the percent cover perennial grass. Grasshopper sparrows require some areas of bare ground since they forage on the ground; however, it is unclear how much they need.

Grasshopper sparrows occasionally inhabit cropland, such as corn and oats, but at a fraction of the densities found in grassland habitats (Smith 1963; 1968, Ducey and Miller 1980, Basore et al. 1986, Faanes and Lingle 1995, Best et al. 1997).

Population Status and Trend

Status

Grasshopper sparrows have a spotty distribution at best across eastern Washington (see of distribution, figure 12). Over the years they have been found in various locales including CRP. They appear to utilize CRP on a consistent basis in southeast Washington (M. Denny pers. comm.).

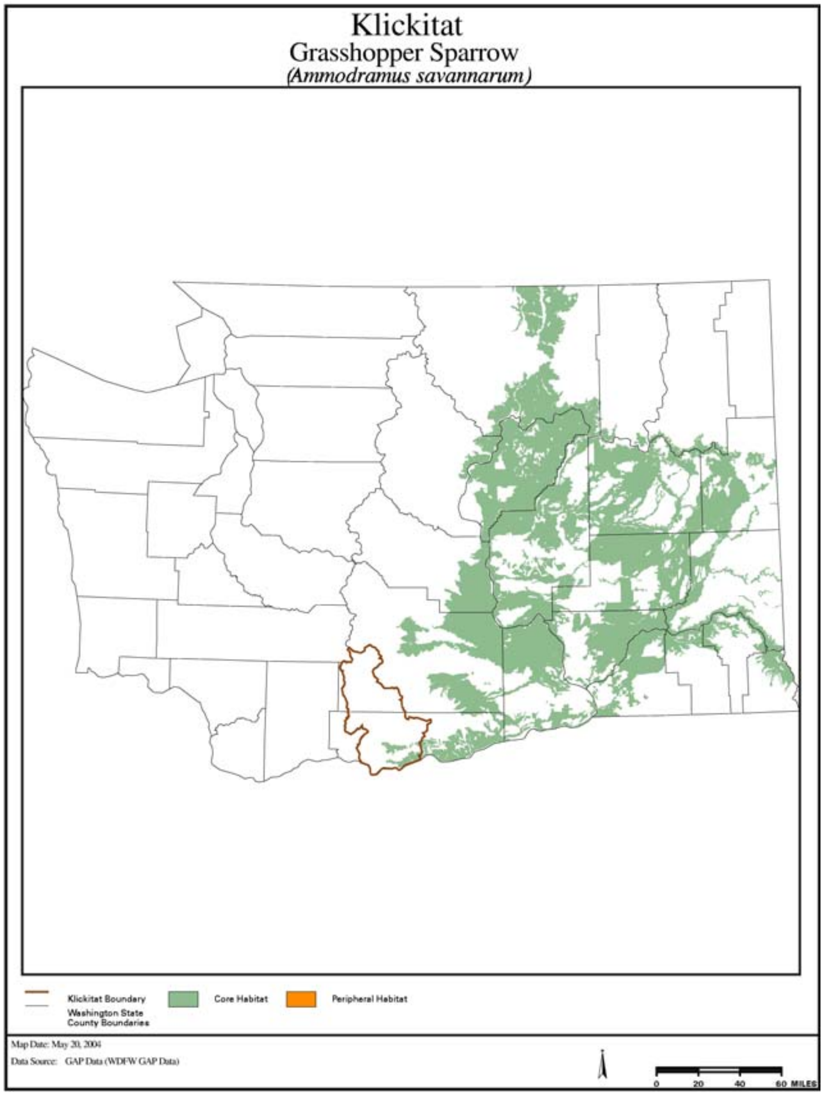

Figure 12 Potential habitat for grasshopper sparrow in the Klickitat subbasin and Washington State (Smith et al. 1997)

Trend

Throughout the U.S., this sparrow has experienced population declines throughout most of its breeding range (Brauning 1992, Brewer et al. 1991, Garrett and Dunn 1981). In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the U.S. since the late 1960s.

Accordingly, Breeding Bird Survey data show long term declines from 1980 through 2002 of –3.0, -1.6 and –10.7 for Washington, Oregon and Idaho, respectively. The entire Intermountain Grassland area shows large decrease of –12.4 over this same time period.

Washington, Oregon and the entire intermountain grassland area show an increasing negative trend when looking at the more recent time period (1996-2002) indicating that recently, populations have decreased even more (Sauer et al. 2003).

Management Issues

Grasshopper sparrow populations in a particular location can vary widely from year to year, as the birds move around in response to changes in their habitat. This tendency is reinforced by its semi-colonial nesting habits. Incentives to public land managers and private landowners are needed to create a landscape mosaic of grassland parcels of different structural stages to provide grasshopper sparrow populations with options for establishing breeding grounds in any given year.

Grasshopper sparrows are considered a grassland-interior species. In several studies, including some in Colorado, breeding populations were more abundant in areas distanced from other land-use types, such as suburban developments, recreational trails, and cropland (Vickery 1996). Provide suitable habitat in patches large enough--at least 12 ha (30 ac)--to accommodate breeding birds.

Grasshopper sparrow populations usually respond negatively to grazing or burning in areas where grasses are already comparatively short and sparse (Saab et al. 1995), due to loss of needed nest cover and song perches. In some areas, vegetation requires several growing seasons to recover to conditions suitable to this species. Graze lightly or not at all in areas of short, sparse grasses. Burn grassland parcels in rotation, such that some unburned habitat is always available.

Mowing operations in hayfields often destroy nests or exposes them to predators. Delay mowing until after the completion of nesting, i.e., until late July (Shugaart and James 1973, Warner 1992).

Relationship with Riparian / Fisheries Issues

Healthy grasslands and shrub steppe is very important in maintaining healthy riparian systems. Upland and floodplain grassland / shrub steppe is important in capturing and holding onto water during snowpack and flooding. During snowpacks, shrubs and bunchgrasses hold onto snow and shade it, reducing the melt rate. When snow melts, the vegetation keeps the moisture from flowing along the surface, but instead infiltrating into the ground. The water than percolates through the soil, where it can be used by vegetation, eventually entering streams. By moving through soil, the water is cleaned, carrying less sediment into the stream then if it entered as runoff. The soil also acts to dissipate the kinetic energy of water as it moves down the elevational gradient. This is also very important during heavy rain and flooding. Grassland / shrub steppe also holds onto water longer, releasing it slowly into the drier seasons, keeping streams running longer, important to fish and other riparian dependent wildlife. Unhealthy grassland / shrub steppe can lead to eroded stream banks, high sediments loads, and more extreme flooding.

Out-of-Subbasin Effects and Assumptions

In spring, the grasshopper sparrow is a notably late migrant, arriving in southern British Columbia in early to late May (Vickery 1996). Grasshopper sparrows arrive in Colorado in mid-May and remain through September. They winter across the southern tier of states and south into Central America.

Data regarding the movements of grasshopper sparrows outside of the breeding season is scarce due to their normally secretive nature (Zeiner et al. 1990). Although diurnally active, grasshopper sparrows are easily overlooked as “they seldom fly, preferring to run along the ground between and beneath tufts of grass" (Pemberton 1917). Because of their secretive nature, the northern limit of their winter range is poorly known. Migratory individuals have been recorded casually south to western Panama (Ridgely and Gwynne 1989) and (in winter) north to Maine (PDV), New Brunswick, Minnesota (Eckert 1990), and western Oregon (Vickery 1996).

Factors Limiting Population

Fragmentation

Often a result from agricultural development and can have several negative effects on landbirds. Effects include: insufficient patch size for area-dependent species, and increases in edges and adjacent hostile landscapes, which can result in reduced productivity through increased nest predation, nest parasitism, and reduced pairing success of males. Making this loss of habitat even more severe is that the grasshopper sparrow, like other grassland species, shows sensitivity to the grassland patch size (Herkert 1994a and b, Samson 1980, Vickery 1994, Bock et al. 1999). Herkert (1991) in Illinois found that grasshopper sparrows were not present in grassland patches smaller than 74 acres despite the fact that their published average territory size is only about 0.75 acres. Minimum requirement size in the Northwest is unknown.

Inappropriate Grazing

Inappropriate grazing can trigger a cascade of ecological changes, the most dramatic of which is the invasion of non-native grasses escalating the fire cycle and converting sagebrush shrublands to annual grasslands. Historical heavy livestock grazing altered much of the sagebrush range, changing plant composition and densities. West (1988; 1996) estimates less than 1 percent of sagebrush steppe habitats remain untouched by livestock. The effects of grazing in sagebrush habitats are complex, depending on intensity, season, duration and extent of alteration to native vegetation. Extensive and intensive grazing in North America has had negative impacts on this species (Bock and Webb 1984). The grasshopper sparrow responds negatively to grazing in shortgrass, semidesert, and mixed grass areas (Bock et al. 1984). However, it has been found to respond positively to light or moderate grazing in tallgrass prairie (Risser et al. 1981).

Parasitism

Grasshopper sparrows are vulnerable to parasitism by brown-headed cowbirds (Elliott 1976; 1978, Davis and Sealy 2000). In Kansas, cowbird parasitism cost grasshopper sparrows about 2 young/parasitized nest, and there was a low likelihood of nest abandonment occurring due to cowbird parasitism (Elliott 1976; 1978). An increase in livestock grazing intensity within shrubsteppe or grassland habitat could increase populations of cowbirds making grassland species more susceptible to nest parasitism.

Altered Fire Regimes

The impact of fire on grassland birds in North America have shown similar results as grazing studies: namely, bird response is highly variable. Similarly, grasshopper sparrows have been found to experience positive (Johnson 1997), negative (Bock and Bock 1992, Zimmerman 1997, Vickery et al. 1999), and no significant (Rohrbaugh 1999) effects from fire. Confounding factors include timing of burn, intensity of burn, previous land history, type of pre-burn vegetation, presence of fire-tolerant exotic vegetation (that may take advantage of the post-burn circumstances and spread even more quickly) and grassland bird species present in the area. The invasion of non-native grass species, such as cheatgrass, has altered the natural fire regime in the western range, increasing the frequency, intensity, and size of range fires.

Mowing and haying

This affects grassland birds directly and indirectly. It may reduce height and cover of herbaceous vegetation, destroy active nests, kill nestlings and fledglings, cause nest abandonment, and increase nest exposure and predation levels (Bollinger et al. 1990). Studies on grasshopper sparrow have indicated higher densities and nest success in areas not mowed until after July 15 (Shugaart and James 1973, Warner 1992). Grasshopper sparrows are vulnerable to early mowing of fields, while light grazing, infrequent and post-season burning or mowing can be beneficial (Vickery 1996).

4.3.3 Shrub Steppe/Interior Grasslands and Focal Species Key Findings, Limiting Factors and Working Hypotheses

Table 15 Key findings, limiting factors and working hypotheses for the Shrub Steppe / Interior Grasslands focal habitat and its representative focal species

SHRUB STEPPE / INTERIOR GRASSLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat has undergone structural and compositional changes. This includes lost species diversity, reduced microbiotic crust, changes in shrub cover and invasion by noxious weeds	Loss of Habitat Quality	Encouraging proper grazing will improve range conditions by reducing future spread of invasive exotic plant species and helping to reestablish a native plant community. Proper livestock management can also reduce soil disturbance in sensitive areas and benefit microbiotic crusts.
	Vegetation and Soil Damage	Limiting ORV traffic to specific marked areas, or eliminating it completely, will protect grassland habitat, reduce stream sedimentation from snowmelt, rain fall runoff from tire tracks, dirt roads.
	Displacement of Native Vegetation by Non-Native Vegetation	Reduction of invasive non-native plant species will increase water availability to native shrubs, forbs and grasses and decrease danger of large wildfires.
	Reduction in Age Class, or Complete Loss, of Shrub Steppe Vegetation	Increasing length of fire cycles to a more natural level will allow native shrub species to reach late seral conditions and reestablish areas they were once historically found. Microbiotic crusts will also increase in quantity and quality.
	Loss of Ephemeral Wetlands	Ephemeral wetlands are a uniquely important part of the shrub-steppe and grasslands adding diversity and stability to the plant community.
Habitat has historically undergone loss of large continual patches resulting in fragmentation of both habitat and wildlife populations.	Loss of Shrub Steppe / Grassland Habitat	Current grassland conservation will continue to decrease fragmentation of grass habitat and maintain existing patches.
SHRUB STEPPE / INTERIOR GRASSLANDS - FOCAL SPECIES		
Mule / Black-Tailed Deer		
Deer are an important species economically, culturally and ecologically.	Loss of Shrub Steppe / Grassland Habitat within Winter Range	Protecting important wintering areas from land conversion and development will increase winter survival.
Grasshopper Sparrow		

SHRUB STEPPE / INTERIOR GRASSLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
The principal factors reducing grasshopper habitat is: habitat loss and fragmentation and habitat degradation and alteration.	Loss of Grassland Habitat within Breeding Range	Restoring converted, abandoned habitat back into native bunchgrass habitat will increase available habitat and reverse population declines.
	Loss of Grassland Quality	Properly managed grazing will decrease spread of non-native understory plant species and help reestablish a native plant community.
	Displacement of Native Shrub Steppe / Grassland Vegetation by Non-Native Vegetation	Control of non-native weeds will maintain and increase habitat available to grasshopper sparrow.

4.4 Ponderosa Pine (*Pinus ponderosa*)/Oregon White Oak (*Quercus garryanna*)

Description of Habitat

Rationale For Selection

Ponderosa Pine

Much of the ponderosa pine forest in Washington State lies at lower elevations under state and private ownership. Most of this land base was heavily harvested in the first part of the last century, leaving very little late seral or old growth ponderosa pine habitat today. Fire suppression and over grazing had additional impacts. Noss et al. (2001) considers ponderosa pine ecosystems to be one of the most imperiled ecosystems of the West. Much of this land is now over stocked with an understory of Douglas-fir and grand fir (Abies grandis) or smaller diameter pine. 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. 2999) 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). Clark's nutcracker (*Nucifraga columbiana*) and brown creepers (*Certia americana*) also use ponderosa pine as a food source (R. Dixon pers. comm.).

Due to the alteration of this ponderosa pine habitat and loss of late seral pines, and due to the importance large pines to wildlife, the Ponderosa Pine / Oregon White Oak wildlife habitat type was chosen as a focal wildlife focal habitat.

Oregon White Oak

Oregon white oak woodlands consist of stands of pure oak or oak / conifer associations. In oak / conifer associations, ponderosa pine and Douglas-fir are important conifer components of these habitats. East of the Cascades, important oak habitat stands should generally be ≥ 5 acres in size to be functional habitat for wildlife. In more developed areas, though, single oaks or small stands of oaks that are < 1 acre in size, can also be valuable to wildlife when the oaks are late seral. These oaks have are larger in diameter, contain more cavities for nesting, produce more acorns, and have a large canopy. Late seral oaks are an important component of all oak forests.

Oregon white oak, known by many as Garry 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, but in the oak forests found along Klickitat River, there are several bird species present not otherwise found in Washington State (Manuwal 1989). These include acorn woodpecker (*Melanerpes formicivorus*), scrub jays (*Aphelocoma coerulescens*), and dusky flycatchers (*Empidonax oberholseri*).

Over the last two centuries, oak habitats have changed due to 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. Late seral oak stands are important to western gray squirrels, white-headed woodpeckers and Lewis' woodpecker. In upland oak-pine stands, some of the more common birds include the chipping sparrow, Nashville warbler (*Vermivora ruficapilla*), lazuli bunting (*Passerina anoena*), red-breasted nuthatch, western tanager, and ash-throated flycatcher (*Myiarchus cinerascens*). In the oak-pine riparian areas, some of the most common birds are the spotted towhee (*Pipilo erythrophthalmus*), black-headed grosbeak (*Pheucticus melanocephalus*), American robin (*Turdus migratorius*), black-throated gray warbler (*Dendroica nigrescens*), MacGillivray's warbler (Oporornis tolmiei), lazuli bunting and red-breasted nuthatch (Manuwal 1989). Reptiles found in oak habitats include the California Mountain king snake (*Lampropeltis zonata*), sharptail snake (*Contia tenuis*), western rattlesnake (*Crotalus viridis*), southern alligator lizard (*Elgaria multicarinata*), and the western skink (*Eumeces skiltonianus*) (St. John 2002). There are also several species of invertebrates that use oak forests.

Due the importance of oak, oak-pine and oak riparian habitats to wildlife, the Ponderosa Pine / Oregon White Oak wildlife habitat was chosen as a focal habitat.

Ponderosa pine and Oregon white oak are separate plant habitats that often occur in proximity to one another or overlapping in transitional zones. In the lower Columbia, there have been five oak and pine habitats defined: riparian hardwoods (various amounts of hardwood species, including oak, no pine), riparian hardwood-pine (hardwoods, including oak with pine), riparian ponderosa pine (pine only), oak-pine forests (oak and pine uplands), and pure oak forests (no pine, uplands). The beginning of this write-up will focus, in a general way, on oak and pine as separate habitats, and then will discuss the importance of zones where they are found together.

Ponderosa Pine

Historic

Prior to 1850, much of the ponderosa pine habitat in the subbasin, and other parts of the inland northwest, was mostly open and park like with relatively few undergrowth trees. Fire scar evidence in the Wenatchee Mountains indicate that ponderosa pine forests burned approximately every 5-30 years prior to fire suppression, preventing contiguous understory development and, thus, maintaining relatively open ponderosa pine stands. Similar fire cycles are likely in the subbasin as well.

The 1930s-era timber inventory data (Losensky 1993) suggests large diameter ponderosa pine-dominated stands occurred in very large stands, encompassing large landscapes. Such large stands were fairly homogeneous at the landscape scale (i.e. large trees, open stands), but were relatively heterogeneous at the acre scale, with "patchy" tree spacing, and multi-age trees (Hillis et al. 2001).

Ponderosa pine forms climax stands that border grasslands and is a common member in many other forested communities (Steele et al. 1981). Ponderosa pine is a drought tolerant tree that usually occupies the transition zone between grassland and forest. Climax stands are characteristically warm and dry, and occupy lower elevations throughout their range. Key understory associates in climax stands typically include grasslike species such as bluebunch wheatgrass (Pseudoroegneria spicata) and Idaho fescue (*Festuca idahoensis*), elk sedge (*Corex geyeri*), and shrubs such as bitterbrush (*Purshia tridentata*), ceanothus [redstem (*Ceanothus sanguineus*), deer brush (*C. integerrimus*), snowbrush (*C. velutinus*), squaw carpet (*C. prostrates*)] and common snowberry (*Symphoricarpus albus*). Ponderosa pine associations can be separated into three shrub-dominated and three gras-dominated habitat types.

Four community types are associated with ponderosa pine (Cooper et al. 1991):

- Ninebark (Physocarpus malvaceus)
- Common snowberry
- Idaho fescue
- Bluebunch wheatgrass

Daubenmire and Daubenmire (1984) recognize two more habitat types within the ponderosa pine series:

- Needlegrass (*Stipa comata*)
- Bitterbrush

In some places, the change from steppe to closed forest occurs without the transitional ponderosa pine zone, for example, at locations along the east slopes of the north and central Cascades. More commonly, the aspect dependence of this zone creates a complex inter-digitization between the steppe and ponderosa pine stands, so that disjunct steep zone fragments occur on south-facing slopes deep within forest while ponderosa pine woodlands reach well into the steppe along drainages and north slopes.

The successional status of ponderosa pine can be best expressed by its successional role, which ranges from seral to climax depending on specific site conditions. It plays a climax role on sites toward the extreme limits of its environmental range and becomes increasingly seral with conditions that are more favorable. On more mesic sites, ponderosa pine encounters greater competition and must establish itself opportunistically, and is usually seral to Douglas-fir and true firs (mainly grand fir). On severe sites, it is climax by default because other species cannot establish. On such sites, establishment is likely to be highly dependent upon the cyclical nature of large seed crops and favorable weather conditions (Steele 1988).

Current

Quigley and Arbelbide (1997) concluded that the interior ponderosa pine habitat type is significantly less in extent than pre-1900 and that the Oregon white oak habitat type is greater in extent than pre-1900. They 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, decreased overstory canopy, 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.

Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that gives the habitat a more closed, multi-layered canopy. For example, this habitat includes previously natural fire-maintained stands in which grand fir can eventually become the canopy dominant. Large late-seral ponderosa pine, and Douglas-fir are harvested for timber 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 habitats are now denser than in the past and may contain more shrubs than in pre-settlement habitats. In some areas, new woodlands have even been created with tree establishment at the forest-steppe boundary.

Throughout most of the zone, ponderosa pine is the sole dominant in all successional stages. At the upper elevation limits of the zone, on north-facing slopes in locally mesic sites, or after long-term fire suppression, other tree species Douglas fir, grand fir, western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta latifolia*), western juniper (*Juniperus occidentalis*), or Oregon white oak may occur. At the upper-elevation limits of the zone, in areas where the ponderosa pine belt is highly discontinuous, and in cooler parts of the zone, Douglas-fir, and occasionally western larch, lodgepole pine, and grand fir become increasingly significant. In Yakima and Klickitat Counties, Oregon white oak may be present, especially in drainages (extensive Oregon white oak stands are assigned to the Oak zone). In the Blue Mountains, small amounts of western juniper commonly occur. Lodgepole pine is common in the northeast Cascades and northeastern Washington (Daubenmire and Daubenmire 1968).

Stresses

Timber Activities

The ponderosa pine ecosystem has been heavily altered by past forest management. Specifically, the removal of overstory ponderosa pine since the early 1900s and nearly a century of fire suppression have led to the replacement of most old-growth ponderosa pine forests by younger forests with a greater proportion of Douglas-fir than ponderosa pine (Habeck 1990). Clear-cut logging and subsequent reforestation have converted many older stands of ponderosa pine / Douglas-fir forest to young structurally simple ponderosa pine stands (Wright and Bailey 1982).

Ponderosa pine is shade intolerant and grows most rapidly in near full sunlight (Franklin and Dyrness 1973, Atzet and Wheeler 1984). Logging is usually done by a selection-cut method. Older trees are taken first, leaving younger, more vigorous trees as growing stock. This effectively returns succession to earlier seral stages and eliminates climax, or old growth, conditions. Logging also impacts understory species by machine trampling or burial under slash. Clearcutting generally results in dominance by understory species present before logging, with invading species playing only a minor role in post logging succession (Atzet and Wheeler 1984).

Fire Suppression

Ponderosa pine has many fire resistant characteristics. Seedlings and saplings are often able to withstand fire. Pole-sized and larger trees are protected from the high temperatures of fire by thick, insulative bark, and meristems are protected by the surrounding needles and bud scales.

Other aspects of the pine's growth patterns help in temperature resistance. Lower branches fall off the trunk of the tree, and fire caused by the fuels in the understory will usually not reach the upper branches. Ponderosa pine is more vulnerable to fire at more mesic sites where other conifers as Douglas-fir, and grand fir form dense understories that can carry fire upward to the overstory. Ponderosa pine seedlings germinate more rapidly when a fire has cleared the grass and the forest floor of litter, leaving only mineral rich soil (Fischer and Bradley 1987).

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, reduces fine fuels that carry low intensity fires, and tends to favor shrub and conifer species. Fire suppression combined with grazing creates conditions that support cloning of oak and invasion by young conifers, including shade tolerant species such as grand fir.

Successional and climax tree communities are inseparable in this zone because frequent disturbance by fire is necessary for the maintenance of open woodlands and savanna. Natural fire frequency is very high, with cool ground fires believed to normally occur at 8 to 20 year intervals by one estimate and 5 to 30 year intervals by another. Ponderosa pine trees are killed by fire when young, but older trees survive cool ground fires. Fire suppression favors the replacement of the fire-resistant ponderosa pine by the less tolerant Douglas-fir and grand fir.

The high fire frequency maintains an arrested seral stage in which the major seral tree, ponderosa pine, is the "climax" dominant because other trees are unable to reach maturity. The ponderosa pine zone is most narrowly defined as the zone in which ponderosa pine is virtually the only tree. As defined in this document, the ponderosa pine zone encompasses most warm, open-canopy forests between steppe and closed forest, thus it includes stands where other trees, particularly Douglas-fir, may be co-dominant with ponderosa pine (Daubenmire and Daubenmire 1968).

The major defining structural feature of this zone is open-canopy forest or a patchy mix of open forest, closed forest, and meadows. On flat terrain, trees may be evenly spaced. On hilly terrain, the more common pattern is a mix of dry meadows and hillsides, tree clumps, closed forest in sheltered canyons and north-facing slopes, shrub patches, open forest with an understory of grass and open forest with an understory of shrubs. Without fire suppression, the common belief is that the forest would be less heterogeneous and more savanna-like with larger, more widely spaced trees and fewer shrubs (see Daubenmire and Daubenmire 1968 for a dissenting opinion).

Inappropriate Grazing

Excessive grazing of ponderosa pine stands in the mesic shrub habitat type tends to lead to swards of Kentucky bluegrass and Canada bluegrass (*Poa compressa*). Native herbaceous understory species are replaced by introduced annuals, especially cheatgrass (*Bromus tectorum*) and invading shrubs under heavy grazing pressure (Agee 1993). In addition, four exotic knapweed species (*Centaurea* spp.) are spreading rapidly through the ponderosa pine zone and threatening to replace cheatgrass as the dominant increaser after grazing (Roche and Roche 1988). Dense cheatgrass stands eventually change the fire regime of these stands.

Oregon White Oak

Historic

Historically, the distribution of Oregon white oaks in Washington was more extensive than today (Detling 1968, Larsen and Morgan 1998).

Oak and oak / conifer habitats are usually confined to drier microsites between conifer and grassland habitats (Stein 1980). Ponderosa pine and Douglas-fir are often important tree species components of oak habitats and can increase their value to wildlife. In the area, understory shrubs are often dominated by bitterbrush and big sagebrush (Artemesia tridentata) (Taylor and Boss 1975). Understory forbs are often dominated by the same species common to adjacent shrub steppe and grassland habitats, such as lupine, balsamroot, Idaho fescue, bluebunch wheatgrass, elk sedge, blue wildrye, and other common grass-like species.

Nest cavities are an important component of oak forests. Many of the cavities found in oak trees are created by the woodpeckers. Woodpeckers, which are primary excavators, cannot create cavities in all trees and snags (Jackman 1975). It is important to have trees of varying ages and diameters to increase the number of woodpecker-created cavities in an oak forest (Conner et al. 1975). In turn, the higher number of cavities present is directly related to the density of cavity-nesting species (Jackman 1975), such as the flammulated owl, a secondary cavity user. Cavities can also be created when decay-causing organisms infect a wound, such as a broken bole or branch, and the tree grows around the wound to contain the decay (Gumtow-Farrior and Gumtow-Farrior 1994). This can create large, deep cavities inside the tree that are used by species such as the western gray squirrel for nesting and rearing young.

Oak have always been an important food source for wildlife. Oaks support insects within its bark that are eaten by woodpeckers (Jackman 1975). The most important food source from oaks, though, are acorns. Oak masts (acorns) make up the significant portion of the diet of many species of birds and mammals (Voeks 1981, Miller 1985, Larsen and Morgan 1998). Consumers of acorns include western gray squirrel, Douglas' squirrel (*Tamiasciurus douglasii*), Lewis' woodpecker, deer, acorn woodpeckers, scrub jays and black bear (*Ursus americanus*). Acorn production fluctuates yearly for unknown reasons (Larsen and Morgan 1998).

Leaves are an important food source for deer and elk, and contain significant amounts of protein (Miller 1985). Deer and elk, in turn, are an important prey item for several carnivores such as cougars (*Puma concolor*), whose population depends on the population of healthy deer (Barrett 1980). Some invertebrates also rely on oak leaves during larval stages (Pyle 1989, Larsen and Morgan 1998). Leaf litter also may help retain soil moisture that aids in oak seedling survival.

Current

In Washington State, the current distribution of Oregon white oak woodlands is limited primarily to along the Columbia Gorge, northward along the east side of the Cascade Range, as well as in the Puget Trough and in the south-central counties (Scheffer 1959, Stein 1980, Miller 1985) (figure 13). Within this limited range, oak woodlands are considered uncommon.

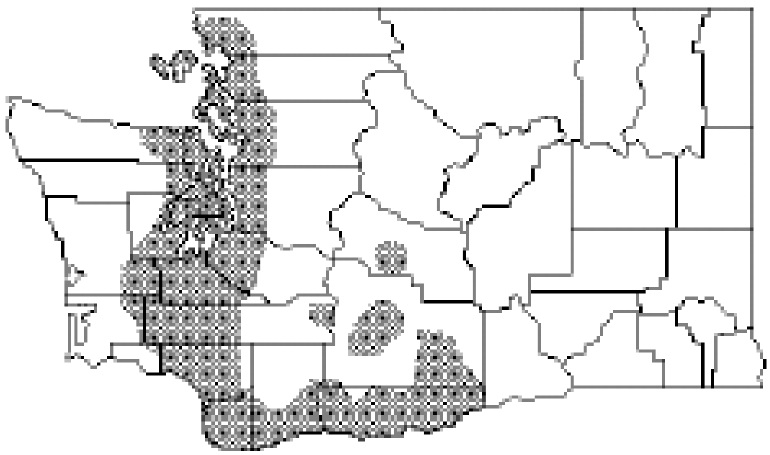

Figure 13 Range of Oregon white oak woodlands in Washington. Map derived from WDFW data files and the literature (Larsen and Morgan 1998).

Stresses

Fire Suppression

Fire suppression has created denser forests with smaller trees. In oak forests, it has led to denser understories, smaller trees and higher fuel loads. Historically, oak forests, like ponderosa pine, were more open and park-like. Open-canopy stands of oak generally have more complex plant understories than closed-canopy stands and can, therefore, support more wildlife species. Canopy cover of 25-50 % provides ideal habitat for a variety of species as well as needed gaps for sunlight (Barrett 1980).

Although conifer encroachment is an issue in oak forests in many parts of Washington State, it may not be in eastern Washington. Conifer encroachment, predominately by Douglas-fir, occurs primarily west of the Cascade crest and in wetter areas on the east side, such as the White Salmon River drainage of the Columbia Gorge. In drier areas east of the Cascades, conifer competition with oaks is generally negligible. Oregon white oak is usually sub-climax and becomes climax only on dry, rocky, southerly exposures (UFS 1965).

Land Conversion

Most oak woodlands in the state are privately owned, and private parcels collectively comprise the largest contiguous tracts (WDW 1993, Larsen and Morgan 1998). Statewide mapping is underway by WDFW to quantify the extent of Washington State's oak habitat. Klickitat County and adjoining lands harbor the largest stands of Oregon white oak in Washington State. Klickitat County alone, contains approximately 195,000 acres of oak and oak/pine woodlands with >25% canopy coverage. Within this area, there has been conversion of oak stands to agricultural lands, urban development, and losses from fuelwood cutting. These are believed to be the most significant contributors to oak woodland decline (Larsen and Morgan 1998). These land conversions are still taking place. Oregon white oak responds to fire by reestablishment through sprouting. Subsequent to settlement, fire control has resulted in less fire tolerant species competing for habitat with oak, thus replacing it in the community. This is arguably the significant impact to oak on private lands.

Woodcutting

Woodcutting may remove the largest trees from oak forests. Snags and snag recruitment trees may also be removed. Oak snags and dead portions of live trees harbor insect populations and provide nesting cavities and perches for birds and mammals.

Insects and Disease

Some trees succumb to defoliating insects or insects that attack by creating galls between the tree's bark and wood (UFS 1965). Recent insect blights have occurred in Klickitat County where already drought stressed trees have succumbed (B. Weiler, pers. comm.).

Thirty-one species of fungi also affect Oregon white oak. Some inhibit growth, and others kill trees. The major decay fungi are shoestring root rot (*Amillaria mellea*) and trunk rot (*Polyporus dryophilus*) (UFS 1965). Decomposing fungi, coupled with the rotting characteristics of this oak species, simplify the excavation of cavities for woodpeckers by softening wood (Jackman 1975). The process is often facilitated by the loss of limbs that expose heartwood (Gumtow-Farrior 1991).

A recent introduction of Sudden Oak Death syndrome, caused by the fungus Phytophthora ramorum, infects and kills other species of oak in California State. Oregon white oak is currently known to be a host to this fungus, but is not killed by it. Managers must stay aware of this fungus in case it mutates into a form deadly to the oaks.

Timber Activities

Clearcutting reduces oak habitat and the numbers of animals within, encourages conifer encroachment, and creates edges. The extent of this activity in the subbasin is currently low, or not occuring. Edges increase the frequency of predation on interior nesting species (Connel et al. 1973, Conner et al. 1979, Chasko and Gates 1982, Reed and Sugihara 1987).

Appropriate timber practices within oak stands vary according to location and tree species composition. When stands are thinned, Douglas-fir and ponderosa pine are harvested, temporarily leaving pure stands of oak. Selective cutting practices can allow for the retention of different age-class and species composition within stands (Conner et al. 1979), and age diversity within stands contributes to species richness and breeding bird diversity (Connel et al. 1973).

Failure to thin even-aged oak stands and failure to open canopy above overshaded oak sprouts and saplings may result in dense, even-aged oak stands of little diversity. Dense, even-aged oak stands support fewer kinds of wildlife.

Oak / Pine Mixed Zones

The difference between conifer encroachment and those oak/conifer associations valuable to wildlife is often unclear. Consultation with biologists from the WDFW and other oak specialists is strongly recommended whenever uncertainty prevails. 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, particularly for western gray squirrels and wild turkeys

(*Meleagris gallopavo*). Conversely, conifer encroachment on oaks in western Washington and along wetter sites in the Columbia Gorge, such as the White Salmon drainage, is prevalent and undesirable.

Oak/conifer associations provide contiguous aerial pathways for squirrels and other animals. Mixed oak/conifer associations are particularly important in potential western gray squirrel habitat and for increasing stand diversity for breeding birds (Rodrick and Milner 1991, WDW 1993).

Failure to provide conifer associations in oak woodlands may limit the number of species of breeding birds present. In addition, roost sites for wild turkeys and other birds, as well as feeding sites for squirrels, will be absent.

4.4.1 Western Gray Squirrel (*Sciurus griseus*)

Rationale for Selection

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. In the subbasin, population loss and fragmentation is largely due to disease (i.e., mange) associated with invasion of California ground squirrels and seasonal weather differences, which affect acorn production. Habitat loss and degradation is also a likely long-term factor. In the future, competition from the introduced eastern grey squirrel may also be an issue. The western gray squirrel is heavily associated with both ponderosa pine and Oregon white oak forests. In the Columbia River Gorge, Oregon white oak-ponderosa pine forests prevail. 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 found that the species was “in danger of extirpation from most of its range in Washington” (WDW 1993), although in Klickitat County the population appears to be stable. The western gray squirrel is now a state threatened species in Washington State and a federal species of concern. Due to their strong association with late seral oak and pine forests, the western gray squirrel was chosen as a focal species for the Ponderosa Pine / Oregon White Oak wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following (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; 8.2-22.6 in, mean = 15.7 in)
- Within 180 m (600 ft) of water
- Adequate food sources
- Acorns important in winter and early spring

- Pine cones and seeds in late summer and fall
- 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)

General

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, 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).

Oak was more common in Washington 10,000 years ago, before a long-term climatic change (Kertis 1986). The western gray squirrel was probably more widely distributed in prehistoric times and has diminished recently along with the oak woodlands (Rodrick 1987). 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.

Nesting

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).

Population Status and Trend

Status

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; 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.

Lewis and Clark (Thwaites 1904) described western gray squirrels as locally abundant in the Columbia River Gorge (see figure 14 for map of historic distribution). In a book written on the Klickitat area (Neils 1967), Norris Young, an early settler of the town of Klickitat, wrote in 1890 “About this time the grub was getting low. We had killed almost enough gray squirrels to cover our roof and fringe the eaves with squirrel tails. However, we stayed until our food was all gone and we started to live on meat alone."

Residents have noticed a decline of western grays in Klickitat County (Rodrick 196). Prior to the invasion of the California ground squirrel (*Spermophilus beecheyi*), local residents reported more western gray squirrels in the gorge in the 1920s (WDW 1993). Ground squirrel both competed for food and introduced mange to this population, likely contributing to the decline in western gray squirrels (WDW 1993). For example, during a study of western gray squirrels in Klickitat County conducted in 1998 and 1999, an outbreak of mange killed all but 4 of 22 squirrels being monitored by radiotelemetry (Cornish et al. 2001). Although exact reasons for their decline are unknown, changes in the landscape may have played a role.

Isolated populations remain in the southeast slope Cascade region, and the Columbia River Gorge, the latter being the largest in the state (figure 15). Recent records indicate that western gray squirrels are present in five major tributaries of the Columbia Gorge: the Klickitat River, Catherine, Majors, and Rock creeks, and the White Salmon drainage. In Klickitat County, the population seems to have been stable during the past 20 years. Since 1973, D. Morrison (from WDW 1993, pers. comm.) has observed several western grays each year on the Klickitat Wildlife Area. The western gray squirrel appears to be widely distributed across forested habitats of Klickitat County, but populations are localized. The core population of the western gray squirrel is currently found in the lower Klickitat drainage from the southern Yakama Nation boundary to the mouth of the Klickitat River.

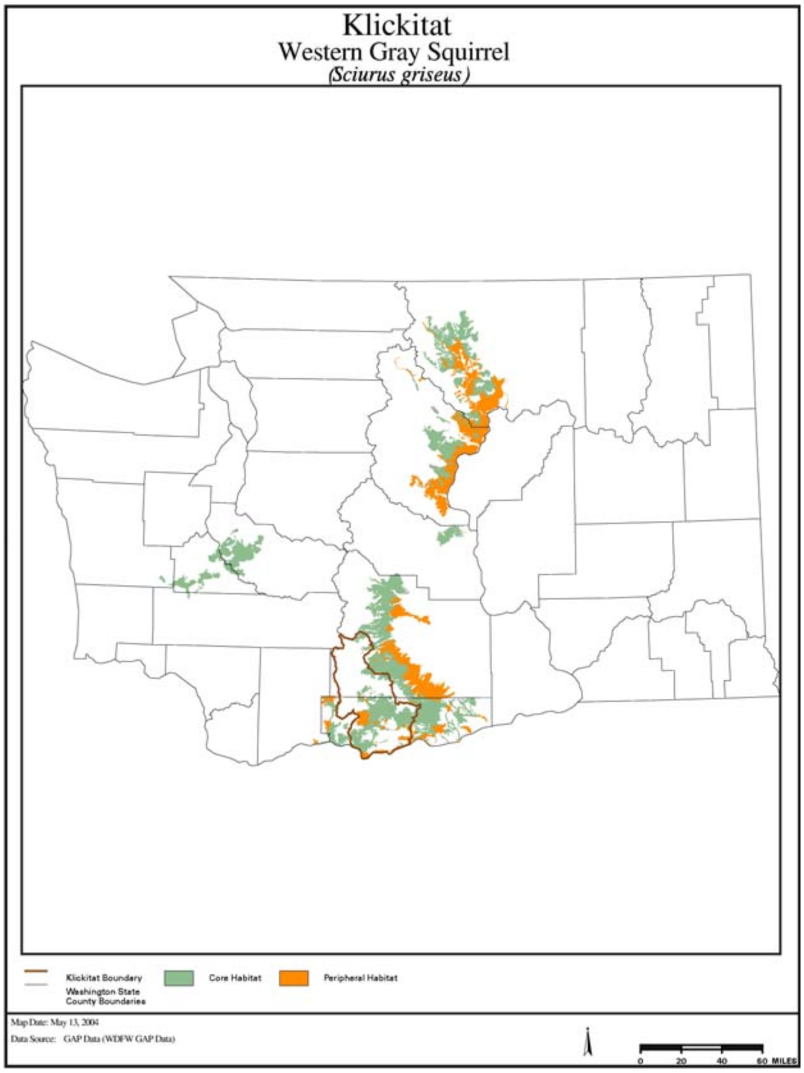

Figure 14 Potential habitat for western gray squirrel in the Klickitat subbasin and Washington State (Johnson and Cassidy 1997)

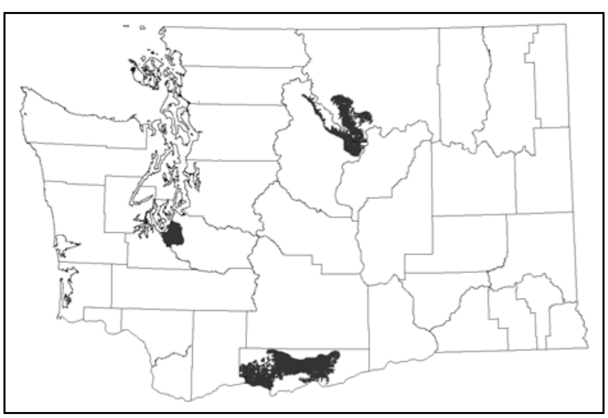

Figure 15 Estimated current distribution of western gray squirrels in Washington (adapted from Booth 1947, Ingles 1965, Source: WDFW 2004)

Trend

Long-term trends in the South Cascades population are unclear, although researchers did observe a decline in response to a widespread mange outbreak in 1998-9 and a subsequent rebound in the years following (M. Linders unpubl. data). In Klickitat County, the population seems to have been stable during the past 20 years.

Management Issues

The Washington Department of Fish and Wildlife is in the process of writing a draft recovery plan, which is expected to be due out for public review in the summer of 2004.

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.

Out-of-Subbasin Effects and Assumptions

A radio telemetry study of 25 western gray squirrels in Klickitat County, Washington, found 95% MCP year-round home ranges from 10-187 ha (mean 73 ha) for males and 3-44 ha (mean 21 ha) for females (Linders 2000). Home ranges of males were largest, then breeding females, with nonbreeding females having the smallest ranges (Linders 2000).

Relationship with Riparian / Fisheries Issues

In lower Columbia subbasins, oak habitat is commonly found along the main rivers and their tributaries. Large oak trees can provide shade for streams edges, while roots can provide bank stabilization. Healthy riparian terrestrial habitat provides habitat for wildlife as well as nutrients and woody debris, an important stream component for fish.

Factors Affecting Population

Weather

Annual fluctuations in rain and temperature can effect acorn production, which will result in annual fluctuation in western gray squirrel mortality.

Absence of late seral oak and pine

Older trees produce more acorns and pine seeds, vital food sources, and produce better nesting sites (cavities in oak, platforms in pine). There is also an increase in crown connectivity:, which is important for arboreal travel.

Presence of non-native squirrel species:

There has been an increase in California ground squirrels in the subbasin, but the affect on the western gray squirrel population is largely anecdotal. They moved up through Oregon naturally, but there was a rapid increase in their numbers following the construction of dams and bridges across the Columbia River (WDW 1993). They likely compete for food and nesting, and has been suspected that California ground squirrels transferred manage to the western gray squirrel population causing a population crash (G. Brady, pers. comm., from WDW 1993).

Eastern gray squirrels (Sciurus carolinensis) were introduced into western Washington. Although it is not clear whether eastern gray squirrels displace western gray squirrels, they do areas where westerns were found historically, but are no longer present. This may be due to easterns tolerance of developed areas that westerns do not have. This may have caused easterns to replace rather than displace westerns (WDW 1993). Eastern gray squirrels have been observed in the Big White Salmon subbasin (D. Anderson and F. Backus, pers. comm.). There presence in the Klickitat subbasin has not been determined.

4.4.2 Flammulated Owl (*Otus flammeolus*)

Rationale for Selection

The flammulated owl is a ponderosa pine forest obligate (Hillis et al. 2001). The mature and older forest stands that are used as breeding habitat by the flammulated owl have changed during the past century due to fire management and timber harvest. The flammulated owl, due to its demography, life history and narrow habitat requirements, is vulnerable to these habitat changes (Hays and Rodrick 2002). The flammulated owl is a State Candidate species in Washington State, a PHS species (see section 2.5.6) and is considered a species-at-risk by the Washington Gap Analysis (see section 2.7) and Audubon-Washington. Because of this, and their strong association with healthy, late seral ponderosa pine forests, they are a focal species for the Ponderosa Pine / Oregon White Oak wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following:

- Old growth, or late seral, forests. The owls' preference appears to be for forests over 100 years old (Howie and Ritcey (1987), and the highest densities are in 140-200 year old stands (Howie and Ritcey 1987). In that habitat the uppermost canopy layer is formed by trees ≥ 200 years old
- Tree size > 20 in. dbh (Bull et al. 1990)
- Adequate snag retention for nesting with snags that are > 20 in. diameter at breast height (dbh) (Goggans 1986; Bull et al. 1990; Powers et al. 1996) and average > 16 ft high (Goggans 1986; Bull et al. 1990; Powers et al. 1996). The snags should be capable of supporting cavities 11 to 12 in. deep with a depth of 8.4 in. (McCallum and Gehlbach 1988)
- Vegetative complexity with multi-layered canopies and openings of up to five acres (Howie and Ritcey 1987)
- Uneven-aged forests (Hayward and Verner 1994)
- Patches of dense vegetation for roosting (Goggans 1986)
- Core areas are near, or adjacent to clearings of 10-80% brush cover (Bull and Anderson 1978, Marcot and Hill 1980)
- Adequate habitat (stated above) is necessary for repeated occupation (Linkhart and Reynolds 1997)

- Nesting home range size recommendations vary from 26 acres (Goggans 1986) to 35 acres (Linkhart 1984)

General

Flammulated owls are typically found in mature to old, open ponderosa pine, Jeffrey pine (*Pinus jeffreyi*), Douglas-fir, and grand fir (Bull and Anderson 1978, Goggans 1986, Howie and Ritchie 1987, Reynolds and Linkhart 1992, Powers et al. 1996). The flammulated owl occurs mostly in mid-level conifer forests that have a significant ponderosa pine component (McCallum 1994b).

Dense mixed understory conifer patches offer important protection for these owls during roosting and calling. Overall, flammulated owls select habitat that combines open forest stands with large trees and snags, clusters of thick understory vegetation, and adjacent grassland openings.

Nesting

Older, larger dbh trees provide more natural cavities and available dead and dying trees for nesting by pileated woodpeckers and other primary excavators. Thus, old growth stands typically may contain more available nesting sites.

Flammulated owls are obligate secondary cavity nesters (McCallum 1994b), requiring large snags in which to roost and nest. They require a natural cavity or old woodpecker excavation in which to lay their eggs. The owls nest primarily in cavities excavated by northern flickers (*Colatesauratus*), hairy woodpeckers (*Picoides villosus*), pileated woodpeckers (*Dryocopus pileatus*), and sapsuckers (*Sphyrapicus* spp.) (Bull et al. 1990, Goggans 1986, McCallum 1994b). The owls selectively nest in dead ponderosa pine snags, and prefer nest sites with fewer shrubs in front than behind the cavity entrance, possibly to avoid predation and obstacles to flight. Flammulated owls will nest only in snags with cavities that are deep enough to hold the birds, and far enough off the ground to be safe from terrestrial predators. Flammulated owls also nest in habitat types with low to intermediate canopy closure (Zeiner et al. 1990).

Territories most consistently occupied by breeding pairs (>12 years) contained the greatest (>75%) amount of late seral ponderosa pine / Douglas-fir forest. Territories are typically found in core areas of mature timber with two canopy layers present (Marcot and Hill 1980).

Diet and Foraging

Flammulated owls principally forage for prey on the needles and bark of large trees. They feed almost excusively on invertebrates. The highest percentage of the diet includes Lepidoptera, Orthoptera and Coeleoptera (Hayward and Verner 1994). Up to 4 times as many lepidopteran prey are associated with old growth ponderosa pine (Yasuda 2001). This gives this small owl a prey base greater within old ponderosa pine stands. Open forest structure associated with late seral ponderosa pine stands favors successful foraging of owls within the upper two-thirds of the tree crowns, between trees, and on the ground (McCallum 1994). Linkhart and Reynolds (1997) found that flammulated owls occupying stands of dense forest were less successful that owls whose territories contain open, old pine/fir forests.

Reynolds and Linkhart (1987) suggested that stands with trees >20 in. were preferred because they provided better habitat for foraging due to the open nature of the stands, allowing the birds access to the ground and tree crowns. Some stands containing larger trees also allow more light to the ground. This produces more ground vegetation, increasing habitat for insects preyed upon by owls (Bull et al. 1990). Reynolds and Linkhart (1987) found that trees where prey was captured had a mean age of 199 years compared to 111 years from a random sample of trees.

Vegetation complexity is also important. Areas with some edge habitat and grassy openings less than 5 acres in size are beneficial to the owls (Howie and Ritcey 1987) for foraging. Flammulated owls prefer to forage in older stands that support understories, and need slightly open canopies and space between trees to facilitate easy foraging. The open crowns and park-like spacing of the trees in old growth stands permit the maneuverability required for hawk and glean feeding tactics (USDA 1994a). A pair of owls appears to need substantial patches of brush and understory to help maintain prey bases (Marcot and Hill 1980).

Population Status and Trend

Status

Because old-growth ponderosa pine is more rare than it was historically, and little is known about the local flammulated owl distribution and habitat use, the USFS has listed the flammulated owl as a sensitive species in the Northern Region (USDA 1994b). It is also listed as a sensitive species by the USFS in the Rocky Mountain, Southwestern, and Intermountain Regions, and receives special management consideration in the States of Montana, Idaho, Oregon, and Washington (Verner 1994). See figure 16 for range map.

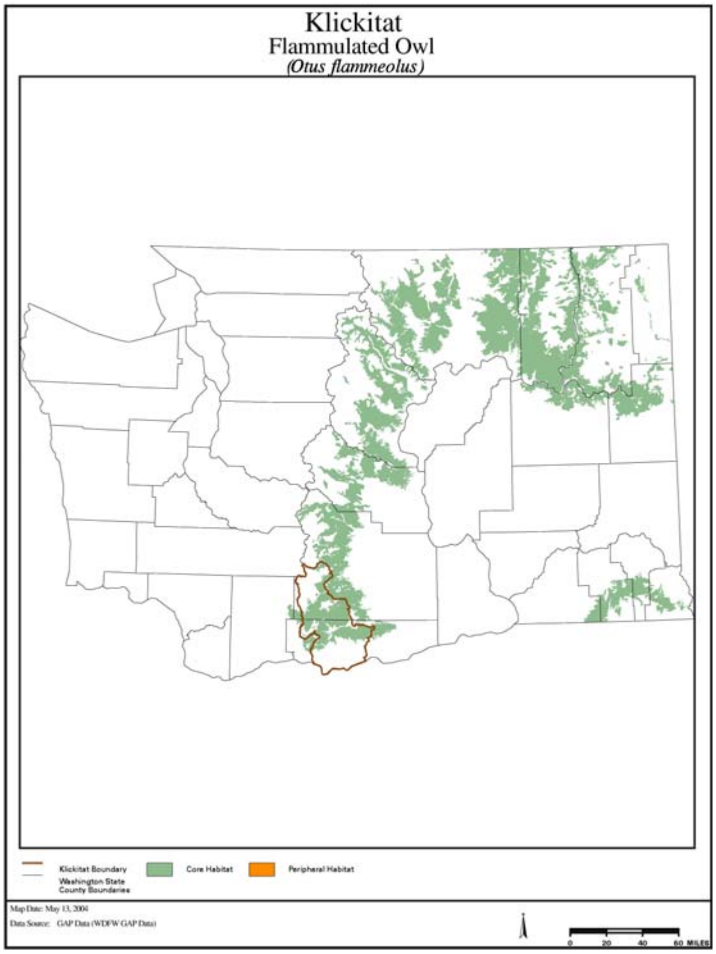

Figure 16 Potential habitat for flammulated owl in the Klickitat subbasin and Washington State (Smith et al. 1997)

Trends

Since little is known about flammulated owl populations, even large-scale changes in their abundance would probably go unnoticed (Winter 1974). Several studies have noted a decline in flammulated owl populations following timber harvesting (Marshall 1939, Howie and Ritcey 1987). However, as more and more nest sightings occur each year, this is most likely due to the increase in observation efforts.

Management Issues

There are only a few reports of this owl using nest boxes (Bloom 1983). Reynolds and Linkhart (1987) reported occupancy in 2 of 17 nest boxes put out for flammulated owls. Nesting boxes are probably not a good replacement of quality habitat.

Relationship with Riparian / Fisheries Issues

The historic and, in some locations, current heavy harvests of ponderosa pine forests can result in increased runoff into adjacent streams, increasing sediment and raising temperatures for those streams. Maintaining appropriate buffers adjacent to streams capable of supporting white-headed woodpeckers will increase the health of the streams and reduce sedimentation. This will in turn provide better habitat for fish and other stream dependent species.

Out-of-Subbasin Effects and Assumptions

The flammulated owl is one of the most migratory owls in North America. It is the only owl in North America that is a Neotropical migrant. It winters primarily in Mexico but has been recorded as far south as Guatemala. Flammulated owls start migrating north in April and probably arrive in Washington in May. Flammulated owls are presumed to be migratory in the northern part of their range (Balda et al. 1975). Flammulated owls can be found in Washington only during their relatively short breeding period. They migrate at night, moving through the mountains on their way south but through the lowlands in early spring.

Factors Affecting Population

Timber Activities

Logging disturbance and the loss of breeding habitat associated with it has a detrimental effect on the birds (USDA 1994a). The owls prefer late seral forests. The main threat to the species is the loss of nesting cavities, as this species cannot create its own nest and relies on existing cavities. Management practices such as intensive forest management, forest stand improvement, and the felling of snags and injured or diseased trees (potential nest sites) for firewood effectively remove most of the cavities suitable for nesting (Reynolds et al. 1989). However, the owls will nest in selectively logged stands, as long as they contain residual trees (Reynolds et al. 1989).

Fire Suppression

Wildfire suppression has allowed many ponderosa pine stands to proceed to the more shade resistant fir forest types, which is less suitable habitat for these species (Marshall 1957, Reynolds et al. 1989).

Roads

Roads and fuelbreaks, often placed on ridgetops, result in removal of snags for safety considerations (hazard tree removal) and firewood can result in the loss of existing and recruitment nest trees.

Pesticides

Pesticides including aerial spraying of carbaryl insecticides to reduce populations of forest insect pests may affect the abundance of non-target insects important in the early spring diets of flammulated owls (Reynolds et al. 1989). Although flamulated owls rarely take rodents as prey, they could be at risk, like other raptors, of secondary poisoning by anticoagulant rodenticides. Possible harmful doses could cause hemmorhaging upon the ingestion of anticoagulants such as Difenacoum, Bromadiolone, or Brodifacoum (Mendenhall and Pank 1980).

Invasive Non-Native Animal Species

Exotic species impact flammulated owl populations. Flicker cavities are often co-opted by European starlings (*Sturnus vulgaris*), reducing the availability of nest cavities for both flickers and owls (McCallum 1994a).

4.4.3 White-Headed Woodpecker (*Picoides albolarvatus*)

Rationale for Selection

White-headed woodpeckers are a native species that is associated with healthy ponderosa pine forests. They are dependent on large, old growth (or late seral) ponderosa pines for nesting and food. They are also a Washington state candidate species, a Partners In Flight (PIF) species and are on the PHS list. Due to their strong association with ponderosa pine forests, they were chosen as a focal species for the Ponderosa Pine / Oregon White Oak wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following:

- Mature and old-growth ponderosa pine and mixed conifer forests (Lewis et al. 2002)
- Varying recommendations on average dbh (diameter at breast height): 10 trees per acre over 20 in. dbh and two trees per acre over 28 in. (Blair and Servheen 1993); mean of 10 trees per acre >21 in. dbh, at least 2 trees per acre > 31 in. dbh (Altman 2000); nine trees over 27 in. dbh per acre (Dixon 1995b); mean 28 in. (Frederick and Moore 1991), and mean of 1.1 trees per acre of 31 in. dbh, for nesting (Frenzel 1998)
- Recommendations also vary regarding large, decayed snags for nesting and roosting: mean average = 51.5 cm dbh (Buchanan et al. 2003), 39.6 cm dbh (J. Kozma, unpub. data); mean of 5 snags per acre over 21 in. dbh, for nesting (Frenzel 1998), and mean of 1.4 per acre > 8 in. dbh with > 50% > 25 in. dbh in a moderate to advanced state of decay (Altman 2000)
- Home Range: 333 acres – predominantly old growth habitat (Dixon 1995b), and 720 acres – fragmented habitat
- Varying mean canopy closure recommendations include: 56% (Dixon 1995b, Frederick and Moore 1991), 10-40% (Altman 2000) and nesting may not occur in stands with > 26% canopy cover (Frederick and Moore 1991)
- Low tree density, mean 116 trees per acre (Frederick and Moore 1991)
- Sparse understory vegetation, increased height of first canopy layer (Bate 1995)

Nesting

White-headed woodpeckers need old growth ponderosa pine forest habitats for healthy populations. Large pines eventually turn into large dead trees, or snags, which are ideal for nesting. White-headed woodpeckers favor selection of completely dead and moderately to well-decayed snags for nesting due to morphological characteristics that result in them being considered a weak primary excavator and unable to excavate into hard wood (Raphael and White 1984, Milne and Hejl 1989, Dixon 1995). Snag decay is often a better predictor of nest site selection in white-headed woodpeckers than diameter of the snag (Frederick and Moore 1991). These birds prefer to build nests in trees with large diameters with preference increasing with diameter. This species typically roosts in both live and dead ponderosa pine trees averaging 60 cm dbh and 7 m tall (Lewis et al. 2002).

Diet and Foraging

Large diameter trees reduce energy expenditure and decrease vulnerability to predation since more time is spent foraging on one tree rather than flying to many trees to find the same quantity of food. In addition, large diameter pine trees often have large cone crops providing a more abundant winter food source. Large conifers selected for foraging also have furrowed bark with numerous fissures; important for species like white-headed woodpeckers that forage predominately by peering and probing bark crevices for insects (Garret et al. 1996). During cold spring weather, birds foraged primarily on ponderosa pine cones, with stomach contents of two males and two females yielding 70-90 percent pine seeds (Ligon 1973). In early summer, males foraged primarily on the thick cluster of growing needles on branches, presumably taking mostly arthropods (Ligon 1973). In late summer, both males and females foraged on the main trunk of trees and unripened (green) pinecones.

Open stands are important, however, not as important as the presence of mature or veteran cone producing pines within a stand (Milne and Hejl 1989). Old growth ponderosa pine trees produce higher numbers of cones, an important source of food for white-headed woodpeckers. The understory vegetation is usually very sparse within the preferred habitat and local populations are abundant in burned or cut forest where residual large diameter live and dead trees are present.

Milne and Hejl (1989) found 68 percent of nest trees to be on southern aspects.

Population Status and Trend

Historically, white-headed woodpeckers were likely widespread and patchy across the lower elevation forests dominated by large ponderosa pine in the Klickitat subbasin. North of the subbasin in the Wenas Valley, bird watcher's records at the site of an annual Audubon Society campout since the 1950s, indicate substantially reduced observations of this species over the years. The area has been logged for large diameter overstory trees several times during this period.

Although populations appear to be stable at present, this species is of moderate conservation importance because of its relatively small and patchy year-round range and its dependence on mature, montane coniferous forests. Knowledge of this woodpecker's tolerance of forest fragmentation and silvicultural practices will be important in conserving future populations

Management Issues

Connor (1979) states that managing for the minimum habitat requirements may cause gradual population declines. Therefore, it is recommended that forests be managed using average rather than minimum suggested values.

Relationship with Riparian / Fisheries Issues

The historic heavy harvests of ponderosa pine forests resulted in increased runoff into adjacent streams, increasing sediment and raising temperatures for those streams. Maintaining appropriate buffers adjacent to streams capable of supporting white-headed woodpeckers will increase the health of the streams and reduce sedimentation. This will in turn provide better habitat for fish and other stream dependent species.

Out-of-Subbasin Effects and Assumptions

The white-headed woodpecker is a non-migratory bird and occupies the same home range year round. However, some birds have been recorded wandering to atypical habitats (lower elevation, suburban areas, etc.) during the winter. Local movement of birds may be in response to locally abundant food sources such as spruce budworms (*Choristoneura occidentalis*) and pine seeds (Garret et al. 1996). Most records of movement outside of normal breeding areas occur from August to April.

Factors Affecting Population

Timber Activities

Logging has removed much of the old growth cone producing pines throughout this species' range, which provide winter food and large snags for nesting. The impact from the decrease in old growth cone producing pines is even more significant in areas where no alternate pine species exist for the white-headed woodpecker to utilize.

Fire Suppression

Fire suppression has altered the stand structure in many of the forests. Lack of fire has allowed dense stands of immature ponderosa pine as well as the more shade tolerant Douglas-fir to establish. This has led to increased fuel loads resulting in more severe stand replacing fires where both the mature cone producing trees and the large suitable snags are destroyed. These dense stands of immature trees has also led to increased competition for nutrients as well as a slow change from a ponderosa pine climax forest to a Douglas-fir dominated climax forest.

4.4.4 Ponderosa Pine/Oregon White Oak Habitat and Focal Species Key Findings, Limiting Factors and Working Hypotheses

Table 16 Key findings, limiting factors and working hypotheses for the Ponderosa Pine / Oregon White Oak focal habitat and its representative focal species

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 fire.
	Loss of Native Understory Vegetation and Composition	Properly managed grazing will decrease spread of non-native understory plant species and help reestablish a native plant community. Presence of native grasses and forbs will provide good conditions for both wildlife and livestock.
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.
PONDEROSA PINE / OREGON WHITE OAK - FOCAL SPECIES		
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	Properly managed grazing will decrease spread of non-native understory plant species and help reestablish a native plant community. Presence of native grasses and forbs will provide good conditions for both western gray squirrels and livestock.
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.

PONDEROSA PINE / OREGON WHITE OAK		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Focal species have suffered declines in their population from competition due to the presence of squirrel species not historically present.	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.
Flammulated Owl		
Loss of large diameter snags has caused habitat loss, fragmentation and degradation for this species.	Reduction of Large Diameter Trees and Snags	Appropriate silvicultural practices that retain old overstory trees, increase average diameter of dominant trees, increase snag density and size will recover ponderosa pine late seral composition and structure. These conditions increase habitat and forage available to flammulated.
	Increased Stand Density and Decreased Average Tree Diameter	Utilizing fire as a tool to improve used and potentially used wildlife habitat will increase the quality of degraded habitat and result in greater numbers of flammulated owls.
	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 flammulated owl habitat.
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.
Survival has decreased for this species due to loss of prey base.	Reduced Food Base	Decreasing misuse of pesticides in ponderosa pine habitat will decrease mortality of prey base of flammulated owls.
White-Headed Woodpecker		
Loss of late seral pine trees has decreased nesting and foraging habitat for white-headed woodpeckers and fragmented potential habitat.	Reduction of Large Diameter Trees and Snags	Appropriate silvicultural practices that retain old overstory trees, increase average diameter of dominant trees, increase snag density and size will recover ponderosa pine late seral composition and structure. These conditions increase habitat and forage available to white-headed woodpeckers.
	Increased Stand Density and Decreased Average Tree Diameter	Utilizing fire as a tool to improve used and potentially used wildlife habitat will increase the quality of degraded habitat and result in greater numbers of white-headed woodpeckers.
	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 white-headed woodpecker habitat.

PONDEROSA PINE / OREGON WHITE OAK		
Key Findings	**Limiting Factors**	**Working Hypotheses**
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.

4.5 Montane Coniferous Wetlands

Rationale for Selection

The Montane Coniferous Wetlands wildlife habitat was chosen as a focal habitat due to its ecological and cultural importance. This habitat type is naturally limited in its extent. Categories within this habitat type include wet meadows, streams, ponds, seeps, bogs, swamps, and other forested wetlands. One of the categories of Montane Coniferous Wetlands we are focusing on isupland meadows. 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, providing a continuing source of water for many surrounding streams throughout the summer. In many montane wetland types, forest practices and grazing activities have over time compressed the soil, caused stream channel incisement, increased sediment delivery, decreased riparian cover. The functional losses are increases in-channel sedimentation, channel instability and bank erosion, lowered water table, and increased summer stream temperatures. 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 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 the presence of often 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.

Description of Habitat

Montane Coniferous Wetlands are typified as meadows, forested wetlands or floodplains with a persistent winter snow pack. In the Klickitat subbasin these habitats typically range in elevation between 2500 and 5000 feet above sea level, with subalpine meadows occurring up to 7000 feet.

Montane Coniferous Wetlands and Wildlife

The majority of terrestrial vertebrate species use some kind of riparian habitat for essential life activities making the density of wildlife in riparian areas comparatively high. Forested riparian habitat has an abundance of snags and downed logs that are critical to many cavity birds, mammals, reptiles, and amphibians. Riparian habitat structure tends to be more horizontally and vertically complex and often includes subcomponents such as marshes and ponds provide critical habitat for a number of species. Riparian habitats also function as travel corridors between essential habitats (e.g., breeding, feeding, season ranges). Species that depend on forested riparian habitats include the greater sandhill crane (*Grus canadensis tabida*), Oregon spotted frog (*Rana pretiosa*) and American beaver.

Historic

The montane coniferous wetland 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.

Historic wetland acreage in our subbasin is difficult to measure. The IBIS riparian habitat data are incomplete; therefore riparian floodplain habitats are not well represented on IBIS maps. Evidence of historic riparian wetland location and extent in the subbasin can be found by examining hydric soil distribution. The aerial photo record begins in the 1940s. In general, more recent photos indicate that historically sinuous meadow streams have become more channelized. Similarly, the distribution and abundance adjacent hydrophytic vegetation has beend reduced.

Snow typically begins accumulating in October and November and persists until March to June with earlier onset and increased duration and abundance directly proportional with elevation. Winter climate varies from moderately cool and wet in rain-on-snow dominated areas (e.g. Cedar Valley) to moderately dry and very cold (e.g. Klickitat Meadows). Summer climates tend to be hot and dry with very little precipitation falling between June and September. Mean annual precipitation ranges from about 30 inches in lower portions of Cedar Valley to 65 inches in the uppermost meadows along the Klickitat River. 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. In the Klickitat Subbasin these habitats generally occur between 2500 and 5000 feet above sea level, occasionally occurring up to 7000 feet in the vicinity of Mt. Adams, Lakeview Moutain, Jennies Butte, the Goat Rocks, and Darland Mountain. 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 of sites the historic hydrology has persisted. Upper soil horizons in meadows where channel incisement has occurred and the water table has dropped, tend to be characterized by relic mottling. 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.

Vegetation

Along with meadow, much of this habitat type occurs as forested streams dominated by evergreen conifer trees (>30 percent tree canopy cover). Deciduous broadleaf trees such as aspen

(*Populus tremuloides*) are occasionally co-dominant or occur along the margins of meadows. 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 are often a prominent feature in streams, although it can be lacking on less productive sites. In meadows, areas of herbaceous vegetation may occur, often with conifers encroaching along the edges.

In our subbasin the indicator tree species present for this habitat include: Douglas-fir (*Pseudtsuga menziesii*), ponderosa pine (*Pinus ponderosa*), grand fir (*Abies grandis*), lodgepole pine (*Pinus contorta*), and Western redcedar (*Thuja plicata*) are typical indicator tree species for this habitat. Western hemlock (*T. heterophylla*) and Alaska yellow-cedar (*Chamaecyparis nootkatensis*) are found sporadically in some areas west of the mainstem Klickitat River. Engelmann spruce (*Picea engelmannii*) and subalpine fir (Abies lasiocarpa) is more common at higher elevations. Trembling aspen above 2500', black cottonwood (*Populus trichocarpa*) below 3500', and several alder species (*Alnus spp.*) are also important occasional co-dominants.

Dominant or co-dominant shrubs present in our subbasin include:red-osier dogwood (*Cornus stolonifera*), Douglas' spirea (*Spirea douglasii*), common snowberry (*Symphoircarpus alba*), mountain alder (*Alnus incana*), and a variety of willow species (*Salix* spp.). The dwarf shrub bog blueberry (*Vaccinium uliginosum*) may be an occasional understory dominant in higher elevations. Shrubs more typical of adjacent uplands are sometimes co-dominant, especially big huckleberry (*V. membranaceum*), oval-leaf huckleberry (*V. ovalifolium*), grouse whortleberry (*V. scoparium*), and fools huckleberry (*Menziesia ferruginea*).

In forested wetlands, graminoids present in our subbasins that may dominate a variety of sedge species including smallwing (*Carex microptera*), beaked (*C. rostrata*), and water (*C. aquatilis*) sedges, tufted hairgass (*Deschampsia caespitosa*). Riparian areas with historic overgrazing tend to be characterized by increased abundance of more mesic graminoids such as bluegrasses (*Poa* spp.), false hellebore (*Veratrum* spp.) and possibly trisetum species (*Trisetum* spp.) Other plants that may be present include forbs and ferns such as 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*). Other important species that may be present in montane meadows include common camas (*Camassia quamash*), Indian carrot (*Perideridia gairdneri*), Indian potato (*Claytonia lanceolata*), wild carrot (*Daucus pusillus*), wapato (*Sagittaria latifolia*), and arum-leaved arrowhead (*Sagittaria cuneata*).

This habitat may extend down into the grand fir zone. It is not well represented by the Gap projects because of its relatively limited acreage and the difficulty of identification from satellite images. The acreage indicated on an earlier table is thus misleading.

Disturbance

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 elevation of the growing surface relative to the stream channel. 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 perhaps the most significant influence in our subbasin. Fires are typically high in severity and can replace entire stands, as most of 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, currant, salmonberry, willows, 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. 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.

Current

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 forest practices and grazing, either directly on site or through modifications of stream flows. This type is probably relatively stable in extent and condition, although it may be locally declining in condition because of road building, timber harvest, inappropriate grazing and recreational use. Five of 32 plant associations representing this habitat listed in the National Vegetation Classification are considered imperiled or critically imperiled in Washington State (Anderson et al. 1998).

These habitats in our subbasin are largely on federal, industrial forest, or tribal lands. They fall roughly into two categories: 1. Well protected: High elevation locations on federal Wilderness designations are generally in excellent condition. The lack of roads and vehicular access allows natural processes to continue there; 2. Routinely degraded: Many montane coniferous wetlands are in areas where substantial degradation occurs each year. Many small Montane wetlands adjacent to streams in our subbasin have been severely disrupted by the placement of road fill and associated ditches that completely disrupt hydrologic function. Human disturbance from recreational use probably limits use of these habitats by sensitive wildlife species. It may be significant that the only breeding site for sandhill cranes in the Klickitat subbasin in on the Yakama Nation Reservation, in a large wetland complex where human disturbance is limited.

Forestry, recreation and grazing activities have been consistently negative in their impacts to these accessible habitats for many years. Changes in grazing patterns, camping sites, vehicle access, road planning and this process offer hope that conditions on the montane wetlands near roads will improve. Without conscious effort, however, trends for these habitats will continue downward.

Stresses

Timber Activities

Logging practices can increase the frequency of landslides and resultant debris flows/torrents, as well as sediment loads in streams (Swanson et al. 1987, Swanson and Dyrness 1975, Ziemer 1981). 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. Blowdown is common in buffers retained around such habitats.

Grazing

Improper timing, duration, and/or intensity of grazing can result in significant impact to herbaceous plant communities due to the continual presence of livestock. Excessive grazing by livestock can alter vegetation communities, change stream morphology, and increase fecal coliform material in ponds, streams and meadow wetlands. Effects from current grazing are particularly notable in small meadows in Cedar Valley, particularly in the Tepee creek watershed. Persistent effects from historic overgrazing are notable in meadows along the upper portion of the Klickitat River (e.g. Cow Camp, Kessler Meadows, Caldwell Prairie, and McCormick Meadows) as well as in upper portions of the Diamond Fork watershed (e.g. Klickitat meadows).

Road Constuction

Road construction and placement can alter hydrologic regimes of wet meadow systems, directing flows into ditches and culverts and eliminating natural flows. Off road recreational vehicular access can create ruts from “mudding”, thus diverting flows, and compaction in high use areas such as campsites. This has happened in several location in the Diamond Fork watershed, where illegal ORV trailing has caused or is threatening to increase channel instability and habitat degradation.

Fire Suppression

Fire suppression has had dramatic effects on montane coniferous wetlands particularly wet upland meadows. Fire suppression results in conifer encroachment onto otherwise treeless meadows. These conifers utilize the water resources, decreasing the water table and drying out the meadow. This can change the vegetation composition of the meadow, which is otherwise an important source of plants for native people. A decreased water table also changes the historical hydrological function of these meadows. Meadows act as important water reserves, retaining water that is slowly released into surrounding streams throughout summer. Without these reserves many of these streams will dry out sooner in the year, decreasing water availability to wildlife.

4.5.1 Greater Sandhill Crane (*Grus canadensis tabida*)

Rationale for Selection

Greater sandhill cranes (hereby referred to as sandhill cranes) were extirpated as a breeder from the state after 1941 when the last nest was documented at Signal Peak in Yakima County. Some 31 years later, they were again found summering in the Glenwood Valley on Conboy Lake National Wildlife Refuge, Klickitat County in 1972, but it was not until 1979 that nesting was confirmed. The sandhill crane has been listed as an endangered species by the state of Washington since 1981. Due to their requirements for wetlands for nesting and the low numbers of confirmed nesting in this area, sandhill cranes have been chosen as a focal species in the Montane Coniferous Wetland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following:

- Security from disturbance, isolation
- Traditional nesting areas available for reuse
- Surrounding trees and shrubs present, but not heavily encroaching
- Vegetation: approx. mean height 37.3 cm (14.5 in) (Littlefield 2001)
- Access to feeding areas during nesting – (Study of 515 nest sites showed the average distance to the nearest feeding meadow was 40 m (131 ft) (Littlefield 2001)
- Water depth: average 25.8 cm (10 in) (Littlefield 2001)

Nesting

Appropriate nesting habitat is vital for usability by sandhill cranes. Generally, sandhill cranes require wetlands for nesting, and will use a wide range of wetland classes and vegetation types, and occasionally will use uplands. Within the sandhill cranes' breeding range, nesting habitat varies from open meadows to deep water bogs and marshes (Armbruster 1987).

At Conboy Lake National Wildlife Refuge, 55% is comprised of wet meadows. Where cranes nest, the vegetation includes reed canarygrass, rushes (*Juncus* spp.), sedges, and spikerushes (*Eleocharis* spp.). Peripheral areas of these meadows (11%) are often encroached upon by lodgepole pine, Douglas spirea and willow. Although approximately half of the crane pairs nest in areas with some trees and shrubs, encroachment can become too heavy, replacing suitable habitat and decreasing water availability to meadows.

At Conboy Lake National Wildlife Refuge, breeding territories include dry grass uplands, partially timbered uplands, emergent marshes, and wet meadows (Engler and Brady 2000). Primary components of a breeding territory are the nest site, roosting area, feeding area, and to some degree, isolation (Armbruster 1987). This prairie-like valley beneath the southeastern slope of Mt. Adams lies at an elevation of only 555 m (1,820 ft) but the influence from surrounding mountains makes the climate harsh. Valley topography is mostly level in this 14 km (9 mi) long wetland basin. Historically, the water level in Conboy Lake remained high later into the season, and portions held more or less permanent water. Ditching and agricultural development in the early 1900's, has speeded annual drying. Water now gradually recedes during early summer as Camas Ditch empties into Outlet Creek. Surrounding timbered uplands are predominately forested with ponderosa pine, Douglas-fir, grand fir and lodgepole pine, with some stands of Oregon white oak (H. Cole, pers. comm.; USFW 1983).

Breeding and rearing occurring in wetland areas with limited human disturbance and an abundance of vertebrate and invertebrate prey.

Population Status and Trends

Status

The Washington Department of Game (the predecessor to WDFW) listed the greater sandhill crane as endangered in 1981 (Washington Administration Code 232-12-014). Sandhill cranes are also listed on the PHS list. Crane habitats are also listed: breeding areas, regular large concentrations, and migration staging areas. Under the Washington Forest Practices Act, sandhill cranes and their habitat are protected. In particular, timber harvest, road construction, aerial application of pesticides, and site preparation are restricted within 1/4 mile (0.4 km) of a known active nesting area.

On tribal lands, the Yakama Nation has listed the greater sandhill crane as a sensitive species in the Yakama Nation Reservation Forest Management Plan (BIA 1993), and it is considered a species of cultural importance.

The following is taken from Littlefield and Ivey (2002): The greater sandhill crane is the only subspecies that nests in Washington (figure 17). Currently, the only known breeding sites are: Conboy Lake National Wildlife Refuge and Panakanic Valley, Klickitat County; Polo Field/Signal Peak on Yakama Nation lands, Yakima County; and Deer Creek on Washington Department of Natural Resources lands in Yakima County (Engler and Brady 2000). All pairs in the Glenwood Valley are listed here as on Conboy Lake National Wildlife Refuge because all territories are at least partially within the boundaries of the refuge (Engler and Brady 2000). From 1995 through 1997 a pair was on territory 19 km (12 mi) south of Fort Simcoe in an area known as the Camas Patch; this site apparently no longer provides suitable habitat (J. Engler, pers. comm.). Additionally, there have been a few summer records of sandhill cranes from dispersed localities that were not confirmed as breeding. Currently, a few migrant greater sandhill cranes stage in Washington as they move to or from breeding areas in British Columbia, but most apparently over-fly the state. We found little evidence that significant numbers of British Columbia greaters stop in Washington. Migrants have also been noted from Klickitat County (Field Notes 50:989).

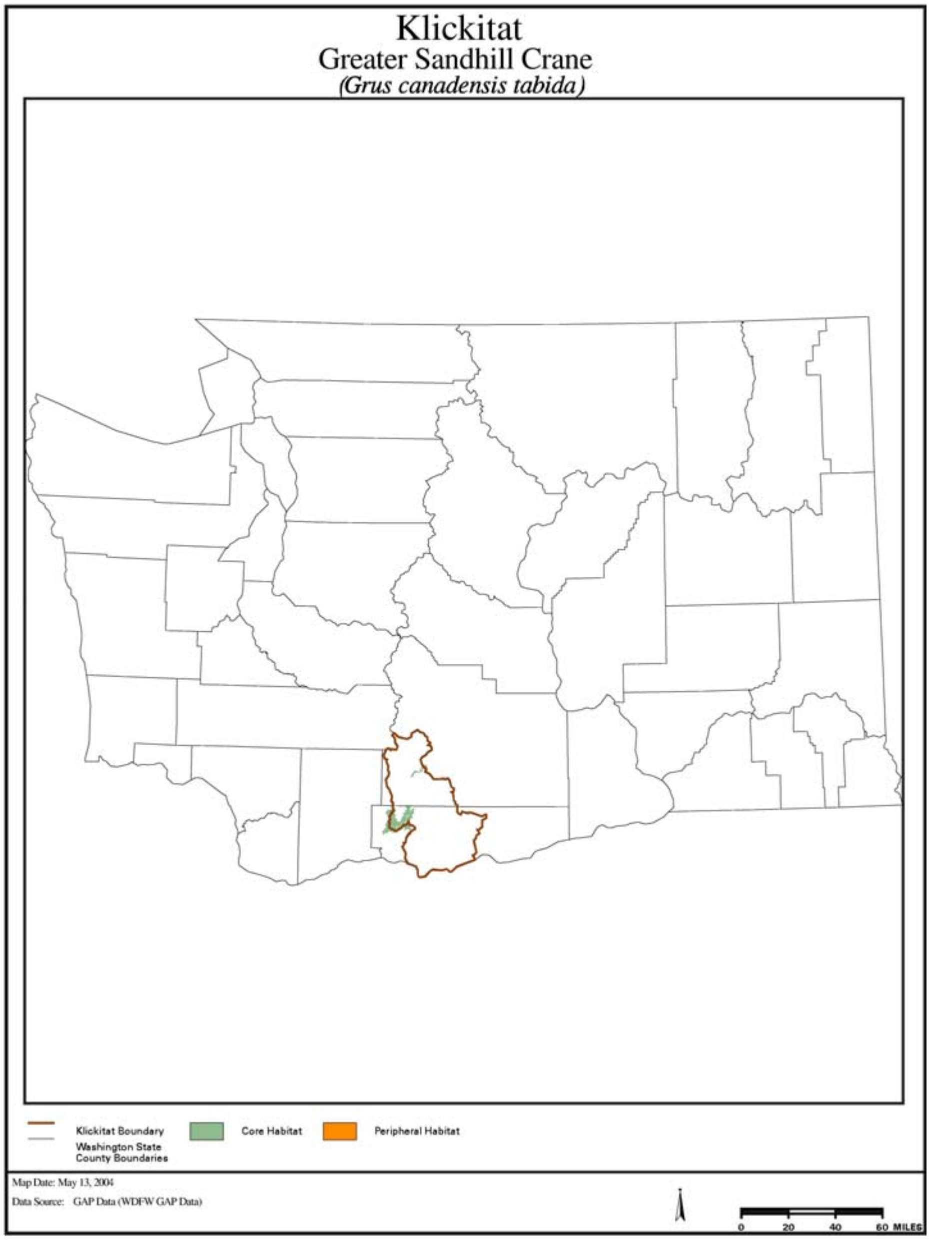

Figure 17 Potential breeding habitat for greater sandhill cranes in the Klickitat subbasin and in Washington State (Smith et al. 1997)

Trends

Breeding pairs at Conboy Lake National Wildlife Refuge have increased from 1 in 1984 to 16 in 2000. For the period 1990 through 2001, Washington's breeding population fledged 30 chicks, with successful reproduction in all years except 1993, 1994, and perhaps 2001. The greatest number was 6 in 2000, while 5 chicks fledged annually during the 3 previous years (Littlefield and Ivey 2002). With continued favorable management practices and environmental conditions, crane pairs should continue to increase and eventually disperse onto nearby sites.

Management Issues

Cranes are in jeopardy of extinction in Washington because of their limited distribution, low numbers, poor breeding success and low colt survival, and loss of shallow marshes or wet meadows for feeding and nesting (Safina 1993). In addition, a large percentage of their wintering habitat is privately owned and subject to potential alteration (Lewis 1980, Pogson and Lindstedt 1991).

Out-of-Subbasin Effects and Assumptions

Sandhill Cranes are a highly migratory species. Historical migration accounts are limited because of the lack of specimen evidence. In 1924, Jewett et al. (1953) listed earliest spring arrival dates for Dallesport (Klickitat county), 27 April.

Crane winter habitat outside the subbasin is threatened with conversion of agricultural lands to cottonwood plantations, tree nurseries, or other incompatible uses and crane use is affected by disturbance by hunters and other recreationists.

Relationship with Riparian / Fisheries Issues

Sandhill cranes need healthy, properly functioning wet meadows for breeding, nesting and raising nestlings and fledglings. Upland wet meadows, though, have been declining steadily in numbers, size and quality. These meadows are extremely important to the functioning of the surrounding riparian systems. They act as a water storage reserve, providing a continuing source of water for many surrounding streams throughout the summer. Improperly functioning meadows negatively impact the lower elevation streams and rivers and the fish that depend on them. Protecting and repairing degraded meadows can increase available habitat for sandhill cranes and enhance habitat for fish and other stream dependent vertebrates and invertebrates.

Factors Affecting Population

Grazing and haying

In spring, sandhill cranes generally prefer to forage in open, flooded meadows. Frequently these sites are the result of mowing and livestock grazing practices which can be detrimental to nesting and fledging. Though meadows are generally good foraging sites for cranes, late June and July meadow mowing can kill crane chicks as they hide in dense vegetation and remain motionless, waiting for the threat to pass (Littlefield and Ivey 1994). In addition, if meadows are dried in June for hay harvest, early drying can result in the unavailability of invertebrate foods, sometimes contributing to chick starvation. Winter livestock grazing of wetlands generally removes residual cover, leaving crane nests exposed to predators in April and May. Spring grazing can also be detrimental to nesting success; 10 April - 15 July grazing can prevent nesting attempts, and in some cases, cause nest abandonment (Littlefield 1989).

Water availability

Because cranes are dependent on wetlands, they are vulnerable to changes in hydrology. Water rights are an issue in some areas, and loss of irrigation rights could eliminate existing habitat for cranes (Ivey and Herziger 2000). Irrigation timing is also important, as cranes should have water applied to their territories by mid-March to prepare for April nesting; water should be maintained through the brooding period (early August). Early drying of wetlands and irrigated fields can lead to increased chick mortality.

Habitat loss

The majority of crane pair territories in Washington are currently on protected lands, primarily those managed by the USFWS, but also by the Yakama Nation and the WDNR.

Loss of habitat through drainage of wetlands, replacement of flood irrigated meadows with sprinkler or pivot irrigation, building construction, and conversion to row crops has also displaced breeding pairs (Littlefield and Thompson 1979, Littlefield 1989, Ivey and Herziger 2000, 2001). At Conboy Lake National Wildlife Refuge, development of wetland impoundments could displace cranes and reduce the amount of available crane habitat.

4.5.2 Oregon Spotted Frog (*Rana pretiosa*)

Rationale for Selection

The Oregon spotted frog is nearly always found in or near a perennial water body such as a spring, pond, lake or sluggish stream (Leonard et al. 1993). They are most often associated with non-woody wetland plant communities. Three populations are known extant in Washington today, one in the south Puget Sound lowlands (Dempsey Creek) and two in the Cascade mountain range in south-central Washington State, one at Conboy National Wildlife Refuge in the Klickitat subbasin, and the other at Trout Lake in the Big White Salmon subbasin. They are currently listed as endangered in Washington State and are a federal candidate species. Although they are found at the lower elevations of forested habitat, due to their strong association with wetland riparian habitats, they have been chosen as a focal species for the Montane Coniferous Wetland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following (McAllister and Leonard 1997):

- Optimal breeding areas, or oviposition sites that include shallow water, often 2–12 in (5–30 cm) deep (also Licht 1974, emergent wetlands, clear, oxygenated water (also M. Hayes, pers; comm.), emergent wetlands within forested landscapes
- Suitably warm summer water temperatures (>68º F) (also Hayes 1994b)
- Abundance of aquatic and emergent vegetation during the growing season
- Large, connected wetlands and riparian habitats (Hayes 1994b)

General

The Oregon spotted frog is typically found in large, perennial wetland complexes, mostly within forested landscapes. Often the perennial water bodies are surrounded by smaller, more shallow ephemeral pools (Licht 1969b) important for breeding. Large marshy wetlands greater than 4 hectares (9 acres) may be necessary to carry sustainable populations of Oregon spotted frogs

(Hayes 1994b). Oregon spotted frogs occupy the same wetland complex year round and larger populations may be able to better sustain the higher predation rates (Hayes 1994b).

Temperature

Warm summer water temperatures appear to be an important habitat feature, more often found in a lower elevation, large, shallow wetland. The physiological importance of temperature has not shown for Oregon spotted frogs. Females will often bask in the sun during summer and early fall to obtain higher body temperatures. This has been observed at all three Washington sites (McAllister and Leonard 1997). Males are rarely observed at this time of year (Hayes pers. obs.). At Dempsey Creek, in the Puget Sound lowland, juveniles are numerous in warm, shallow water during late summer (Hayes pers. obs.). In the Oregon Cascades, Oregon spotted frogs were found in water that averaged 83° F (28.6° C). Less than 5% of temperatures taken next to active frogs were <68° F (20° C) (Hayes 1994b).

In early spring, warm temperatures do not appear to be as much an important factor. During this breeding season, Oregon spotted frogs are active at substantially lower water temperatures. Frogs seen at Dempsey Creek were active in water consistently <50° F (10° C) and frogs were found active under ice (including a pair in amplexus) where the water temperature was 31° F. (-0.5° C.) (Leonard et al. 1997a).

Vegetation

Oregon spotted frogs are primarily found in vegetatively productive habitats. During the growing season, these systems support an abundance of aquatic and emergent vegetation. The decomposing vegetation along the bottom of wetlands support a diverse community of invertebrates that, in turn, support many vertebrates such as the Oregon spotted frog.

Vegetative mats are often used for basking (McAllister and Leonard 1997) and for escape from danger (McAllister pers. obs.).

Breeding

Oregon spotted frogs show a preference for shallow water for ovipositioning. Water depth of breeding sites vary from 2–12 inches (5–30 cm) deep (McAllister and Leonard 1997). Shallow, emergent wetlands appear to provide habitat critical to the persistence of this species (Hayes 1994a). Grasses, sedges, and rushes are usually present though eggs are laid where the vegetation is low or sparse (Hayes pers. obs.). Vegetation is characterized by soft rush (Juncus effusus), slough sedge (*Carex obnupta*), and creeping buttercup (*Ranunculus repens*). Mats of aquatic vegetation are used for basking. These habitats often provide a thin layer of unusually warm water that the frogs appear to prefer. Escape from danger is also achieved by a quick dive beneath the cover of the vegetation (Hayes pers. obs.). At Trout Lake during early spring, numerous adults have been found in shallow pools under a canopy of black cottonwood (McAllister and Leonard 1997).

Licht (1974) described improved hatching success for egg masses laid in river margin areas where flowing water improved oxygenation and cleansed the eggs of algae and fungus. Communal oviposition sites found to date are sufficiently removed from run-off channels such that surface water movement is imperceptible, except during periods of high water (Hayes pers. obs.).

Diet and Foraging

Oregon spotted frogs are almost entirely aquatic in habit, making suitable wetland habitat even more important than for other more terrestrial species. Wetlands associated with lakes, ponds, and slow-moving streams can provide suitable habitat; however, these aquatic environments must include a shallow emergent wetland component to be capable of supporting an Oregon spotted frog population (McAllister and Leonard 1997). 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 waters of this shallow emergent wetland environment (McAllister and Leonard 1997).

Population Status and Trend

Three populations are known extant in Washington today, one in the south Puget Sound lowlands and two in the Cascade mountain range in south-central Washington: one near Trout Lake in the Big White Salmon subbasin and the other at Conboy National Wildlife Refuge, in the Klickitat subbasin (figure 18). These two populations inhabit large expanses of marsh. Surveys during 1997 at Trout Lake produced a minimum egg mass count of 572 (Leonard 1997). From this data, researchers are able to calculate an estimated adult population of a minimal 1,144 frogs. Engler (pers. comm.) reported that surveys at Conboy Lake covered an estimated 35-40% of suitable habitat and counted 664 egg masses. From this data, the population was estimated to include a minimum 1,328 adult frogs.

Range wide, Oregon spotted frogs have been found at only 13 of the 59 historical localities where there is verification that they once occurred. Based on current status at specific historic sites, loss of populations is estimated to have affected 78% of the species' former range (Hayes 1997). However, when considering the much broader range suggested by the historical data, it is estimated that the species has been lost from over 90% of its former range (Hayes 1997) and has lost much of its former habitat (see figure 19).

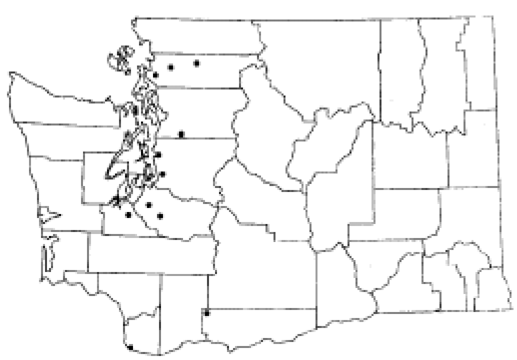

Figure 18 Locations of Oregon spotted frog populations found prior to 1990 (McAllister and Leonard 1997)

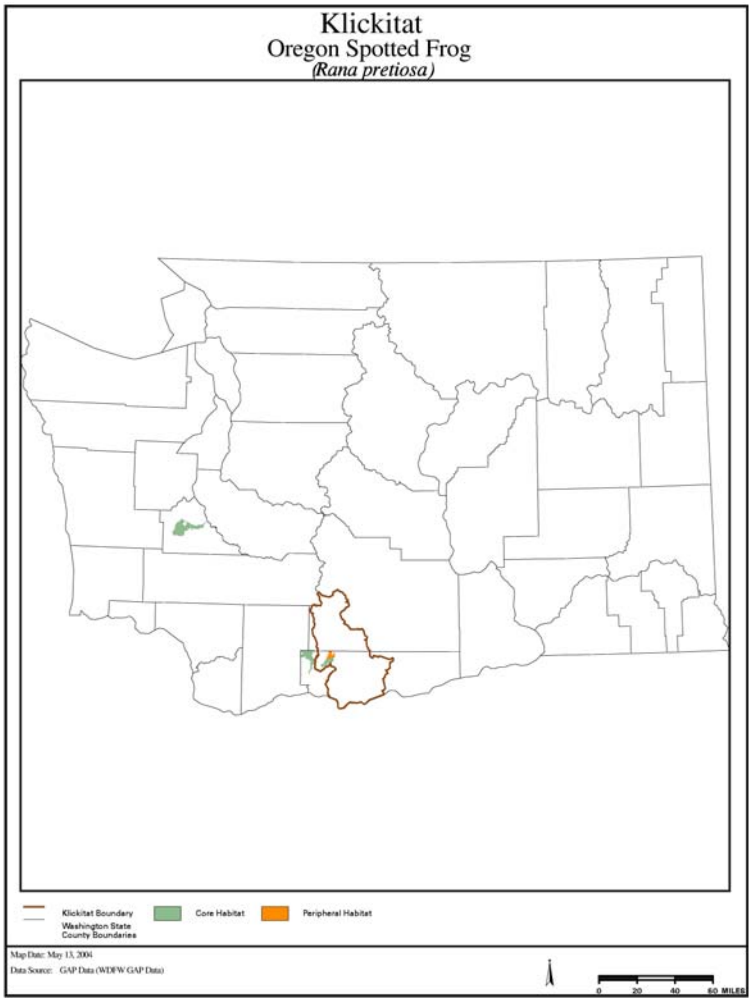

Figure 19 Potential habitat currently available for Oregon spotted frog in the Klickitat subbasin and Washington State (Dvornich et al. 1997)

The sizes and geographic extent of the three known remaining populations in Washington State are poorly known.

Management Issues

The two southern Washington Cascades populations are undergoing varying levels of research, inventory, and habitat protection. These activities are the combined effort of Federal and state agencies as well as a private landowner

The Trout Lake population is well-distributed over a mixture of state and private land. The site was approved for a new Natural Area Preserve and money has been appropriated to acquire privately-owned lands. Acquisition of this site is ongoing. Meanwhile, Oregon spotted frog surveys are conducted each year to identify key habitats such as overwintering and oviposition sites. Much of this marsh is currently grazed, including the oviposition sites found to date. Once established as a Natural Area Preserve, grazing will likely be discontinued (unless grazing is shown to be important to maintaining habitat conditions which benefit Oregon spotted frogs).

The Conboy Lake population is predominately within a National Wildlife Refuge. It is the only population in Washington known to be surviving in close contact with a population of introduced bullfrogs. Portions of this large marsh and ditch network have been surveyed for Oregon spotted frogs. The U.S. Fish and Wildlife Service have completed an initial evaluation of bullfrog predation on Oregon spotted frogs at this site (Engler and Hayes pers. comm.).

Out-of-Subbasin Effects and Assumptions

There was no literature found documenting long distance migration that would be needed for movement between subbasins. Seasonal movements appear to be within the large wetland complexes Oregon spotted frogs are found in (McAllister and Leonard 1997).

Relationship with Riparian / Fisheries Issues

Oregon spotted frogs need healthy, properly functioning wetlands for breeding, foraging and overwintering. Many wetlands, though, have been declining steadily in size and quality. Wetlands are an integral part of a properly functioning riparian system. Even though Oregon spotted frog depends on fishless wetlands, an improperly functioning wetland can negatively affect the connected riparian systems that do contain fish. Protecting and repairing degraded wetlands can increase available habitat for Oregon spotted frogs and enhance the connected habitat that fish and other vertebrates and invertebrates depend on.

Factors Affecting the Population

Habitat Loss and Degradation

Human population increases and concomitant development will continue to alter or eliminate habitat for breeding. Alteration of aquatic habitats, by water diversion projects or similar situations, may impose considerable hazard and hardship on migrating frogs and result in higher than normal levels of mortality.

Many wetlands have been drained and many more have been filled and developed. State-wide, a tremendous number of former wetlands, as well as uplands, are now covered by impervious surfaces such as roof-tops, asphalt, or compacted soil. These impervious surfaces shed run-off water quickly, putting increased demands on existing wetlands and stream courses to retain or carry the run-off water. As a result of these changes to the landscape, water levels fluctuate more dramatically. Rain or meltwater quickly enters the remaining wetlands and streams and fills them to capacity, often overflowing into non-wetland areas. Many streams have been dredged and straightened to help carry these floodwaters more quickly away from human developments. The floodwaters rise and fall at an increased rate. Oregon spotted frog breeding habitat (the margins of shallow wetlands) can be dramatically affected by these hydrologic changes. Eggs laid during or immediately following late winter rains are often left exposed to freezing and desiccation by rapidly dropping water levels.

Roads can fragment habitat and create barriers to migration. Overland movements by Oregon spotted frogs increase their vulnerability to vehicle mortality as well as increase their exposure to predation.

Diversion of water for irrigation and other purposes has also eliminated or altered frog habitat. The construction of dams and creation of reservoirs has been detrimental to western pond turtles by altering water flow in drainages, inundating habitat behind dams and reservoirs, and creating habitat suitable for the spread of non-native species (bullfrogs, warm water fishes) that are harmful to Oregon spotted frogs. Additionally, dams and their associated reservoirs may have fragmented populations by creating barriers to dispersal (Holland 1991b).

When these changes result in a reduction of size, permanence, and spring water depth, the otherwise suitable habitat can become unsuitable for Oregon spotted frog. This becomes especially critical in breeding habitat.

Non-native species

Introduced species have changed the ecological environment in the region for Oregon spotted frogs. As significant predators on tadpoles and small subbadult frogs, non-native species such as bullfrogs (*Rana catesbeiana*)and warm water fish seem to reduce survivorship and alter recruitment patterns (Lampman 1946, Holland 1985b). Non-native fish can also alter aquatic habitat when feeding on submerged and emergent vegetation. Many ponds where bullfrogs and non-native fish are found today are absent of native amphibian species that were once found there before.

Inappropriate Grazing

Cattle trample and eat aquatic emergent vegetation that serves as habitat for hatchlings and they may crush nests (Hayes et al. 1999).

Disturbance

Human caused disturbance (grazing, logging, roads, urban) can interfere with breeding behavior and alter breeding habitat, making it unsuitable.

Chemicals and Contaminants

The effect of biocontaminants on Oregon spotted frogs is largely unstudied. Rotenone, a biodegradable substance extracted from a tropical plant, is commonly used in fishery management to eradicate fish species. Rotenone has been documented to kill amphibian adults and tadpoles (Fontenot et al. 1994, McCoid and Bettoli 1996). Application of rotenone should be avoided in areas where Oregon spotted frogs likely to occur.

4.5.3 Montane Coniferous Wetlands Habitat and Focal Species Key Findings, Limiting Factors and Working Hypotheses

Table 17 Key findings, limiting factors and working hypotheses for the Montane Coniferous Wetlands focal habitat and its representative focal species

MONTANE CONIFEROUS WETLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Montane Coniferous Wetlands have suffered from habitat degradation and loss of hydrological functions.	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.
	Overall Loss of Native Vegetation and Wetland Function	Better monitoring of livestock grazing in riparian areas will reduce damage to native meadow and stream side vegetation, reduce damage to stream banks, and reduce pollution in streams and ponds from livestock (other animal?) manure (fecal coliform).
	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.
	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.
	Vegetation and Soil Damage	Reducing off road vehicle (ORV) traffic in wet meadow would decrease damage to sensitive plant species as well as disturbance to breeding species.
	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.
	Incised Streams and Loss of Wetland Function	Restoring stream channels in selected reaches will allow for hydrologic reconnection into wetland habitats.
	Loss of Hydrological Function	Reestablishing beaver and their habitat in montane wetlands will restore hydrological function.
MONTANE CONIFEROUS WETLANDS - FOCAL SPECIES		
Greater Sandhill Crane		

MONTANE CONIFEROUS WETLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Breeding habitat loss and degradation have dramatically lowered greater sandhill crane population size and presence in the subbasin.	Loss of Native Vegetation	Carefully managing timing and location of grazing in crane habitat (during the spring breeding season), and delaying hay harvest and grazing will increase egg and chick survival.
	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.
	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 greater sandhill cranes.
	Increased Disturbance	Reducing disturbance to sandhill crane nesting pairs during the breading seasons will increase breeding success and chick survivorship.
Oregon Spotted Frog		
Much of the Oregon spotted frog's suitable habitat has become unsuitable due to 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.
	Loss of Wetlands	Increasing and retaining suitable habitat available to Oregon spotted frogs will result in population stabilization and possible increase.
	Decrease in Water Quality	Increasing water quality will increase tadpole survival and population size.
	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.
	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.

4.5.4 Habitat of Concern–Agriculture

Description

Agriculture has replaced much of the native habitats historically existing in the subbasin, especially interior grasslands and shrub steppe. Due to the extensive presence of agriculture, it is considered a habitat type today. Some native species still exist in this habitat type, but the diversity of wildlife and plant species is decreased compared to historical habitat that have been replaced by agriculture. Also, agriculture has resulted in introduced plants and animals in the subbasin, many spreading beyond the borders of the agricultural habitat, reducing the quality of native habitats still existing today. Due to the quantity, and likely permanence of this habitat, it must be considered in management of wildlife in the subbasin. It is not considered a focal habitat, but is a habitat of concern that must be addressed in this subbasin plan. Although there are no focal species chosen for this habitat type, some of the wildlife species that are found in these habitats are: Great blue herons (*Ardea herodias*), Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), gopher snakes (*Pituophis catenifer*), and deer, among others.

Key Findings

Agricultural lands are an important economic and habitat component in the subbasin. Agricultural lands are found in areas that were historically shrub steppe, or interior grasslands. Athough not a historic land use, agriculture does provide many benefits to wildlife. A significant portion of what has been traditionally cropped is now in CRP (Conservation Reserve Program). This program provides Permanent native grass with scattered native shrubs that create excellent habitat for wildlife. The remaining agricultural land is predominantly alfalfa, wheat, or pasture. Agriculture like most other industries is becoming more environmentally friendly. No till or Direct Seeding is now being used wherever it is feasible, reducing emissions, erosion, and conserving natural resources. This subbasin, along with the majority of eastern Washington depends on agriculture as its leading economy.

4.6 Fish Assessment

4.6.1 Rationale for Focal Fish Species Selection

Focal species and species of interest were chosen with the following considerations: 1) status under the Endangered Species Act; 2) ecological significance; 3) cultural significance; 4) US v. Oregon guidance. The determinations made by the aquatic technical committee to identify a species as a 'Focal Species' or 'Species of Interest' were made in consideration of the above factors as well as the amounts and types of information available. In addition, the committee limited the scope of focal species selection to a number of species that could be assessed within the limited time available.

The following species were chosen as Focal Species (table 18):

Table 18 Focal Species and Criteria Used For Selection

Focal Species Criteria	Steelhead/Rainbow	Spring Chinook	Bull Trout
ESA Status	Threatened	None	Threatened
US v Oregon Significance	Yes	Yes	
Has Ecological Significance	Yes	Yes	Yes
Has Cultural Significance	Yes	Yes	
Anadromous and/or Resident	A and R	A	A and R

The following species were chosen as species of interest (table 19):

Table 19 Species of Interest and Criteria Used for Selection

Focal Species Criteria	Pacific Lamprey	Cutthroat	Coho
ESA Status	None	Candidate in Anadromous Form	No
US v Oregon Significance	No	No	Yes
Has Ecological Significance	Yes	Yes	No
Has Cultural Significance	Yes	Yes	Yes
Anadromous and/or Resident	A	A and R	A

4.6.2 Spring Chinook

Spring Chinook Description

Life History Forms

The timing of their return to freshwater as adults distinguishes spring chinook from other chinook races. Upriver runs, those above Bonneville Dam, enter the Columbia River in March and attain their largest numbers in the lower river in April and May(WDF and ODFW 1994). The length of time juveniles reside instream prior to migration is another differentiation. Generally, two patterns of behavior are characteristic: stream-type and ocean-type (Gilbert 1913). Stream-type chinook typically reside in freshwater for one year (occasionally more) as fry or parr. Ocean-type chinook typically migrate to the ocean the first year of life (Healy 1991).

Spring chinook in the Klickitat Subbasin exhibit a stream-type life history. They are native to the Klickitat River basin.

Historic Distribution and Abundance

Bryant (1949) cited reports of large spring chinook runs in the Klickitat River and a significant tribal fishery at Lyle Falls (RM 2) prior to 1920. This was despite difficult passage at the falls. By 1951, the annual spring chinook run varied from 1,000 adults to 5,000 adults (WDFW 1951, Sharp 2000). Quantitative data regarding historic abundance of spring in the basin does not exist. Distribution is considered to have been similar to current distribution, although the depression of total numbers of the stock, loss of genetic fitness, and some alterations done to Castile Falls in 1960s have diminished the utilization of historical habitat. Actions are under way to improve passage at Castile Falls; upon their completion the falls are not expected to be a hindrance.

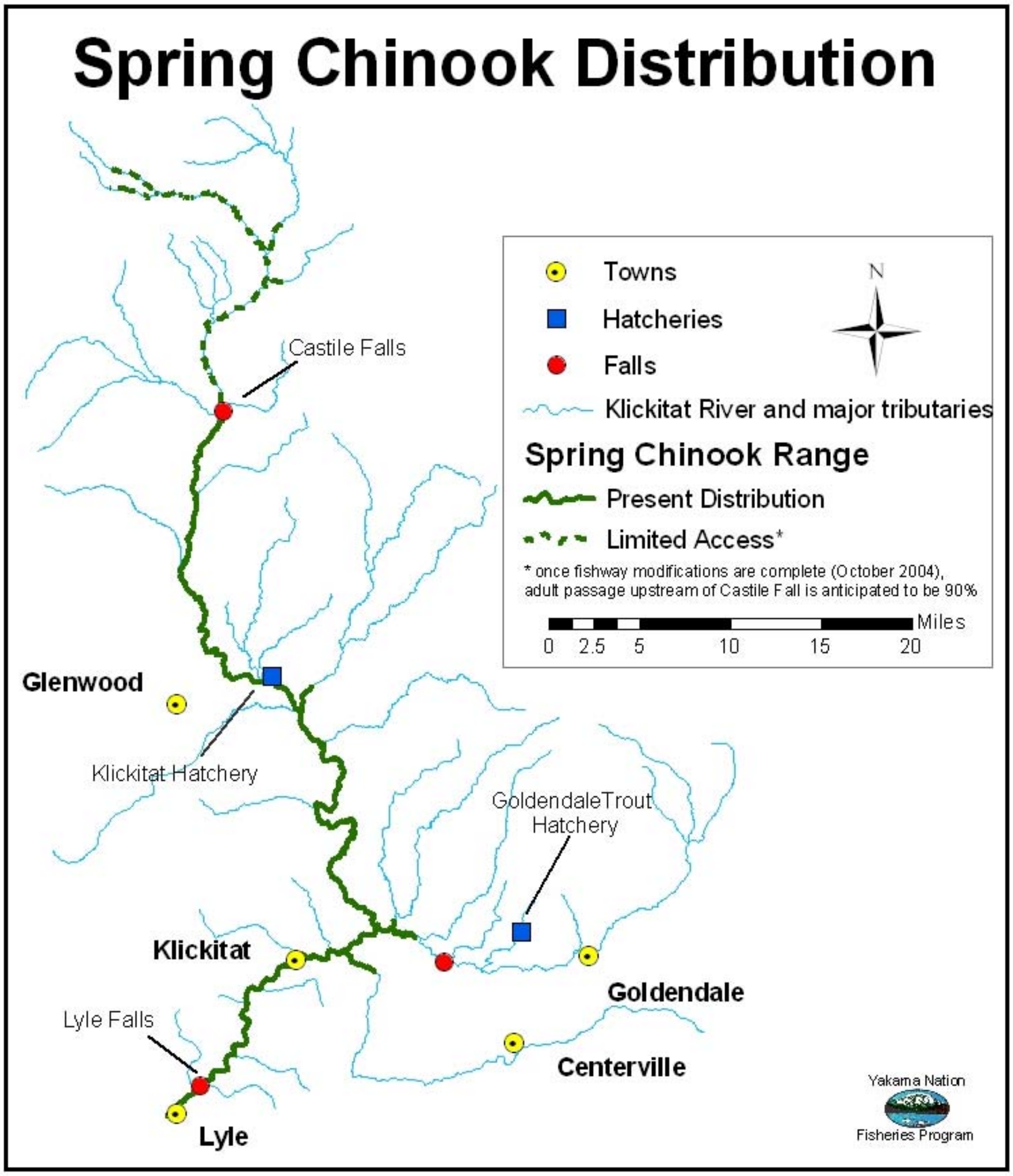

Figure 20 Spring Chinook Salmon distribution in the Klickitat Subbasin

Current Distribution and Abundance

The figure above identifies current distribution. As previously mentioned, passage difficulties at Castile Falls are presumed to be addressed through modifications of the tunnels that are complete. Their actual effectiveness is unknown. Monitoring and evaluation will be needed. Construction was completed before major migration in 2004. This year will be the first opportunity to gauge passage effectiveness.

The Klickitat Hatchery (RM 42.5) and two fishways at Lyle Falls were constructed in 1952, using Mitchell Act funds. Managers trapped spring chinook broodstock at the upper fishway

(Falls 5) each year from 1952 through at least 1959. Estimates of spring chinook run sizes ranged from 1,614 fish to 3,488 fish, with a mean of 2,523 fish (adults plus jacks).

Since 1977, estimates of spring chinook (adults plus jacks) returning to the Klickitat River mouth have ranged from about 500 to 5,300 fish, averaging about 1,900 fish annually (table 20). In-basin harvest has ranged from under 100 to nearly 1,800 fish, averaging about 700 fish annually. Tribal fishers account for nearly 75% of the harvest on average since 1977.

Figure 20 shows distribution of spring chinook in the basin. Currently 600,000 hatchery smolts are released on-station at the Klickitat Hatchery. On average, approximately 150,000 hatchery fry also are out-planted in the upper basin above Castile Falls (RM 64) as a thinning release in late spring

Based on redd counts, natural escapement has ranged from under 100 fish to about 1,100 fish and averaged about 300 fish since 1977 (Table 20). These figures likely include some hatchery-origin fish spawning in the wild. While WDFW considers this population depressed (WDF & WDW 1993), these fish are not listed under the Endangered Species Act.

Table 20 Spring chinook salmon returns, harvest and escapement

Return Year	Returns			Harvest					Escapement		
					Sport		Tribal				
	Total	Hat.	Wild	Total	Hat.	Wild	Hat.	Wild	Total	Hat.	Wild
1977	533	380	153	95	6	3	61	25	438	312	126
1978	1,528	1,160	368	906	202	64	486	154	622	472	150
1979	851	773	78	89	81	8	0	0	762	692	70
1980	1,685	1,619	66	67	6	0	59	2	1,618	1,555	63
1981	2,528	2,211	317	574	133	19	369	53	1,954	1,709	245
1982	3,238	2,988	250	1,775	399	33	1,239	104	1,463	1,350	113
1983	2,417	2,190	227	1,745	256	27	1,325	137	672	609	63
1984	1,323	1,086	237	754	268	59	350	77	569	467	102
1985	848	340	508	716	73	108	215	320	132	53	79
1986	1,112	860	252	485	19	5	357	104	627	485	142
1987	1,682	1,235	447	507	118	42	255	92	1,175	863	312
1988	3,929	2,239	1,690	1,353	141	107	630	475	2,576	1,468	1,108
1989	5,254	4,807	447	1,783	760	71	871	81	3,471	3,176	295
1990	2,583	1,858	725	1,785	256	100	1,028	401	798	574	224
1991	1,477	1,018	459	702	96	43	388	175	775	534	241
1992	1,540	1,026	514	587	82	41	309	155	953	635	318
1993	3,702	2,985	717	1,483	228	55	967	233	2,219	1,789	430

Return Year	Returns			Harvest					Escapement		
					Sport		Tribal				
	Total	Hat.	Wild	Total	Hat.	Wild	Hat.	Wild	Total	Hat.	Wild
1994	958	831	127	233	44	7	158	24	725	629	96
1995	696	606	90	140	0	0	122	18	556	484	72
1996	1,156	782	374	308	97	46	112	53	848	574	274
1997	1,861	1,083	778	437	157	113	97	70	1,424	829	595
1998	702	397	305	149	8	6	76	59	553	313	240
1999	728	578	150	151	60	16	60	15	577	458	119
2000	2,708	1,601	1,107	1,446	233	162	621	430	1,262	746	516
2001	1,126	595	531	464	66	58	180	160	662	350	312
2002	2,330	1,143	1,187	568	76	78	203	211	1,762	864	898
20031	3,892	1,895	1,997	1,666	333	350	479	504	2,226	1,084	1,142
Avg:	1,940	1,418	522	777	155	60	408	153	1,164	855	309

Run Timing

Most Columbia River adult spring chinook spend two years in the ocean and, on average, return to their natal streams at four years of age (Mullan 1987; Fryer et al. 1992; Tonseth 2003) Spring chinook enter the mainstem portions of tributaries from in April and May, and hold in deeper pools and under cover until onset of spawning. The spawning population typically includes of a small number of individuals that do not migrate to sea (Healey 1991; Mullan et al. 1992CPb). The spring chinook hold in June and July, spawn in August and September.

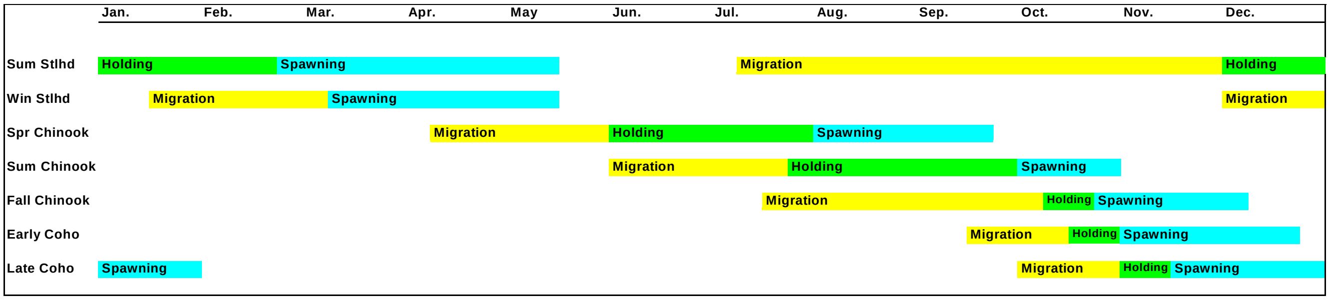

Figure 21 Spawn timing for salmon and steelhead

Spawning

Spring chinook spawning occurs between Leidl Bridge (RM 32) and McCormick Meadows (RM 84). The bulk of spawning (96% in 1998) occurs between the confluence with Big Muddy Creek (RM 54) and Castile Falls (RM 64). Improved passage at Castile Falls is expected to allow better access to 35 miles of spawning habitat above the falls; in 1998, only 3% spawned above the falls. Spawning is limited in the reach between the confluence with Big Muddy Creek and the Klickitat Hatchery (none in 1998). Spring chinook generally spawn above the hatchery from mid-August to mid-September and from mid- to late September in the area downstream from the hatchery. Spring chinook are not known to spawn in tributaries, although juveniles have been found rearing in the lower reaches of several tributaries.

Incubation and Emergence

Fertilized eggs incubate in the substrate from the time of redd construction in the late fall and winter until emergence as alevins in the spring.

Rearing

Juvenile spring chinook generally spend one year in fresh water before they enter the sea. Healey (1991) reports that some smolts spend an additional year in fresh water. However, most stream-type chinook spend no more than one winter in fresh water. Juveniles typically redistribute themselves downstream the spring and summer after emergence. The highest densities are found in summer below the major spawning areas.

Smolt Outmigration

Smoltification describes the physiological transformation that juvenile chinook undergo in preparation for life in the ocean. Spring Chinook exhibit an extensive downstream migration of pre-smolts in the late fall and early winter. Smolt outmigration most commonly occurs the first spring following overwintering.

Important Stock Characteristics

The Klickitat spring chinook run is comprised of approximately 75% hatchery, and 25% wild/natural fish (table 20). The genetic divergence found between the Klickitat River wild spring chinook population and the Klickitat Hatchery population (Marshall 2000) suggests some amount of reproductive isolation between the two, or perhaps that some natural or production-related factors are maintaining differentiation despite exchange of spawners between them.

Several factors have adversely affected natural production of spring chinook in the Klickitat River.

Domestication of the hatchery stock may have resulted in a fish that is unable to exploit the upper Klickitat subbasin. Potential truncation of run timing and reduction of overall body size has resulted in an existing hatchery stock that cannot negotiate Castile Falls as effectively as the wild stock. Recently completed hydraulic surveys of Castile Falls illustrate this point. Flow analysis and swimming dynamics of spring chinook indicate that early big fish would have been able to pass April flows at a 60 % success rate, with diminished success on the descending hydrograph (Sharp 2000). The native wild stock negotiating these falls were presumed to be larger fish, thus more fecund and able to produce more offspring to use the available habitat.

Passage “improvements” to the falls in the 1960s inadvertently resulted in decreased passage.

More than 70 years of habitat degradation (livestock grazing, logging and road construction) in the upper basin have diminished the quality and quantity of the required key habitat for the incubation and rearing life stages.

Active debris flows and glacial outwash from the east slope of Mt. Adams result in high mainstem suspended sediment during summer months that colors the Klickitat River from the West Fork to the Columbia River 63 miles downstream. This adversely affects natural production for all species that spawn in the mainstem Klickitat below the Big Muddy Creek confluence (Sharp 2000).

4.6.3 Steelhead

Steelhead Description

Life History Forms

The Klickitat River basin supports winter and summer steelhead. Both are native. The winter run is one of only two populations of inland winter steelhead in the United States (NMFS 1999) (the other is in Fifteenmile Creek). Both runs of Klickitat River steelhead are part of the Mid-Columbia Evolutionarily Significant Unit (ESU) and were listed as threatened under the ESA in March of 1999 (NMFS 1999).

The Mid-Columbia steelhead ESU, as described by NMFS, occupies the Columbia River Basin from Mosier Creek, Oregon, upstream into the Yakima River subbasin in Washington. In proposing to list this ESU, NMFS cited low returns to the Yakima River, poor abundance estimates for Klickitat River and Fifteenmile Creek winter steelhead, and an overall decline for naturally producing stocks within the ESU (NMFS 1999).

Oncorhynchus mykiss, of which steelhead and rainbow trout are members, displays a wide variety of life history strategies. Anadromy is not obligatory in *O. mykiss* (Rounsefell 1958, Mullan et al. (1992Cpa)). However, rainbow trout is not widely distributed within Klickitat (anecdotal evidence suggests greater historical distribution and population numbers). Progeny of anadromous steelhead can spend their entire life in freshwater, while progeny of rainbow trout can migrate seaward. Anadromous steelhead is the focus of interest within Klickitat. Limited knowledge is available due to a historical lack of resources available for monitoring and evaluation.

Steelhead may be classified into two runs (Smith 1960; Withler 1966; Everest 1973; Chilcote et al. 1980). Winter-run fish ascend streams between November and April, while summer-run fish enter rivers between May and October. Steelhead do not all die after spawning. A small proportion of spawners (known as kelts) may return to the ocean for a short period and repeat the spawning migration. Spawning adults typically range between three and seven years of age.

Young steelhead typically rear in streams for some time prior to migrating to the ocean as smolts. Steelhead smolts have been shown to migrate at ages ranging from 1-5 years, with most populations smolting at ages 2 or 3 (Shapovalov and Taft 1954; Withler; 1966; Hooton et al. 1987; Loch et al. 1988). Steelhead grow rapidly after reaching the ocean, where they feed on crustaceans, squid, herring, and other fishes (Wydoski and Whitney 1979; Pauley et al. 1986). The majority of steelhead spend 2 years in the ocean (range 1 - 4) before migrating back to their natal stream (Shapovalov and Taft 1954; Narver 1969; Ward and Slaney 1988). Once in the river, steelhead apparently rarely eat, and grow little, if at all (Maher and Larkin 1954). These various behaviors, in combination, produce fish that range between three and seven years of age at the time of spawning.

Historic Distribution and Abundance

Using available redd count data and assuming an average of 2.5 fish per redd, the average escapement of naturally spawning (summer and winter, hatchery and wild combined) steelhead in the Klickitat River from 1987 to present has been fewer than 300 fish . This figure is undoubtedly an underestimate due to the inherent difficulty in conducting accurate counts during spring flow conditions.

Table 21 Sum of harvest and escapement

Year	Run[1]	Harvest[2]		Escape[3]	Redds
		Sport	Tribal		
1986-87	8,598	1,480	6,008	1,100	
1987-88	3,279	1,514	1,342	423	
1988-89	3,679	1,718	1,486	475	
1989-90	1,681	833	631	217	
1990-91	2,905	1,055	1,722	128	51
1991-92	2,847	831	1,906	110	44
1992-93	2,842	1,260	1,215	367	
1993-94	2,974	1,236	1,354	384	
1994-95	1,674	891	567	216	
1995-96	1,482	873	418	191	
1996-97	1,075	621	284	170	68
1997-98	1,630	1,080	490	60	24
1998-99	1,114	662	179	273	109
1999-2000	1,062	603	217	243	97

2000-01	2,545	1,489[4]	559	498	199
2001-02	4,833	3,713[4]	712	408	163
2002-03			1,014	653	261
Avg:[5]	2,375	1,225	872	277	94

YN and WDFW databases and U.S. v. Oregon Technical Advisory Committee reports

Assumes 2.5 fish per redd. For years when redd counts were unavailable, assumes average escapement-to-total-harvest ratio from years when redd counts were available. (Do these escapement estimates take into account varying effort, i.e. miles surveyed, from year to year? jz) (Where do these escapement data come from? Is it mine and extrapolated If so, I think we are way underestimating the escapement. [wein])

Data are preliminary.

Average is for 1987-88 through 2001-02.

The *U.S. v. Oregon* Technical Advisory Committee worked on a run reconstruction for Columbia Basin steelhead in the mid-1990s. Data from this run reconstruction, which included analysis of mainstem Columbia River dam counts and escapement into other tributaries and hatchery locations, indicate that the terminal run size to the Klickitat River mouth may be twice as high as that depicted in Table 21 using available Klickitat subbasin data only. The *U.S. v. Oregon* run reconstruction also indicated that the Klickitat River steelhead run is comprised, on average, of about 27% wild fish.

Current Distribution and Abundance

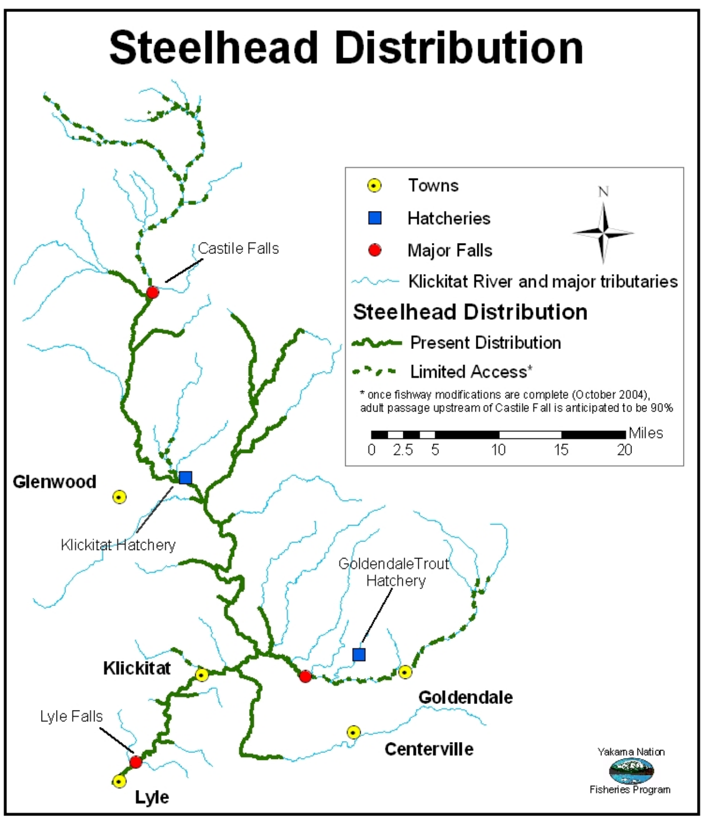

Figure 22 Steelhead distribution in the Klickitat Subbasin

Run-timing

Steelhead typically spend one to three years in the ocean before returning to natal streams to spawn.

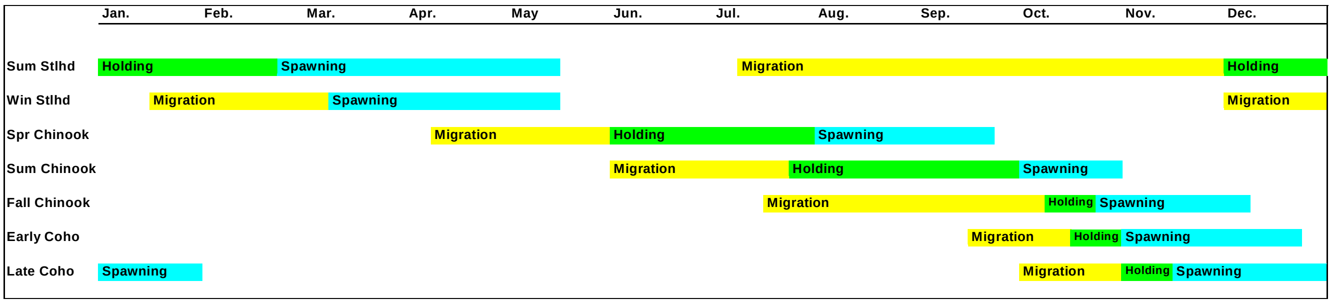

Figure 23 Spawn timing for salmon and steelhead

Spawning

Mainstem spawning distribution of steelhead is concentrated between RM 5 and RM 50, with occasional spawning above Castile Falls (RM 64, Figure 18). Tributary spawning occurs in Swale, Summit, and White creeks, the lower (and occasionally upper) Little Klickitat River, and other smaller tributaries. Spawning occurs March through May.

Incubation and Emergence

Unlike other species in the Oncorhynchus genus, steelhead eggs incubate at the same time temperatures are increasing. In the lower mainstem where densities are highest, fry emerge very rapidly.

Rearing

Juvenile steelhead typically rear in their natal streams for a period of several months, undertake a winter migration to positions lower in the basin, overwinter in these locations, and then begin outmigration. Pre-smolt rearing migrations are not well known.

Outmigration

As stated previously, the age at which steelhead trout outmigration occurs varies between one and three years.

Important Stock Information

Approximately 120,000 summer-run steelhead from the Skamania Trout Hatchery and Vancouver Hatchery are currently released directly into the Klickitat River annually. Broodstock is made up of Skamania Hatchery returns, although founding broodstock for the Skamania stock included adults trapped in the Klickitat River. Like the Wind River, the Klickitat River has had releases from the Skamania and Vancouver hatcheries for 40 years. Releases were also made from the Beaver Creek Hatchery, Goldendale Hatchery, and Naches Hatchery. Unlike the Wind River, where steelhead releases were terminated because of potential adverse genetic effects on wild steelhead (wein), releases in the Klickitat River were decreased rather than terminated.

Skamania steelhead releases in the Klickitat River are mainly to provide for sport fisheries in the river.

In addition to the Skamania stock releases, approximately 30,000 Ringold Hatchery steelhead have been transferred to the Klickitat Hatchery annually for rearing and then transferred back to Ringold Hatchery for release. Hatchery-reared winter steelhead have never been released in the Klickitat basin (Sharp 2000).

4.6.4 Bull Trout

Life History Forms

Bull trout exhibit both resident and migratory life-history strategies (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear one to four years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989; Goetz 1989), or in certain coastal areas, to saltwater (anadromous) (Cavender 1978; McPhail and Baxter 1996; Washington Department of Fish and Wildlife. et al. 1997). Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993).

Bull trout are known for their diverse life histories. A member of the char family, they exhibit resident and migratory life histories in varying degrees across their range. Not enough is known about Bull Trout in the Klickitat Subbasin to confidently state the life forms present. Bull trout are listed as threatened under the ESA.

The resident life history form completes all life stages in their natal and/or nearby streams. This life form is typically found in the smaller headwater streams, including some in which lower portions of the system have been blocked by impassable barriers. Adults of this life history form are typically the smallest, usually reaching about 12 inches in length, with a range of 8-15 inches. Resident bull trout have been known to interbreed with other forms when opportunities are present.

Fluvial bull trout spawn and rear in smaller tributaries for 1-3 year then move downstream to rear in mainstem rivers, where major growth and maturation occurs. They may move randomly throughout river systems, generally congregating near spawning tributaries in summer. Mature adults are usually smaller than anadromous or adfluvial char, ranging from 16 to 26 inches long.

Historical Distribution and Abundance

Historical distribution of bull trout is presumed to have been greater than present distribution. Historic abundance is not known and is regarded as a data gap. It is likely that three of four known life history forms (including the anadromous form) were found in the basin historically. Anadromous, fluvial and resident forms would have been foraging in the mainstem and tributaries.

Current Distribution and Abundance

Abundance is presumed to be very low in the Klickitat. Distribution is likely as presented in the distribution graphic. They have been found in the lower mainstem (from Klickitat Hatchery downstream), as well as in West Fork and several of its tributaries (wein).

Four bull trout up to 10 inches in length were observed during snorkel surveys in the upper mainstem (RM 64, above the West Fork) and 23 bull trout (three to seven inches in length) were observed during electro-fishing surveys in Trappers Creek (consistent with “resident” life history--je). Portions of the West Fork upstream of Fish Lake Stream contain an isolated naturally reproducing population of bull trout. The presence of brook trout—an introduced species—in these areas raises concerns about hybridization.

Recent evidence indicates both resident and fluvial bull trout may be present in the basin. In 1998, CRITFC tribal pikeminnow gillnetters reported capturing two bull trout at the river’s mouth. In May 2000, an additional bull trout recovery and release was reported at the Pikeminnow Sport-reward Registration Station at the river’s mouth. Photographs of fish angled in the mid-1980s are of a size associated with mainstem river fluvial populations. Additional survey work is being conducted throughout the subbasin to determine the distribution and abundance of bull trout.

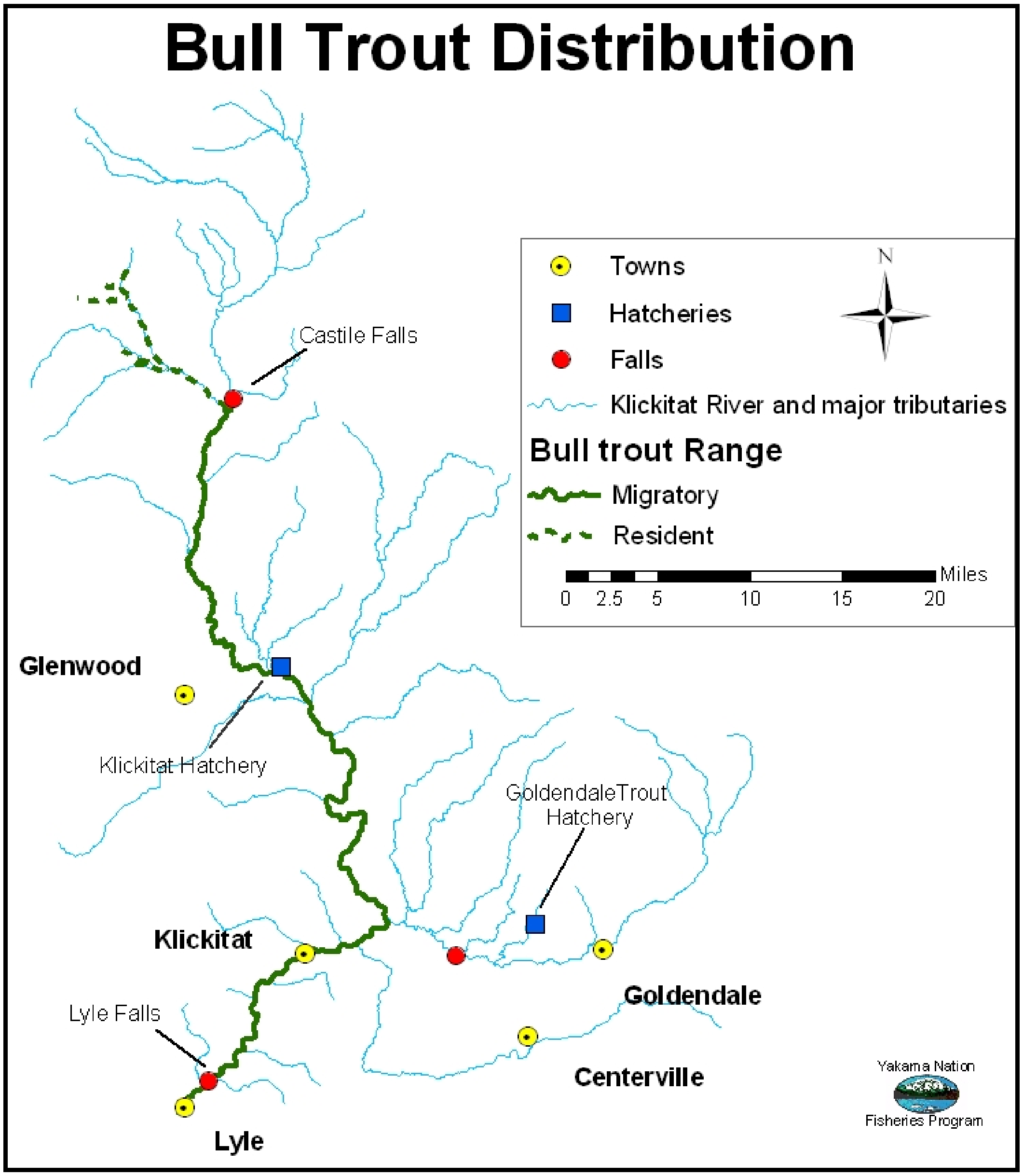

Figure 24 Bull trout distribution in the Klickitat Subbasin

Run-timing

Run timing in bull trout is variable and appears to vary depending on life history (resident/fluvial/adfluvial), elevation, and size of adult. Bull trout are widely known for their temperature sensitivity. As explained in the USFWS Recovery Plan, "Bull trout are strongly influenced by temperature and are seldom found in streams exceeding summer temperatures of 18º C. Cool water temperatures during early life history results in higher egg survival rates, and faster growth rates in fry and possibly juveniles as well (Pratt 1992)."

Spawning

The diversity of life histories and of habitat use in bull trout are also reflected in their spawning activity. Most Yakima stocks migrate to their spawning grounds between June and July with spawning beginning as early as late August and extending to as late as mid-December (USFWS Recovery Plan 2002, Wydoski & Whitney 2003). The height of spawning occurs from early September to mid-October. Bull trout are known as repeat, annual, and alternate-year spawners, with spawning years extending to age 12 or longer.

Incubation and Emergence

Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992), and after hatching, juveniles remain in the substrate. Time from egg deposition to emergence of fry may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

Rearing

With emergence in spring, all three forms of freshwater bull trout begin a rearing period of 2-4 years, with full maturation of males occurring in years 5 and 6, and maturation of females occurring in years 6, 7, and 8.

Outmigration

Outmigration patterns are unknown in the Klickitat subbasin.

4.6.5 Pacific Lamprey

Pacific Lamprey Description

Pacific lamprey or "eel" are restricted in North America to the Pacific Coast and coastal islands from the Aleutians to Baja, California. They were once widely distributed throughout the Columbia Basin in Oregon, Washington, and Idaho (Kan 1975; Wydoski and Whitney 1979). Since the completion of the hydropower system in the Columbia Basin, numbers of Pacific lamprey have declined dramatically compared with historical levels of abundance and distribution. Distribution was likely a function of access to suitable spawning and rearing areas (Kan 1975). The life cycle of Pacific lamprey is similar to that of salmonids.

Historical Distribution and Abundance

Historic distribution is unknown but presumed to be greater than current.

Current Distribution and Abundance

Pacific lampreys are known to occur in the Klickitat basin. The historic and present distribution and status are relatively unknown. Juveniles have been collected at the rotary screw trap stations Adult Pacific lampreys have been observed at RM 57.

Run-timing

Spawning

Lamprey typically reach spawning grounds in mid-summer (Kan 1975; Beamish 1980), Pacific lamprey generally spawn the following spring. Thus, adult lamprey spend approximately 1 year in freshwater. Spawning generally occurs in small tributary streams, where both sexes construct a crude redd (Scott and Crossman 1973), generally located in the center of the stream near the tailout of a pool, and immediately upstream of shoreline depositional areas (Beamish 1980). Mating is repeated several times in the redd, with each mating followed by actions that move substrate over newly laid eggs. Water temperatures of 10-15oC have been measured in Clear Creek, a tributary of the John Day River, during spawning (Kan 1975). Adults die soon afterward and provide valuable nutrients to small tributaries where salmon fry rear (Kan 1975).

Incubation and Emergence

Eggs typically hatch into ammocoetes in less than 2 weeks; these newly hatched larvae, which are filter feeders, then drift downstream and bury themselves in silt, mud, or fine gravel along the margins and backwaters of streams and rivers (Scott and Crossman 1973; Hammond 1979). Ammocoetes generally spend 5-6 years in freshwater (Scott and Crossman 1973). In the fall of their last year, they metamorphose into macrophthalmia, which resemble the adult form. This transformation process is generally completed by early winter.

Outmigration

Downstream migration of macrophthalmia appears to be stimulated by and dependent on late winter and early spring floods (Hammond 1979). Because they are not strong swimmers, lamprey appear to be dependent on spring flows to carry them to the ocean (Kan 1975; Beamish 1980).

4.7 Fish Habitat Conditions

Introduction

The upper two-thirds of the Klickitat subbasin is forested, and most of that lies within the Yakama Reservation. Logging operations, including the construction and use of logging roads, are the principal activities affecting the upper Klickitat subbasin. Streams in the forested portion of the subbasin, both on and off the Reservation, have suffered from past and current forest practices, including timber harvest and road construction in riparian areas, poor design and maintenance of roads and crossings, skidding on steep slopes and upstream channels, off-season use of wet roads with resulting erosion, and facilitation of overgrazing by providing cattle access over logging roads to riparian areas. Most of these problems are continuing.

The deeply incised lower Klickitat River has remained relatively isolated from direct shoreline development over most of its length. However, floodplain roads, both abandoned and active, have led to channelization and constriction problems in these reaches. Shoreline development is occurring within increasing regularity along the Highway SR 142 corridor between RM 0.0 and 19.0 of the mainstem. An abandoned paved floodplain road hugs the west bank of the Klickitat River from RM 14 to 31. The abandoned Champion log haul road experienced considerable damage from the 1996 flood. However, the road even now cuts off side channels and river meanders at many key locations.

Lower subbasin tributaries historically provided the majority of wild steelhead spawning and rearing habitat, although tributary habitat has been severely degraded. The Little Klickitat drainage is heavily logged and roaded in its upper reaches and is grazed and diverted further downstream, resulting in lack of riparian cover, diminished baseflows, and increased temperatures. Nutrients from farming and a sewage treatment outfall cause excessive algal growth. Other lower subbasin tributaries share many of the same problems. Dewatering is a concern on Swale, Wheeler, and Dillacort creeks, where development is believed to have degraded summer instream habitat conditions.

Loss of wetlands in tributary headwaters, possibly in conjunction with groundwater withdrawals by agricultural and domestic wells, has diminished storage capacity and recharge capability. Elevated stream temperatures are common among lower tributaries because of riparian degradation and lowered flows. The historic hydrograph has been altered by intensive logging and wetland loss in the headwaters, and agriculture development in the middle and lower basin tributaries.

Habitat degradation has impacted anadromous species. Lack of access to many lower subbasin tributaries due to reduced baseflows and thermal barriers has limited the amount of spawning and rearing habitat available to anadromous species. Poor design and maintenance of tribal, private, county, and state road culverts have also affected passage of steelhead and resident salmonids in many tributaries basin-wide and further reduced habitat availability throughout the subbasin.

Steelhead production, in particular, has been impacted lack of access because they use all portions of the basin through their life cycles. Over 70 years of habitat degradation (livestock grazing, logging and road construction) in the upper basin and mainstem has led to loss of habitat complexity, as well as channelized streams, riparian degradation, lowered LWD levels, and diminished quantity of required key habitat for the incubation and rearing life stages of fish.

Due to the loss of the ability to attenuate higher flows, tributaries now have a more pronounced peak flow, followed by a reduced summer base flow. Extreme events are more likely to scour spawning gravels and reduce bank storage that would have been available to ameliorate low flows. These impacts have relegated coho to spawning on the margins of the mainstem Klickitat River where sediment impacts from the Big Muddy are more pronounced and hinder incubation survival.

Additional factors have impacted natural production of anadromous fish in the Klickitat River (LF for summer chinook are assumed to be similar to that of fall chinook). Hatchery domestication of spring chinook may have resulted in a genetically less fit fish that is unable to exploit the upper Klickitat subbasin. Potential truncation of run timing and reduction of overall body size has resulted in an existing stock that cannot negotiate Castile Falls as effectively as the wild stock.

A 1960s attempt to improve fish passage at Castile Falls inadvertently resulted in decreased passage for spring chinook and steelhead. The modifications affect the fish’s ability to negotiate the falls, particularity at the headworks dam above falls #10. There is historic evidence for steelhead above Castile Falls; the native wild stock negotiating these falls were presumed to be larger fish, thus more fecund and able to produce more offspring to utilize the available habitat. It is likely that hatchery hybridization of Skamania stock with steelhead has also occurred.

4.7.1 Assessment Tools

Ecosystem Diagnosis and Treatment

Reach Analysis

Estimation of reach-specific restoration and preservation values is one of several EDT applications. Reach analysis is based on the same fish abundance, productivity, and diversity information derived for population analysis from historic/template and current/patient habitat conditions. Reach analysis provides a greater level of detail as it identifies reaches based on their preservation value and restoration potential.

Preservation value is estimated as the percent decrease in salmon performance if a reach was thoroughly degraded. Reaches with a high preservation value should be protected because of the disproportionately high negative impact on the population that would result from degradation.

Restoration value is estimated as the percent increase in salmon performance if a reach is completely restored. A reach with a high restoration potential would provide a greater benefit to the population than a reach with low restoration potential.

Preservation and restoration are two sides of the same coin. Reaches with excellent habitat conditions have high preservation values but low restoration values. Reaches with poor habitat conditions have high restoration potential but little preservation value. Reach analysis results are specific to each fish species because of the different fish habitat requirements of each. Reach analysis results are typically displayed in a graphical format that is often referred to as a ladder or tornado diagram.

Habitat Factor Analysis

Habitat Factor Analysis is one of several and perhaps the most basic of the EDT applications. Comparing current/patient habitat conditions with optimum conditions in a historic/template baseline identifies key limiting habitat conditions. This analysis illustrates the specific habitat factors that, if restored, would yield the greatest benefit to population abundance. The habitat factor analysis depicts a greater level of detail than the reach analysis in that it looks at the specific habitat factors rather than the aggregate effect of all habitat factors.

EDT analyses are based on condition scores assigned to 46 habitat attributes (level II attributes) for each EDT homogenous stream reach used by the population of interest. Reaches may vary widely in length. This information is organized into a database used as input to the EDT model. The level II attributes are rated for under the current (patient) and historical (template) conditions. The EDT model translates the 46 level II attributes into 17 “habitat survival factors” (level III attributes) that represent hydrologic, stream corridor, water quality, and biological community characteristics. These 17 habitat survival factors described in habitat factor analysis outputs.

Specific level III attributes affect particular life stages of salmonids. The impact to survival of each life stage in individual reaches is combined with information on available habitat area and then integrated across the various life history trajectories of the population in order to derive population productivity (survival) and abundance. The number of different possible life history trajectories that a population exhibits determines an index of diversity.

The standard EDT habitat factor output presents the effect of habitat attributes on life stage survival for each life stage and each reach. These outputs are typically referred to as consumer reports or Report 2. While this level of information is useful for salmon biologists, it is too detailed for the scope of this document. Therefore, the attribute analysis presented here summarizes all life stages within a reach. Stage-specific values were then weighted by the impact that restoration of the reach values would have on overall population abundance. In this way, the degree of impact of a particular habitat factor in a particular reach can be compared to other habitat factors in the same reach as well as to habitat factors in other reaches.

*Source: Draft Wind River Subbasin authored by the LCFRB.

Environmental Conditions by Assessment Units

As a part of the subbasin plan development process environmental assessments were developed in table form to organize changes in environmental conditions by reach. The tables,which are included as an appendix to this document, characterize change within an EDT framework, from past to present. Specific definitions for particular attributes may be found in the appendix[place definitions in appendix]. The methodologies employed to provide rankings for each attribute are distinct, and in some cases different methodologies were employed for a single attribute due to incongruities of available data (appendix E)

The reach assessment forms were intended to be used to look for patterns of environmental change. Subsequently, those patterns of change were reviewed, analyzed, and working hypotheses were developed. From these working hypotheses and the patterns of change key findings were derived. This process contributed significantly to identifying strategies and actions that for potential restoration or enhancement project opportunities. This is a significant part of the process performed in subbasin planning to identify key uncertainties, working hypotheses, and subsequent strategies to address the uncertainties.

For purposes of simplification, each attribute that changed is classified. “Slight” means that an attribute changed less than one whole number within the attribute’s EDT ranking. “Medium” means that an attribute changes between one and less than two whole numbers within the attribute’s EDT ranking. “Large” means that an attribute changes two or great whole numbers within an attribute’s EDT ranking.

Each attribute has a numerical value associated with it that is not presented in these forms. The values were reviewed in the greater subbasin planning context however. It should be noted here that the ranking of slight, medium, and large do not necessarily characterize the relative impact of change within a specific attribute. For some attributes a change characterized as slight in these forms may have significant real world impact. There are many ways to organize information regarding environmental conditions. These forms were one of the simplest ways of capturing the core of change.

4.7.2 Upper Klickitat Assessment Unit

Topography and Climate

Steeper slopes and higher elevations are found in this part of the subbasin. Elevations reach 8,000 feet along the northwest corner in the Goat Rocks area, and average 7,000 feet along the northern edge and Klickton Divide. The majority of the landscape falls between 4,000 and 6,000 feet, with the mainstem Klickitat River arising from the Cascades below Cispus Pass at approximately 5,000 feet. This assessment unit lies within the Highland and Snow-Dominated WDNR precipitation zones, with mean annual precipitation ranging from 30-80 inches (WDNR 1991, Oregon Climate Service 1998). On average, entire area has snow coverage by Jan. 1, with a mean of 12-24 inches reported throughout the majority of upper elevation areas in the AU between Feb. 1 and April 1. Mean snow levels atop ridges can reach between 24-36 inches in March and April.

Vegetation Patterns

Vegetation in this area can be described as natural forested uplands. Evergreen forest dominates this AU based on USGS land cover dataset derived from Landsat imagery collected in the early 1990s.

Demographics and Land Use

The northern third of the AU in the upper Diamond Fork area contains a checkerboard mix of private and state-owned lands. Remaining lands are owned and managed by the Yakama Nation. The Land Use Management Area in the western portion of the AU and Goat Rocks is primitive area; alpine area watershed and general forest designations are found. The upper mainstem Klickitat and its headwaters are classified as watershed areas, with the goal being to maintain the vegetative and drainage characteristics needed for water quality protection.

Water Quantity

Notable tributaries include Diamond Fork (RM 76.8) and McCreedy creek. Their hydrographs and that of the upper mainstem are snowmelt-dominated, with the highest flows occuring in the late spring months. Dominant HSG is B hydrologic soil group. The volcanic basalt that occurs near the surface in the northernmost portion of the AU has limited relevance to water resources of the watershed as a whole.

Riparian / Floodplain Condition and Function

In the upper subbasin, an unpaved major haul road follows the upper Klickitat River from RM 66 to RM 78. Within this section, the road is directly in the floodplain for 40 percent of its length, cutting off side channels and river meanders.

Stream Channel Conditions and Function

From the headwaters to the upper extent of McCormick Meadow at RM 85, channel gradient of the upper mainstem Klickitat River is 8 percent or greater. Through the Meadow area downstream to RM 78 (just upstream of the Diamond Fork confluence), gradient changes significantly to an average of 0.5 percent or less. Below RM 78, channel gradient is between 1 and 2 percent until just above the falls at RM 64.5. Elevation then drops approximately 80 feet over the series of 11 falls that occur in the one-half mile reach between RM 64.5 and 64.0

Cattle and sheep grazing impacts pose stream morphological, channel stability, and riparian cover problems. The upper Klickitat River flows through McCormick Meadow in the tribally designated Primitive Area, which has been heavily grazed for many years. In spite of its remoteness, this section of river is now poor habitat for resident or anadromous fish. Aerial photographs reveal that the river channel through the meadow and others nearby has been seriously damaged during 60 years or more of cattle use. Sheep grazing on a WDNR allotment within Tract "C" of the Reservation has degraded riparian and in-channel habitat, and threatens stream and wetland meadow function in the upper Diamond Fork basin. Active lateral and vertical channel instability in conjunction with off-channel headcutting threaten to further degrade fish habitat.

Environmental / Population Relationships / Limiting Factors

While Castile Falls has always presented a serious obstacle to adult upstream migration, historic passage through the falls is known to have occurred. In the early 1960s Washington Department of Fisheries blasted obstructions and attempted to build a continuous 3200-foot tunnel. Construction difficulties forced design modifications resulting in two shorter tunnels linked with an open fishway. The performance of this project has been deemed marginal at best, based on low returns above the falls.

Several factors are known to have contributed to the decreased passage performance. These factors include inadequate fishway maintenance, poor fishway design, and low attraction potential at the entrances to the two unlighted tunnels. Adult salmon migrating during summer and fall months have no alternative except to enter the improperly designed tunnel, as the headworks dam constructed at the uppermost falls (falls #10) creates a barrier to migration. The 12-foot headworks dam has no fish passage or adequate plunge pools.

On average, approximately 150,000 hatchery spring chinook fry also are outplanted in the upper basin above Castile Falls as a thinning release in late spring. Spring chinook spawning has been observed in the mainstem as far upstream as RM 84, although little spawning occurs above Castile Falls at RM 64.

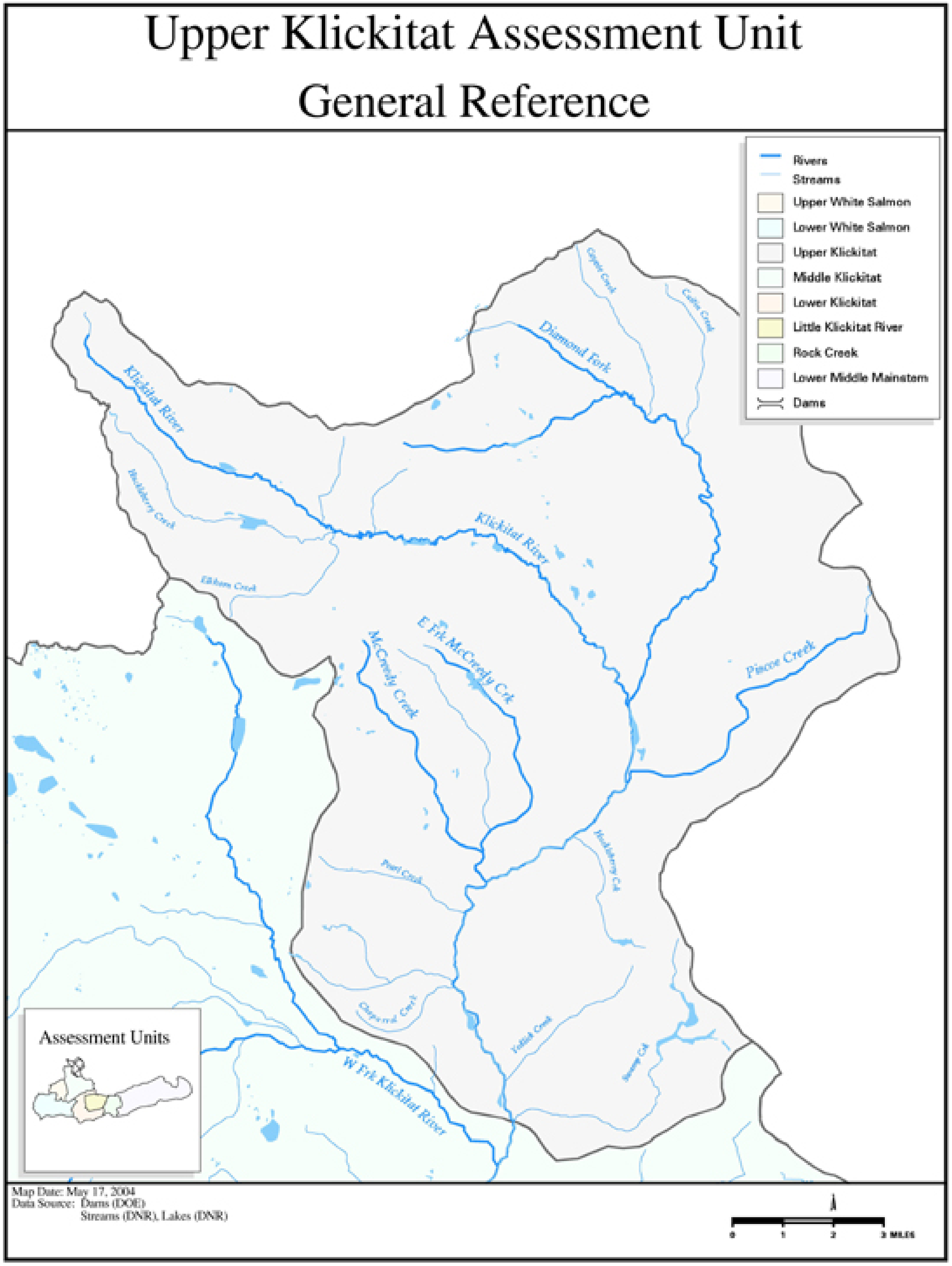

Figure 25 General reference map for the Upper Klickitat Assessment Unit

4.7.3 Upper Klickitat Assessment by Reach

Table 22 Upper Klickitat reach assessments

REACH	**Subwatershed**	**Assessment Unit**
Klickitat 23		**Upper Klickitat**
FOCAL SPECIES	Steelhead, Spring Chinook	
PHYSICAL HABITAT CONDITIONS		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology medium increase in harassment slight increase in salmon carcasses		
COMMENTS		

REACH	**Subwatershed**	**Assessment Unit**
Klickitat 25		**Upper Klickitat**
FOCAL SPECIES	Steelhead, Spring chinook	
PHYSICAL HABITAT CONDITIONS		
slight decrease in woody debris slight increase in embeddedness		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 25		**Upper Klickitat**
FOCAL SPECIES	Steelhead, Spring chinook	
large increase in fish pathology medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight increase in fish community richness slight increase in salmon carcasses		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Chaparrel 1		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
PHYSICAL HABITAT CONDITIONS		
medium increase in hydro-confinement slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness large increase in fish pathology medium decrease in riparian function medium increase in fish species introduction medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Chaparrel 1		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	

REACH	Subwatershed	Assessment Unit
Klickitat 26		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
PHYSICAL HABITAT CONDITIONS		
slight decrease in HbBckPls slight decrease in pools slight decrease in small cobble slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in hydro-confinement slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight decrease in riparian function slight increase in salmon carcasses slight increase in fish community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
McCreedy Creek		Upper Klickitat
FOCAL SPECIES	Steelhead, Spring chinook	
PHYSICAL HABITAT CONDITIONS		
slight decrease in HbBckPls slight decrease in small cobble slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity medium increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness slight decrease in riparian function large increase in fish pathology medium increase in fish species introduction medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 27		Upper Klickitat
FOCAL SPECIES	Steelhead, Spring chinook	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 27		Upper Klickitat
FOCAL SPECIES	Steelhead, Spring chinook	
medium increase in hydro-confinement slight decrease in HbBckPls slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight increase in salmon carcasses slight increase in fish community richness slight decrease in benthic community richness slight decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Piscoe Creek 1		Upper Klickitat
FOCAL SPECIES	Steelhead, Spring chinook	
PHYSICAL HABITAT CONDITIONS		
slight increase in embeddedness		
WATER QUALITY CONDITIONS		

REACH	Subwatershed	Assessment Unit
Piscoe Creek 1		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology medium increase in fish species introduction medium increase in harassment slight decrease in riparian function slight increase in fish community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Piscoe Creek 2		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight increase in embeddedness		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness medium increase in fish species introduction		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Piscoe Creek 3		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
large increase in hydro-confinement slight decrease in HbBckPls slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides		
WATER QUALITY CONDITIONS		
medium increase in fine sediment slight increase in turbidity slight decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
medium decrease in benthic community richness medium decrease in riparian function medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 28		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 28		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
slight decrease in HbBckPls slight decrease in pools slight decrease in small cobble slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in hydro-confinement slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight increase in fish community richness slight decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Diamond Fork 1		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Diamond Fork 1		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
slight decrease in HbBckPls slight decrease in HbOfChFctr slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in hydro-confinement slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment slight decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology medium decrease in riparian function medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight increase in salmon carcasses slight increase in fish community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Diamond Fork 2		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight increase in embeddedness		
WATER QUALITY CONDITIONS		

REACH	Subwatershed	Assessment Unit
Diamond Fork 2		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness medium increase in fish pathology medium increase in fish species introduction medium increase in hatchery outplants		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Diamond Fork 3		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight increase in embeddedness slight increase in fish community richness		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in fish pathology medium increase in fish species introduction medium increase in hatchery outplants slight decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Coyote Creek 1		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
large increase in hydro-confinement slight decrease in pools slight decrease in small cobble slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
medium decrease in temperature spatial variation slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
medium decrease in benthic community richness medium decrease in riparian function medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Diamond Fork 4		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Diamond Fork 4		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
medium increase in hydro-confinement slight decrease in HbBckPls slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment slight decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
medium decrease in benthic community richness medium decrease in riparian function medium increase in fish pathology medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight increase in fish community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Butte Creek 1		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Butte Creek 1		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
medium increase in fish pathology medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants medium increase in hydro-confinement slight decrease in riparian function slight decrease in small cobble slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
WATER QUANTITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment slight decrease in temperature spatial variation		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in fish pathology medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Butte Creek 2		**Upper Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Butte Creek 2		Upper Klickitat
FOCAL SPECIES	Steelhead	
medium increase in hydro-confinement slight decrease in pools slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight decrease in riparian function medium increase in fish species introduction		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Butte Creek 3		Upper Klickitat
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
medium increase in hydro-confinement slight decrease in HbBckPls slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		

REACH	Subwatershed	Assessment Unit
Butte Creek 3		Upper Klickitat
FOCAL SPECIES	Steelhead	
ECOLOGICAL HABITAT CONDITIONS		
medium increase in fish species introduction medium increase in harassment slight decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Diamond Fork 5		Upper Klickitat
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
medium increase in hydro-confinement slight decrease in pools slight decrease in tailouts slight decrease in woody debris slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
medium increase in fine sediment slight increase in turbidity slight decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
medium decrease in riparian function medium increase in fish pathology medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight increase in fish community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 29		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
PHYSICAL HABITAT CONDITIONS		
medium decrease in woody debris slight increase in bed scour slight increase in embeddedness		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment slight decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness slight increase in salmon carcasses medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight decrease in riparian function large increase in fish pathology		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 30		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 30		Upper Klickitat
FOCAL SPECIES	Steelhead, Spring Chinook	
medium increase in hydro-confinement slight decrease in HbBckPls slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
medium decrease in temperature spatial variation slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology medium decrease in riparian function medium increase in fish species introduction medium increase in harassment medium increase in hatchery outplants slight increase in salmon carcasses slight increase in fish community richness slight decrease in beaver ponds		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Huckleberry Creek		Upper Klickitat
FOCAL SPECIES	Steelhead, Spring chinook	
PHYSICAL HABITAT CONDITIONS		
slight increase in embeddedness		
WATER QUALITY CONDITIONS		

REACH	Subwatershed	Assessment Unit
Huckleberry Creek		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness medium increase in fish species introduction medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 31		**Upper Klickitat**
FOCAL SPECIES	**Steelhead, Spring chinook**	
PHYSICAL HABITAT CONDITIONS		
WATER QUALITY CONDITIONS		
slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in fish species introduction slight increase in fish community richness slight increase in salmon carcasses		
COMMENTS		

4.7.4 Middle Klickitat Assessment Unit

Topography and Climate

Elevations around 12,000 feet occur in the northwestern part of this assessment unit along the cascade crest and slopes of Mt. Adams, with some slopes steeper than 100%. The majority of elevations above 4,000 feet are found in the headwaters areas of the West Fork, Big Muddy Creek and Surveyor's creek drainages, while elevations along the mainstem between the confluence of Big Muddy Creek (RM 53.8) and Summit Creek, and around Glenwood fall within a range of 1,000-2000 feet.

The Glenwood area of the assessment unit falls within the snow-dominated precipitation zone, as do the mid-elevation areas. Elevations rise eastwardly into the Simcoe Mountains, and into the cascades to the northwest and west. Upper elevations fall within the highlands, while the area along the mainstem Klickitat lies within the rain-on-snow precipitation zone. Almost all of the AU has a hydrologic soil group rating of “B”, indicating moderate rates (0.15-0.30 in/hr) of infiltration and water transmission. South and east of Glenwood lie pockets of HSG “D” soils (clayey, have a high water table, or are shallow to an impervious layer) resulting in very slow infiltration and water transmission rates (0-0.05 in/hr). Along the mainstem roughly between the Trout and Summit Creek confluences, tributary soils have an HSG rating of “A”, indicating high infiltration rates and the highest rates of water transmission (greater than 0.30 in/hr). Mean annual precipitation is highest along the western edge as a result of the cascades, ranging from 40 inches in lower elevations to 140 inches on Mt. Adams. The majority of the AU falls receives an average of 30-40 inches annually. All of the AU is covered by some snow by January 1st, with the exception of the area along the mainstem roughly between Trout and Summit Creeks, which typically remains snow free.

Vegetation Patterns

The majority of vegetation in this area can be described as natural forested uplands. Evergreen forest dominates this AU based on USGS land cover dataset derived from Landsat imagery collected in the early 1990s. Pasture/Hay dominates the Glenwood/Camas Prairie area.

Demographics and Land Use

The Yakama Nation owns a large portion of the lands within this assessment unit. The West Fork, Big Muddy Creek, White, and Surveyor’s Creek drainages fall entirely within the reservation, along with the majority of Trout, Brush and Summit Creeks. Yakama Reservation LUMA designations along the western portion of the AU include alpine area and tract D recreation area. General Forest areas predominate the remainder of the Yakama Nation lands in the AU, with watershed area designations found along the mainstem Klickitat and its tributaries. Scattered old growth and special use areas are also present.

Private ownership occurs primarily on the western side of the mainstem below the Yakama Reservation boundary. Urban development in the AU is limited to the unincorporated town of Glenwood, with rural residential in the surrounding area. Agricultural uses include pasture, dry-land farming and livestock grazing. Irrigation water use is concentrated in the Glenwood/Camas Prairie area (Outlet Creek drainage) where climatic conditions do not support commercial timber species outside of riparian areas.

Klickitat Hatchery at RM 42.4

Aquatic Habitat Conditions

(Feature each of the four+ components (not climate) as well as critical habitat attributes and other major related features (hatchery facilities, etc.). This is the primary place that EDT / QHA info. is presented.)

Water Quality

Low egg survival for fall chinook is believed to be the result of glacial sediment from Big Muddy Creek in the Klickitat River.

Water Quantity

Major tributaries to the mainstem include the West Fork (RM 63.1) and Big Muddy Creek (RM 53.8). Others include Surveyor's Creek, Trout Creek (RM 43.4), Outlet Creek (RM 39.7), and White Creek (RM 39.6); the Summit Creek confluence occurs at RM 37.3. Most tributaries have a rain-on-snow dominated hydrograph, with the highest flows occurring in the winter months during relatively warm winter storms; however, the hydrograph of Big Muddy Creek is dominated by snowmelt from the cascades.

Riparian/Floodplain Condition and Function

Stream Channel Conditions and Function

Below Castile Falls, most tributaries have short (less than 100 feet) to medium-length (several miles) low gradient reaches along the valley floor, followed by a falls and/or a moderate- to high gradient (greater than 4%) reach that continues until the tributary attains the plateau, where gradients typically decrease to less than 0.5%. Channel gradients vary from 0.4 to 0.8 percent downstream of the Klickitat Hatchery (RM 42.4).

Ecological Conditions

Areas of Special Concern

Environmental / Population Relationships / Limiting Factors

Natural spring chinook spawning occurs between the base of falls #10 at Castile Falls (RM 64.0) downriver to the Big Muddy confluence (RM 53.8). The most severe constraint to establishment of natural production for fall chinook is natural sediment from the Big Muddy drainage. Since all fall chinook spawning occurs in the mainstem Klickitat below the Big Muddy confluence, fish have been negatively impacted by incubation losses, embedded substrate, reduced spawning habitat, and lack of interstitial over-wintering and refugia habitats.

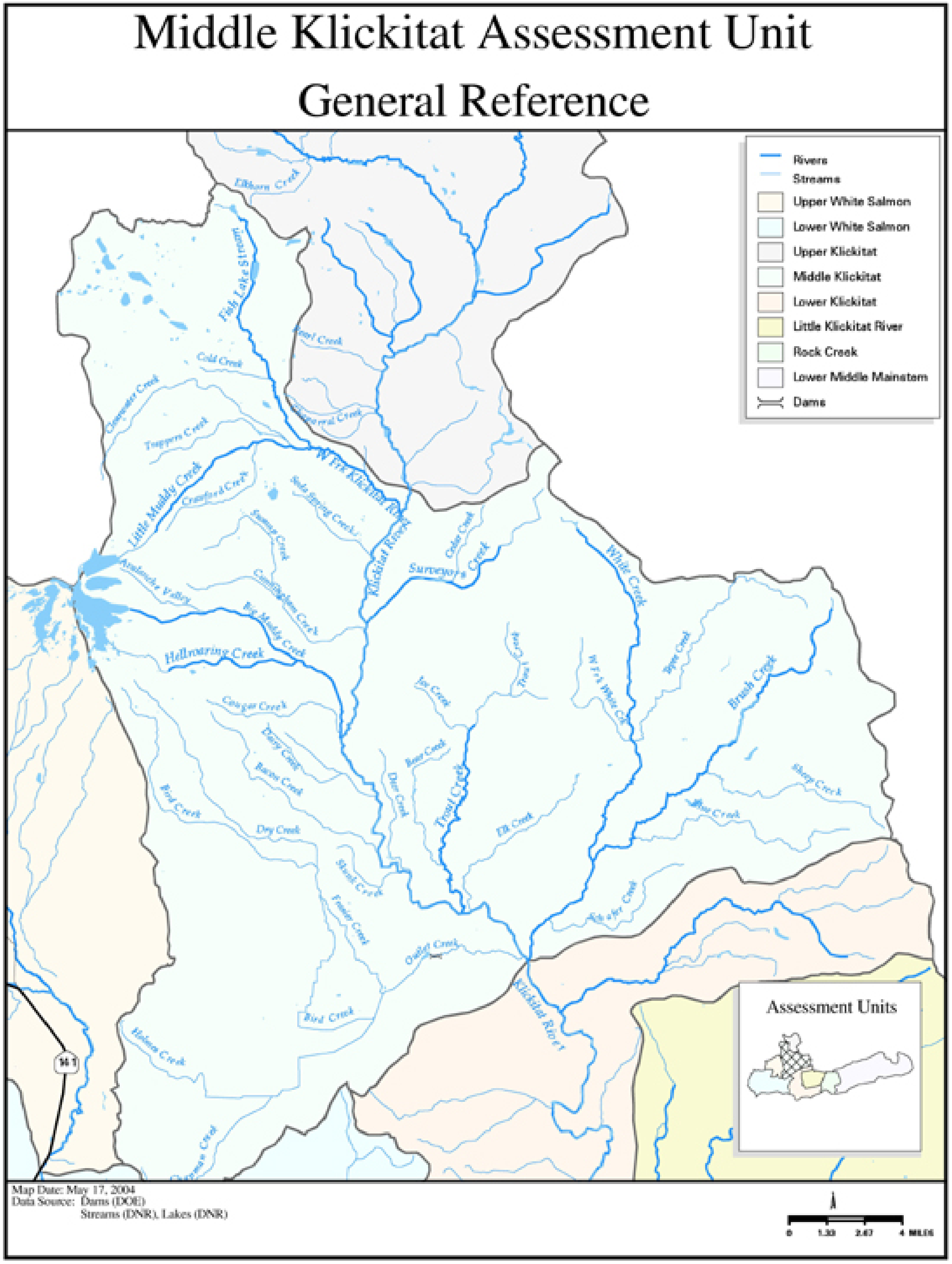

Figure 26 General reference map for the Middle Klickitat Assessment Unit

4.7.5 Middle Klickitat Assessment by Reach

Table 23 Middle Klickitat reach assessments

REACH	Subwatershed	Assessment Unit
Summit Creek		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight decrease in small cobble slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in hydro-confinement slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity slight increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in fish community richness medium increase in fish pathology medium increase in fish species introduction medium increase in harassment slight decrease in benthic community richness slight decrease in riparian function slight decrease in salmon carcasses		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 13		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 13		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
medium increase in hydro-confinement slight decrease in woody debris slight increase in bed scour slight increase in embeddedness		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness slight increase in salmon carcasses slight decrease in benthic community richness slight decrease in riparian function large increase in fish pathology large increase in hatchery outplants medium increase in fish species introduction medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
White Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
slight decrease in small cobble slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in hydro-confinement slight increase in large cobble slight increase in low flow		
WATER QUALITY CONDITIONS		

REACH	Subwatershed	Assessment Unit
White Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
slight increase in turbidity slight increase in fine sediment slight decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in fish species introduction medium increase in harassment slight decrease in benthic community richness slight decrease in riparian function slight decrease in salmon carcasses		
COMMENTS		

REACH	Subwatershed	Assessment Unit
White Creek 2		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight increase in turbidity		
WATER QUALITY CONDITIONS		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight decrease in benthic community richness slight decrease in woody debris		
COMMENTS		

REACH	Subwatershed	Assessment Unit
White Creek 3		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in hydro-confinement slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight decrease in riparian function medium increase in harassment slight decrease in benthic community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Brush Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in embeddedness slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment		

REACH	Subwatershed	Assessment Unit
Brush Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight decrease in riparian function slight decrease in benthic community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Brush Creek 2		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
medium decrease in woody debris medium increase in hydro-confinement slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in mean monthly temperature slight increase in turbidity slight increase in fine sediment medium decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in harassment slight decrease in riparian function slight decrease in benthic community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Brush Creek 2		Middle Klickitat
FOCAL SPECIES	Steelhead	

REACH	Subwatershed	Assessment Unit
White Creek 4		Middle Klickitat
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
large decrease in woody debris medium increase in hydro-confinement slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in mean monthly temperature slight increase in turbidity slight increase in fine sediment slight decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight decrease in benthic community richness medium decrease in riparian function medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
White Creek 5		Middle Klickitat
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
medium decrease in woody debris medium increase in hydro-confinement slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight increase in bed scour slight increase in embeddedness slight increase in glides		
WATER QUALITY CONDITIONS		
slight increase in mean monthly temperature slight increase in turbidity slight increase in fine sediment medium decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight decrease in benthic community richness medium increase in harassment medium decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Tepee Creek 1	White Creek	Middle Klickitat
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
slight decrease in pools slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in hydro-confinement		

REACH	Subwatershed	Assessment Unit
Tepee Creek 1	**White Creek**	**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
WATER QUALITY CONDITIONS		
slight increase in mean monthly temperature slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in harassment slight decrease in benthic community richness slight decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
NE Trib 1	**White Creek**	**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
large increase in hydro-confinement slight decrease in pools slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in small cobble		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in harassment slight decrease in benthic community richness slight decrease in riparian function		

REACH	Subwatershed	Assessment Unit
NE Trib 1	**White Creek**	**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	
COMMENTS		

REACH	Subwatershed	Assessment Unit
SE Trib 1	**White Creek**	**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

slight increase in embeddedness
slight increase in hydro-confinement

WATER QUALITY CONDITIONS

slight increase in turbidity
slight increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium increase in harassment
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
NE Trib 2	**White Creek**	**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

slight increase in bed scour
slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in turbidity
medium decrease in temperature spatial variation
large increase in fine sediment

WATER QUANTITY CONDITIONS

REACH	Subwatershed	Assessment Unit
NE Trib 2	**White Creek**	**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in benthic community richness
medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Tepee Creek 2	**White Creek**	**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

medium increase in hydro-confinement
slight decrease in pools
slight decrease in tailouts
slight decrease in woody debris
slight increase in bed scour
slight increase in embeddedness
slight increase in fine sediment
slight increase in glides
slight increase in small cobble

WATER QUALITY CONDITIONS

slight increase in turbidity
slight increase in mean monthly temperature
medium decrease in temperature spatial variation

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in riparian function
medium increase in harassment
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
White Creek 6		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

large increase in hydro-confinement
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight decrease in woody debris
slight increase in bed scour
slight increase in embeddedness
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in mean month;y temperature
slight increase in turbidity
slight increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in riparian function
medium increase in harassment
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
White Creek 7		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

medium increase in hydro-confinement
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight decrease in woody debris
slight increase in bed scour
slight increase in embeddedness
slight increase in glides
slight increase in large cobble

REACH	Subwatershed	Assessment Unit
White Creek 7		Middle Klickitat
FOCAL SPECIES		Steelhead

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight increase in turbidity
slight increase in fine sediment
slight decrease in temperature spatial variation

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in riparian function
medium increase in harassment
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
White Creek 8		Middle Klickitat
FOCAL SPECIES		Steelhead

PHYSICAL HABITAT CONDITIONS

medium increase in hydro-confinement
slight decrease in pools
slight decrease in tailouts
slight decrease in woody debris
slight increase in bed scour
slight increase in embeddedness
slight increase in glides

WATER QUALITY CONDITIONS

slight increase in mean month;y temperature
slight increase in turbidity
slight decrease in temperature spatial variation
slight increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
White Creek 8		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

slight decrease in riparian function
slight decrease in benthic community richness
medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
White Creek 9		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

slight decrease in pools
slight decrease in tailouts
slight increase in bed scour
slight increase in embeddedness
slight increase in glides

WATER QUALITY CONDITIONS

slight increase in turbidity
slight increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium increase in harassment
slight decrease in benthic community richness
slight decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
Klickitat 14		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	

PHYSICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Klickitat 14		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	

medium increase in hydro-confinement
slight decrease in large cobble
slight decrease in woody debris
slight increase in glides

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

slight increase in salmon carcasses
slight increase in fish community richness
slight decrease in benthic community richness
large increase in fish pathology
large increase in hatchery outplants
medium increase in fish species introduction
slight decrease in riparian function
medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Outlet Creek		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large increase in hatchery outplants
medium increase in fish pathology

COMMENTS

REACH	Subwatershed	Assessment Unit
Outlet Creek		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

REACH	Subwatershed	Assessment Unit
Klickitat 15		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	

PHYSICAL HABITAT CONDITIONS

medium increase in hydro-confinement
slight decrease in large cobble
slight decrease in pools
slight decrease in small cobble
slight decrease in woody debris
slight increase in bed scour
slight increase in glides

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large increase in fish pathology
large increase in hatchery outplants
medium increase in fish species introduction
medium increase in harassment
slight increase in fish community richness
slight increase in predation risk
slight decrease in riparian function
slight decrease in salmon carcasses
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Klickitat 17		**Middle Klickitat**

FOCAL SPECIES **Steelhead, Spring Chinook, Bull trout**

PHYSICAL HABITAT CONDITIONS

slight decrease in woody debris

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

slight increase in fish community richness
slight increase in predation risk
slight increase in salmon carcasses
large increase in fish pathology
large increase in hatchery outplants
medium increase in fish species introduction
medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Trout Creek 1		**Middle Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

slight increase in fish community richness
large increase in fish pathology

COMMENTS

REACH	Subwatershed	Assessment Unit
Trout Creek 3		**Middle Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

slight decrease in pools
slight decrease in small cobble
slight decrease in woody debris
slight increase in bed scour
slight increase in embeddedness
slight increase in glides
slight increase in hydro-confinement
slight increase in tailouts

WATER QUALITY CONDITIONS

slight decrease in temperature spatial variation
medium increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in benthic community richness
medium decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
Bear Creek 1		**Middle Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

medium increase in embeddedness
slight decrease in pools
slight decrease in small cobble
slight decrease in woody debris
slight increase in bed scour
slight increase in glides
slight increase in hydro-confinement
slight increase in tailouts

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
medium increase in fine sediment

REACH	Subwatershed	Assessment Unit
Bear Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium increase in harassment
medium decrease in benthic community richness
medium decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
Trout Creek 4		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

medium decrease in woody debris
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in embeddedness
slight increase in glides
slight increase in hydro-confinement
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
medium increase in fine sediment
slight decrease in temperature spatial variation

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in benthic community richness
medium decrease in riparian function
medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Klickitat 18		Middle Klickitat
FOCAL SPECIES	Steelhead, Spring Chinook, Bull trout	

PHYSICAL HABITAT CONDITIONS

WATER QUALITY CONDITIONS

slight increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

slight increase in salmon carcasses
large increase in fish pathology
medium increase in fish species introduction
medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Klickitat 19		Middle Klickitat
FOCAL SPECIES	Steelhead, Spring Chinook, Bull trout	

PHYSICAL HABITAT CONDITIONS

slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in fine sediment
slight increase in turbidity

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

slight increase in salmon carcasses

COMMENTS

REACH	Subwatershed	Assessment Unit
Surveyor Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

slight increase in bed scour

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

large increase in fish pathology
large increase in hatchery outplants
medium increase in fish species introduction
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Surveyor Creek 3		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

slight increase in bed scour
slight decrease in HbBckPls
slight decrease in small cobble
slight increase in embeddedness
slight increase in glides

WATER QUALITY CONDITIONS

medium increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

slight decrease in benthic community richness
large increase in fish pathology
large increase in hatchery outplants
medium increase in fish species introduction
slight decrease in riparian function

REACH	Subwatershed	Assessment Unit
Surveyor Creek 3		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

COMMENTS

REACH	Subwatershed	Assessment Unit
Klickitat 20		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	

PHYSICAL HABITAT CONDITIONS

slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

slight increase in salmon carcasses
large increase in fish pathology

COMMENTS

REACH	Subwatershed	Assessment Unit
Klickitat 21		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	

PHYSICAL HABITAT CONDITIONS

slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

slight increase in salmon carcasses
large increase in fish pathology

REACH	Subwatershed	Assessment Unit
Klickitat 21		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	

COMMENTS

REACH	Subwatershed	Assessment Unit
West Fork Klickitat 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Bull trout**	

PHYSICAL HABITAT CONDITIONS

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large increase in fish pathology

medium increase in harassment

slight increase in salmon carcasses

COMMENTS

REACH	Subwatershed	Assessment Unit
West Fork Klickitat 3		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Bull trout**	

PHYSICAL HABITAT CONDITIONS

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
West Fork Klickitat 3		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Bull trout**	

large increase in fish pathology

medium increase in harassment

slight decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
Clearwater Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Bull trout**	

PHYSICAL HABITAT CONDITIONS

slight decrease in woody debris

WATER QUALITY CONDITIONS

slight increase in turbidity

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

medium increase in fish species introduction

medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Little Muddy Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Bull trout**	

PHYSICAL HABITAT CONDITIONS

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Little Muddy Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Bull trout**	

medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Clearwater Creek 2		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

slight increase in turbidity

ECOLOGICAL HABITAT CONDITIONS

medium increase in fish species introduction
medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Trappers Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Bull trout**	

PHYSICAL HABITAT CONDITIONS

WATER QUALITY CONDITIONS

slight increase in turbidity

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

medium increase in harassment

REACH	Subwatershed	Assessment Unit
Trappers Creek 1		**Middle Klickitat**
FOCAL SPECIES	**Steelhead, Bull trout**	

COMMENTS

REACH	Subwatershed	Assessment Unit
Clearwater Creek 3		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

WATER QUALITY CONDITIONS

slight increase in turbidity

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

medium increase in fish species introduction

medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
West Fork Klickitat 5		**Middle Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

WATER QUALITY CONDITIONS

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large increase in fish pathology

medium increase in fish species introduction

medium increase in harassment

REACH	Subwatershed	Assessment Unit
West Fork Klickitat 5		Middle Klickitat

FOCAL SPECIES **Steelhead**

COMMENTS

REACH	Subwatershed	Assessment Unit
Fish Creek 1		Middle Klickitat

FOCAL SPECIES **Steelhead, Bull trout**

PHYSICAL HABITAT CONDITIONS

slight decrease in woody debris

WATER QUALITY CONDITIONS

slight increase in turbidity

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large increase in fish pathology
medium increase in fish species introduction
medium increase in harassment
medium increase in hatchery outplants

COMMENTS

REACH	Subwatershed	Assessment Unit
Klickitat 22		Middle Klickitat

FOCAL SPECIES **Steelhead, Spring Chinook**

PHYSICAL HABITAT CONDITION

WATER QUALITY CONDITIONS

slight increase in turbidity
slight increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Klickitat 22		Middle Klickitat
FOCAL SPECIES	Steelhead, Spring Chinook	

large increase in fish pathology

medium increase in harassment

slight increase in salmon carcasses

4.7.6 Little Klickitat Assessment Unit

Topography and Climate

Little Klickitat Falls is located at river mile 6.1. This is a 14–16 foot falls that provides difficult passage for steelhead and is likely impassable for coho (WSCC 1999, WDOE 1998, Caldwell and Hirschey 1990). The frequency that the falls is passable to steelhead is unknown.

This watershed is on the drier side of the Klickitat basin. Here there is less snowpack for runoff and streams tend to have lower flows.

Vegetation Patterns

Demographics and Land Use

This watershed is a mix of small private land ownership in the lower basin and private timber lands in the upper portion of the basin. The main Little Klickitat has some diking and channelization between river miles 10 and 18 (WSCC 1999). There are parcels along the main little Klickitat with grazing above river mile 12 and more extensive rural residential developments above river mile 17.4. These land uses impact riparian conditions and floodplain development (WSCC 1999). North of the town of Goldendale, Highway 97 parallels the stream resulting in some floodplain encroachment (WSCC 1999).

Aquatic Habitat Conditions

Water Quality and Quantity

Because of the drier climate and limited snowpack, water temperatures tend to be warmer. Data collected in support of the Little Klickitat River TMDL (Brock and Stohr 2002) indicate water temperatures in much of the subbasin exceed state water quality standards. The TMDL estimates reductions in temperatures are possible with increased shade, thereby improving fish habitat; however the state water temperature criteria is unlikely to be met in several areas despite the increases in shade.

The greatest number of recorded water rights, and the greatest cumulative volume of allocated rights (34,000 acre-feet/year), occur within the Little Klickitat Subbasin (Chapter 6). The estimated mean and low flows in June are 74 and 30 cfs respectively and in January the estimated mean and low flows are 178 and 46 cfs (Chapter 5). Between river miles 15.0 to 17.0, there are diversions resulting in low flows of 1 to 3 cfs between June and January (WSCC 1999). These flows are low enough that there are areas of intermittent flow preventing fish movements through the mainstem during portions of the year.

Riparian/Floodplain Condition and Function

Stream Channel Conditions and Function

Environmental / Population Relationships / Limiting Factors

Heavy timber harvest, road building, and grazing in the upper reaches of the Little Klickitat River has reduced riparian cover and has increased temperatures and sediment delivery to streams. Nutrients from farming and a sewage treatment outfall cause excessive algal growth in the Little Klickitat. Adjacent tributaries in the lower basin share many of the same problems.

Ecological Conditions

Restoration projects have been focused on in-stream structural modifications, re-vegetation of the riparian corridor, construction of sediment retention ponds to provide late-season flow to the creek and exclosure fencing to prevent channel degradation from livestock.

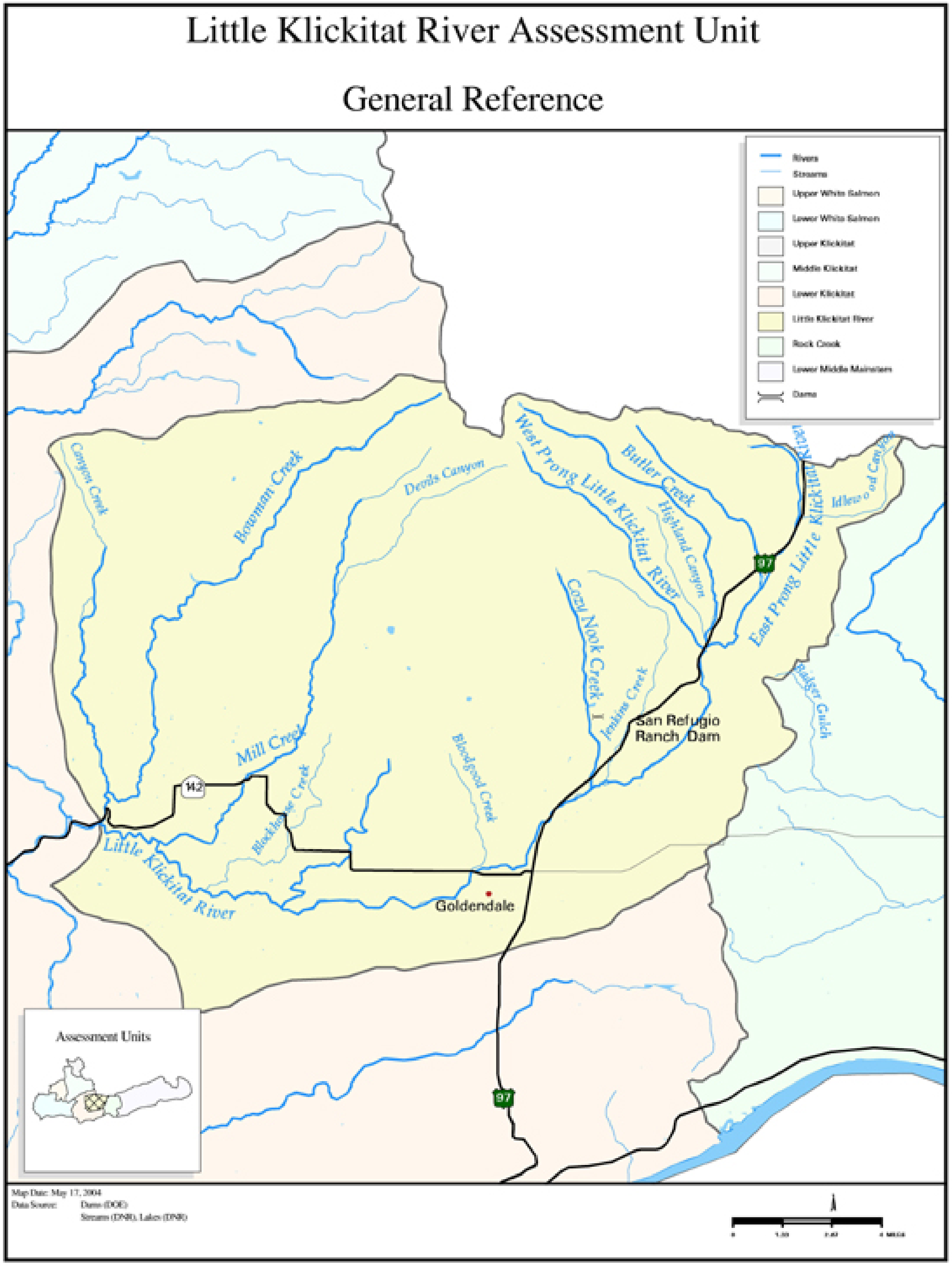

Figure 27 General reference map for the Little Klickitat River Assessment Unit

4.7.7 Little Klickitat Assessment by Reach

Table 24 Little Klickitat reach assessments

REACH	Subwatershed	Assessment Unit
Little Klickitat 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook**	

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
slight increase in bed scour
slight increase in embeddedness
slight increase in glides
slight increase in hydro-confinement

WATER QUALITY CONDITIONS

slight increase in turbidity
medium increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

medium increase in fish pathology
medium increase in fish species introduction
medium increase in harassment
medium increase in hatchery outplants
medium increase in nutrient enrichment
slight decrease in riparian function
slight decrease in salmon carcasses
medium decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Canyon Creek 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook**	

PHYSICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Canyon Creek 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook**	

medium increase in embeddedness
medium increase in hydro-confinement
slight decrease in small cobble
slight decrease in woody debris
slight increase in bed scour
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in turbidity

WATER QUANTITY CONDITIONS

slight increase in low flow
medium increase in fine sediment

ECOLOGICAL HABITAT CONDITIONS

medium increase in nutrient enrichment
slight decrease in benthic community richness
slight decrease in riparian function
slight decrease in salmon carcasses
medium increase in fish pathology
medium increase in fish species introduction
medium increase in harassment
medium increase in hatchery outplants

COMMENTS

REACH	Subwatershed	Assessment Unit
Bowman Creek 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

medium increase in embeddedness
slight decrease in woody debris

WATER QUALITY CONDITIONS

slight increase in turbidity
medium increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

REACH	Subwatershed	Assessment Unit
Bowman Creek 1	Little Klickitat	Little Klickitat
FOCAL SPECIES	Steelhead	

ECOLOGICAL HABITAT CONDITIONS

medium increase in fish pathology
medium increase in fish species introduction
medium increase in hatchery outplants
medium increase in nutrient enrichment
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Canyon Creek 2	Little Klickitat	Little Klickitat
FOCAL SPECIES	Steelhead	

PHYSICAL HABITAT CONDITIONS

medium increase in embeddedness
slight decrease in woody debris

WATER QUALITY CONDITIONS

medium increase in fine sediment
slight increase in turbidity

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium increase in fish pathology
medium increase in hatchery outplants
medium increase in nutrient enrichment
slight decrease in benthic community richness
slight decrease in salmon carcasses

COMMENTS

REACH	Subwatershed	Assessment Unit
Little Klickitat 2	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook**	

PHYSICAL HABITAT CONDITIONS

slight decrease in woody debris
slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in turbidity
slight increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

medium increase in fish pathology
medium increase in fish species introduction
medium increase in hatchery outplants
medium increase in nutrient enrichment
slight decrease in benthic community richness
slight decrease in salmon carcasses
slight increase in fish community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Mill Creek	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

medium decrease in woody debris
slight increase in bed scour
slight increase in embeddedness
slight increase in hydro-confinement

WATER QUALITY CONDITIONS

slight increase in turbidity
medium increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Mill Creek	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

medium increase in fish pathology
medium increase in hatchery outplants
medium increase in nutrient enrichment
medium decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Little Klickitat 3	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead, Spring Chinook**

PHYSICAL HABITAT CONDITIONS

slight decrease in woody debris
slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in fine sediment
slight increase in turbidity

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

medium increase in fish pathology
medium increase in fish species introduction
medium increase in hatchery outplants
medium increase in nutrient enrichment

COMMENTS

REACH	Subwatershed	Assessment Unit
Little Klickitat 7	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Little Klickitat 7	Little Klickitat	Little Klickitat

FOCAL SPECIES **Steelhead**

large decrease in woody debris
large increase in hydro-confinement
slight decrease in HbBckPls
slight decrease in HbOfChFctr
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in embeddedness
slight increase in glides
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in turbidity
slight increase in fine sediment
slight increase in mean monthly temperature
slight decrease in temperature spatial variation

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in benthic community richness
medium decrease in riparian function
medium increase in nutrient enrichment
large increase in fish pathology
large increase in harassment
large increase in hatchery outplants

COMMENTS

REACH	Subwatershed	Assessment Unit
Cozynook Creek 1	Little Klickitat	Little Klickitat

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Cozynook Creek 1	Little Klickitat	Little Klickitat
FOCAL SPECIES		Steelhead

large decrease in woody debris
large increase in hydro-confinement
medium increase in embeddedness
slight decrease in large cobble
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in glides

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight increase in turbidity
large increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large decrease in riparian function
medium increase in fish pathology
medium increase in harassment
medium increase in hatchery outplants
large increase in nutrient enrichment
medium decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Spring Creek 1	Little Klickitat	Little Klickitat
FOCAL SPECIES		Steelhead

PHYSICAL HABITAT CONDITIONS

medium decrease in woody debris
medium increase in embeddedness
medium increase in hydro-confinement

WATER QUALITY CONDITIONS

slight increase in turbidity
medium increase in fine sediment

REACH	Subwatershed	Assessment Unit
Spring Creek 1	Little Klickitat	Little Klickitat

FOCAL SPECIES **Steelhead**

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large increase in fish pathology
large increase in hatchery outplants
medium decrease in benthic community richness
medium decrease in riparian function
medium increase in nutrient enrichment
medium increase in harassment

COMMENTS

REACH	Subwatershed	Assessment Unit
Little Klickitat 5	Little Klickitat	Little Klickitat

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

slight decrease in woody debris
slight increase in embeddedness

WATER QUALITY CONDITIONS

slight increase in turbidity

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large increase in fish pathology
large increase in hatchery outplants
medium increase in nutrient enrichment

COMMENTS

REACH	Subwatershed	Assessment Unit
Little Klickitat 6	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
medium increase in hydro-confinement
slight decrease in HbBckPls
slight decrease in HbOfChFctr
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in embeddedness
slight increase in glides
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in turbidity
slight increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

large increase in hatchery outplants
medium decrease in riparian function
medium increase in harassment
medium increase in nutrient enrichment
slight decrease in benthic community richness
large increase in fish pathology

COMMENTS

REACH	Subwatershed	Assessment Unit
Little Klickitat 9	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Little Klickitat 9	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

medium decrease in woody debris
medium increase in hydro-confinement
slight decrease in small cobble
slight increase in bed scour
slight increase in embeddedness
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in turbidity
medium increase in fine sediment
slight increase in mean monthly temperature

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

slight decrease in benthic community richness
slight decrease in riparian function
medium increase in harassment
large increase in fish pathology
large increase in hatchery outplants

COMMENTS

REACH	Subwatershed	Assessment Unit
West Prong 1	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
medium increase in embeddedness
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in large cobble

WATER QUALITY CONDITIONS

REACH	Subwatershed	Assessment Unit
West Prong 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

slight increase in turbidity
large increase in fine sediment
slight increase in mean monthly temperature

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium increase in harassment
medium increase in hatchery outplants
slight decrease in benthic community richness
large increase in fish pathology
medium decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
West Prong 2	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
medium increase in embeddedness
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in turbidity
slight increase in mean monthly temperature
large increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
West Prong 2	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

medium increase in harassment
medium increase in hatchery outplants
slight decrease in benthic community richness
large increase in fish pathology
medium decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
West Prong 3	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
medium increase in embeddedness
medium increase in hydro-confinement
slight decrease in beaver ponds
slight decrease in HbBckPls
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in glides
slight increase in large cobble

WATER QUALITY CONDITIONS

large increase in fine sediment
slight increase in turbidity
slight increase in mean monthly temperature

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

slight decrease in benthic community richness
medium increase in harassment
medium increase in hatchery outplants
large increase in fish pathology
medium decrease in riparian function

REACH	Subwatershed	Assessment Unit
West Prong 3	Little Klickitat	Little Klickitat
FOCAL SPECIES	Steelhead	

COMMENTS

REACH	Subwatershed	Assessment Unit
West Prong 4	Little Klickitat	Little Klickitat
FOCAL SPECIES	Steelhead	

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
large increase in hydro-confinement
slight decrease in small cobble
slight increase in bed scour
slight increase in embeddedness
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight in slight increase in fine sediment
slight increase in turbidity

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in benthic community richness
medium decrease in riparian function
medium increase in hatchery outplants
large increase in fish pathology

COMMENTS

REACH	Subwatershed	Assessment Unit
East Prong 1	Little Klickitat	Little Klickitat
FOCAL SPECIES	Steelhead	

PHYSICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
East Prong 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

large decrease in woody debris
slight decrease in small cobble
slight increase in bed scour
slight increase in embeddedness
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight increase in turbidity
medium increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

large increase in fish pathology
large increase in harassment
medium decrease in riparian function
medium increase in hatchery outplants
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Butler Creek 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
medium increase in embeddedness
medium increase in hydro-confinement
slight decrease in small cobble
slight increase in bed scour
slight increase in large cobble

WATER QUALITY CONDITIONS

large increase in fine sediment
slight increase in mean month;y temperature
slight increase in turbidity

WATER QUANTITY CONDITIONS

REACH	Subwatershed	Assessment Unit
Butler Creek 1	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

slight decrease in benthic community richness

medium increase in harassment

medium increase in hatchery outplants

large increase in fish pathology

medium decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
Butler Creek 3	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris

medium increase in embeddedness

medium increase in hydro-confinement

slight decrease in beaver ponds

slight decrease in HbBckPls

slight decrease in HbOfChFctr

slight decrease in pools

slight decrease in tailouts

slight increase in bed scour

slight increase in glides

slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature

slight increase in turbidity

slight decrease in temperature spatial variation

medium increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Butler Creek 3	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

medium increase in harassment
medium increase in hatchery outplants
large decrease in riparian function
large increase in fish pathology
slight decrease in benthic community richness

COMMENTS

REACH	Subwatershed	Assessment Unit
Butler Creek 4	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
large increase in hydro-confinement
slight decrease in HbBckPls
slight decrease in pools
slight decrease in small cobble
slight increase in bed scour
slight increase in embeddedness
slight increase in glides
slight increase in large cobble

WATER QUALITY CONDITIONS

medium increase in fine sediment
slight increase in mean monthly temperature
slight increase in turbidity

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in riparian function
medium increase in hatchery outplants
slight decrease in benthic community richness
large increase in fish pathology

COMMENTS

REACH	Subwatershed	Assessment Unit
East Prong 2	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

large increase in hydro-confinement
medium decrease in woody debris
slight decrease in HbOfChFctr
slight decrease in small cobble
slight increase in bed scour
slight increase in embeddedness
slight increase in glides

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight increase in turbidity
slight increase in fine sediment
medium decrease in temperature spatial variation

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

slight decrease in benthic community richness
medium increase in hatchery outplants
medium decrease in riparian function
large increase in fish pathology
slight decrease in beaver ponds

COMMENTS

REACH	Subwatershed	Assessment Unit
Dry Creek 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

REACH	Subwatershed	Assessment Unit
Dry Creek 1	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

large increase in hydro-confinement
medium decrease in woody debris
slight decrease in HbOfChFctr
slight decrease in small cobble
slight increase in bed scour
slight increase in embeddedness
slight increase in glides

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight increase in turbidity
slight increase in fine sediment
medium decrease in temperature spatial variation

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium increase in hatchery outplants
slight decrease in beaver ponds
slight decrease in benthic community richness
medium decrease in riparian function
large increase in fish pathology

COMMENTS

REACH	Subwatershed	Assessment Unit
Dry Creek 3	**Little Klickitat**	**Little Klickitat**
FOCAL SPECIES	**Steelhead**	

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
large increase in hydro-confinement
medium increase in embeddedness
slight decrease in HbOfChFctr
slight decrease in pools
slight decrease in tailouts
slight increase in glides

REACH	Subwatershed	Assessment Unit
Dry Creek 3	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight increase in turbidity
slight decrease in temperature spatial variation
large increase in fine sediment

WATER QUANTITY CONDITIONS

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium increase in harassment
slight decrease in beaver ponds
medium decrease in benthic community richness
medium decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
Dry Creek 4	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
large increase in hydro-confinement
medium increase in embeddedness
slight decrease in HbBckPls
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in glides
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight increase in turbidity
medium increase in fine sediment

WATER QUANTITY CONDITIONS

REACH	Subwatershed	Assessment Unit
Dry Creek 4	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

slight increase in low flow

ECOLOGICAL HABITAT CONDITIONS

medium decrease in benthic community richness
medium decrease in riparian function

COMMENTS

REACH	Subwatershed	Assessment Unit
East Prong 3	**Little Klickitat**	**Little Klickitat**

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

large increase in hydro-confinement
medium decrease in woody debris
medium increase in embeddedness
slight decrease in HbBckPls
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in glides
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
medium increase in turbidity
medium decrease in temperature spatial variation
large increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

medium increase in harassment
medium increase in hatchery outplants
slight decrease in beaver ponds
slight decrease in benthic community richness
large decrease in riparian function
large increase in fish pathology

REACH	Subwatershed	Assessment Unit
East Prong 3	Little Klickitat	Little Klickitat

FOCAL SPECIES **Steelhead**

COMMENTS

REACH	Subwatershed	Assessment Unit
Idlewild 1	Little Klickitat	Little Klickitat

FOCAL SPECIES **Steelhead**

PHYSICAL HABITAT CONDITIONS

large decrease in woody debris
large increase in hydro-confinement
medium increase in embeddedness
slight decrease in pools
slight decrease in small cobble
slight decrease in tailouts
slight increase in bed scour
slight increase in large cobble

WATER QUALITY CONDITIONS

slight increase in mean monthly temperature
slight increase in turbidity
large increase in fine sediment

WATER QUANTITY CONDITIONS

ECOLOGICAL HABITAT CONDITIONS

slight decrease in riparian function
medium increase in harassment
slight decrease in benthic community richness

COMMENTS

4.7.8 Lower Klickitat Assessment Unit

Topography and Climate

The majority of elevations in the assessment unit fall within the 1000-3000 foot range; elevations between 1000-2000 feet are found closer to the mainstem Klickitat and Columbia Rivers, and within the Swale Creek drainage. Along the lower mainstem Klickitat, elevation decreases to between 0-1000 feet. The primary area of topographic relief is a result of down cutting into the

Columbia Plateau by the Klickitat River (Watershed Professionals Network and Aspect Consulting, Inc. 2004).

Some soils within the "A" Hydrologic Soil Group are found along the mainstem immediately downstream from Summit Creek. The remainder of the AU is predominated by and roughly split between both B and C HSGs, indicating moderate to slow rates of water infiltration and transmission. A higher percentage of HSG "C" soils are found within the Swale Creek drainage. Some soils with an HSG of "D" are also distributed throughout the AU.

Higher elevations in this AU fall within the rain-on-snow precipitation zone, while the lower elevations areas along the mainstem and tributaries, particularly Swale Creek, fall entirely within the rain-dominated precipitation zone. Mean annual precipitation may reach approximately 40 inches along the western edge, although most of the AU receives an average of 10-30 inches annually, with the lower mainstem averaging 20-30 inches. Mean first of month snowpack is less than 12" in this portion of the subbasin, with virtually no snow remaining by April 1.

Vegetation Patterns

Excluding the Swale Creek drainage, the primary land cover/land use category is this assessment unit is "forested uplands", comprised of evergreen, deciduous, and mixed forest. The Swale Creek watershed has only a minor proportion (12%) that is forested, while 33% is classified as herbaceous planted/cultivated areas (Watershed Professionals Network and Aspect Consulting, Inc. 2004). "Orchards/vineyards/other", along with "pasture/hay" is also present. The classification "Shrubland" makes up 47% of the Swale Creek watershed area (Watershed Professionals Network and Aspect Consulting, Inc. 2004). Shrubland is also found along the lower mainstem Klickitat from the Summit Creek confluence to its mouth.

The Klickitat River forms a deep, twisting canyon on its way south to the Columbia River. This twisting characteristic has created juxtaposing areas of forage on south slopes and thermal cover on north slopes. General vegetation types include the forest riparian zone along the Klickitat River, south-facing hillsides of open grasslands, north-facing hillsides forested with conifers, and the flatter plateau covered by mixed forests of oak and pine interspersed with small grassland openings

Demographics and Land Use

The towns of Lyle, Klickitat, and Centerville lie within this portion of the subbasin; urban development is limited to these areas. Rural residential use is found primarily along the main thoroughfares (SR 142 and US 97). Most of the watershed that is not forested is agricultural land, dedicated primarily to pasture, dry-land farming and livestock grazing. Irrigated arable lands are found primarily in the Camas Prairie area and in the upper Swale Creek watershed.

Ownership is primarily private, with state and some federal land holdings. The Klickitat Wildlife Area is owned and managed by WDFW. The area covers approximately 14,000 acres and lies on the east slope of the Cascade Mountains within the AU.

The Conboy Lake National Wildlife Refuge (NWR) is managed by USFWS. The refuge is located approximately 10 miles east of Trout Lake and 7 miles southwest of Glenwood, in the Glenwood Valley/Camas Prairie area. The NWR contains 5,184 acres of marsh, meadows, grasslands, and forest. The former mountain lake is now present only in winter and early spring.

The area provides a spring migration area for Canada geese and ducks, (mainly mallards and pintails) and wintering use for tundra swans, Canada geese, ducks, and bald eagles. Additionally, one of three known nesting areas for sandhill cranes in Washington is located on the NWR, as is one of two known populations of Oregon spotted frogs.

Wild and Scenic Rivers Act -- the lower 10 miles of the Klickitat River were designated recreational under this legislation.

Aquatic Habitat Conditions

Water Quantity

The Little Klickitat River (RM 19.8) and Swale Creek (RM 17.2) are primary tributaries within this AU. Other include Snyder, Wheeler, Logging Camp and Dillacort Creeks.

Tributary hydrographs and lower mainstem response are likely affected by both a rain-on-snow and rainfall runoff. The highest flows likely occur in the winter months during relatively warm winter storms and in response to local thunderstorms with accompanying high-intensity rainfall (Watershed Professionals Network and Aspect Consulting, Inc. 2004). Due to the smaller water budget and earlier runoff, the east side tributaries are more dependent on meadow complexes for storing water and releasing flow from springs to sustain base flow.

Dewatering is a concern on Swale, Wheeler, and Dillacort creeks, where development is believed to have degraded summer instream habitat conditions. Where the surficial alluvium is extensive, such as in the Swale Creek valley and the Camas Prairie area surrounding Glenwood, it can provide a groundwater source for domestic supplies (Watershed Professionals Network and Aspect Consulting, Inc. 2004).

Riparian/Floodplain Condition and Function

An abandoned paved floodplain road hugs the west bank of the Klicktiat River from RM 14 to 31. Although the abandoned Champion log haul road experienced considerable damage from the 1996 flood, it even now cuts off side channels and river meanders at many key locations.

Stream Channel Conditions and Function

The deeply incised lower Klickitat River has remained relatively isolated from direct shoreline development over most of its length. However, floodplain roads, both abandoned and active, have led to channelization and constriction problems in these reaches.

Ecological Conditions

Areas of Special Concern

Environmental / Population Relationships / Limiting Factors

Steelhead mainstem spawning distribution is concentrated between RM 5.2 and RM 50.0, with occasional spawning above Castile Falls (RM 64). Tributary spawning occurs in Swale, Wheeler, Summit, and White creeks and the upper Little Klickitat River.

Coho hatchery releases have resulted in a small population of naturally spawning fish. Spawning occurs between RM 5.2 and RM 42.0 on the mainstem. Tributary spawning occurs in Summit, White, and Swale creeks and in the lower Little Klickitat

Lower basin tributaries historically provided the majority of wild steelhead spawning and rearing habitat. The habitat within these tributaries has been severely degraded. Logging, roading and grazing have resulted in lack of riparian cover, diminished baseflows, and increased temperatures.

Shoreline development is occurring with increasing regularity along the Highway SR 142 corridor between RM 0.0 and 19.0 of the mainstem.

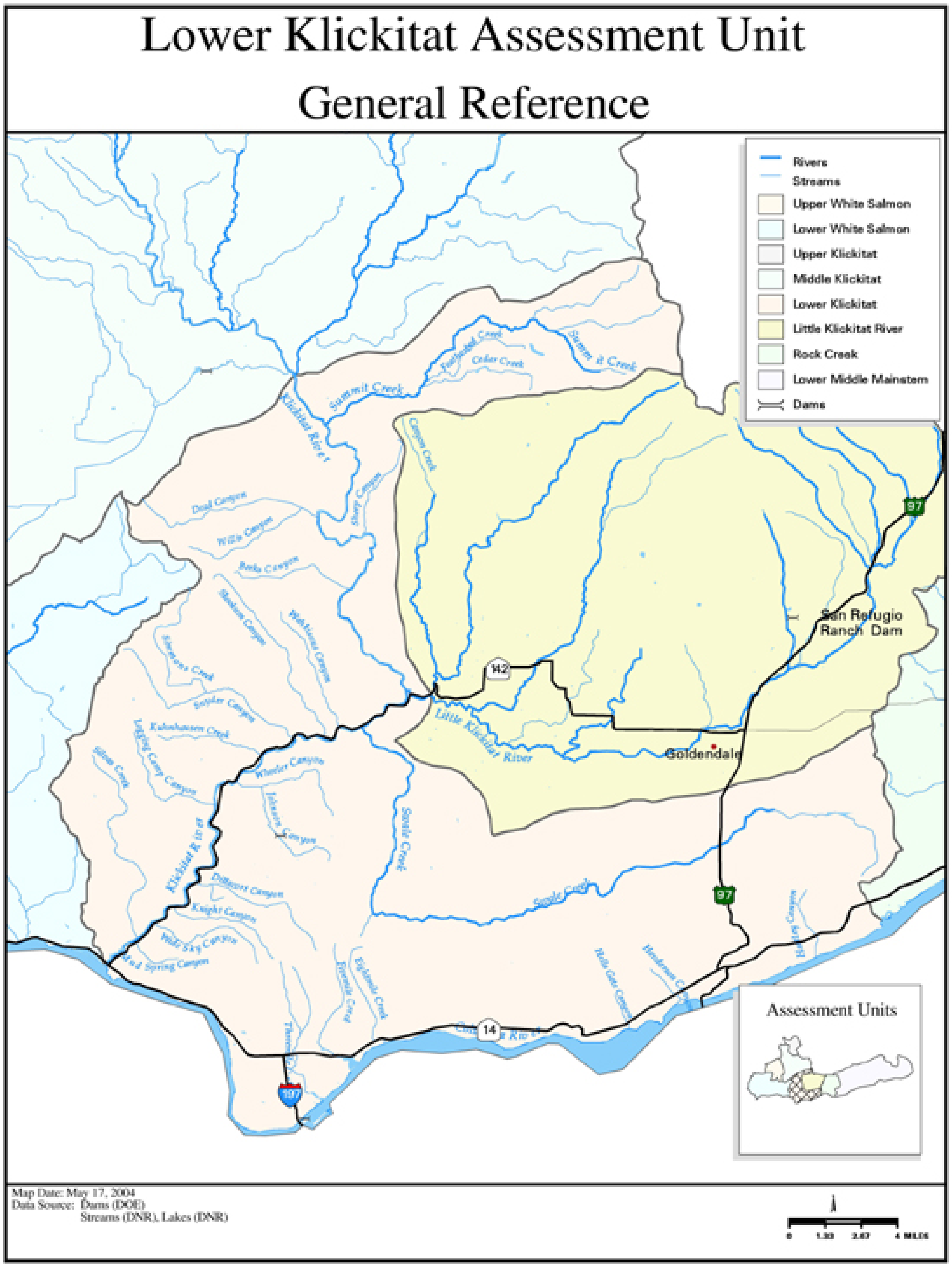

Figure 28 General reference map for the Lower Klickitat Assessment Unit

4.7.9 Lower Klickitat Assessment by Reach

Table 25 Lower Klickitat reach assessments.

REACH	Subwatershed	Assessment Unit
Klickitat 1		Lower Klickitat
FOCAL SPECIES	Steelhead, Spring Chinook, Bull trout	
PHYSICAL HABITAT CONDITIONS		
medium decrease in bed scour medium increase in embededness slight decrease in gradient slight decrease in HbBckPls slight decrease in glides	slight decrease in large cobble slight increase in pool habitat slight decrease in tailouts slight decrease in small cobble	
WATER QUALITY CONDITIONS		
large increase in fine sediment medium decrease in temperature spatial variation slight decrease in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight loss of fish community richness large increase in fish pathology large increase in fish species introduction large increase in harassment large increase in hatchery outplants	medium increase in nutrient enrichment medium increase in predation risk large decrease in riparian function medium decrease in salmon carcasses large decrease in woody debris	
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 2		Lower Klickitat
FOCAL SPECIES	Steelhead, Spring Chinook, Bull trout	
PHYSICAL HABITAT CONDITIONS		
slight increase in embeddednes		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in nutrient enrichment		
WATER QUANTITY CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 2		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology slight increase in fish species introduction slight increase in harassment large increase in hatchery outplants large decrease in salmon carcasses		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 4		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
slight increase in glides slight decrease in pools slight decrease in tailouts slight decrease in small cobble slight decrease in woody debris slight increase in hydro-confinement slight decrease in embeddedness slight increase in bed scour		
WATER QUALITY CONDITIONS		
slight increase in nutrient enrichment slight decrease in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 4		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
large increase in fish pathology medium increase in fish species introduction large increase in harassment large increase in hatchery outplants slight increase in predation risk slight decrease in riparian function slight loss of benthic community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Dillacort Canyon		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight increase in bed scour medium increase in hydro-confinement slight increase in embeddedness slight increase in large cobble slight decrease in pools slight decrease in tailouts slight decrease in small cobble medium decrease in woody debris		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness medium increase in fish species introduction slight decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 5		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
slight increase in bed scour medium increase in hydro-confinement slight increase in embeddedness slight decrease in HbBckPls slight increase in glides slight decrease in large cobble slight loss in pools slight loss of tailouts slight loss of small cobble slight loss in woody debris		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight loss of benthic community richness large increase in fish pathology medium increase in fish species introduction large increase in harassment large increase in hatchery outplants medium increase in nutrient enrichment slight decrease in riparian function slight decrease in salmon carcasses		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Logging Camp Creek		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight increase in hydro-confinement slight increase in embeddedness medium decrease in woody debris		

REACH	Subwatershed	Assessment Unit
Logging Camp Creek		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 6		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
slight increase in bed scour medium increase in hydro-confinement slight increase in embeddedness slight decrease in HbBckPls slight increase in glides slight decrease in large cobble slight decrease in pools slight decrease in tailouts slight decrease in small cobble slight decrease in woody debris		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 6		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
slight loss of benthic community richness slight increase in predation risk slight decrease in riparian function slight increase in salmon carcasses large increase in harassment large increase in hatchery outplants large increase in fish pathology medium increase in fish species introduction		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Wheeler Canyon		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight increase in bed scour slight increase in hydro-confinement slight increase in embeddedness slight increase in large cobble slight decrease in pools slight decrease in small cobble slight decrease in woody debris		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight decrease in salmon carcasses medium decrease in riparian function medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 7		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
slight increase in bed scour medium increase in hydro-confinement slight increase in embeddedness slight decrease in HbBckPls slight increase in glides slight decrease in large cobble slight decrease in pools slight decrease in tailouts slight decrease in small pools		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight loss of benthic community richness large increase in fish pathology medium increase in fish species inctroduction large increase in harassment large increase in hatchery outplants		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Snyder Creek 1		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Snyder Creek 1		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
medium increase in bed scour large increase in hydro-confinement slight decrease in embeddedness slight decrease in HbBckPls slight increase in glides slight decrease in large cobble slight decrease in HbOfChFctr slight decrease in pools slight decrease in tailouts slight decrease in small cobble large decrease in woody debris		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in monthly mean temperature medium decrease in temperature spatial variation slight decrease in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
large loss of benthic community richness large decrease in riparian function medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Snyder Creek 2		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Snyder Creek 2		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
slight increase in bed scour large increase in hydro-confinement slight decrease in embeddedness sligth decrease inHbBckPls slight increase in large cobble slight decrease in pools slight increase in tailouts slight decrease in small cobble large decrease in woody debris		
WATER QUALITY CONDITIONS		
slight increase in monthly mean temperature medium increase in temperature spatial variation slight increase in turbidity slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
large loss in riparian function medium loss of benthic community richness medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Snyder Creek 3		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight increase in embeddedness		
WATER QUALITY CONDITIONS		
slight increase in fine sediment slight increase in turbidity		
WATER QUANTITY CONDITIONS		
slight increase in low flow		

REACH	Subwatershed	Assessment Unit
Snyder Creek 3		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
ECOLOGICAL HABITAT CONDITIONS		
slight loss of benthic community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 8		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
slight increase in bed scour large increase in hydro-confinement slight increase in embeddedness slight decrease in HbBckPls slight increase in glides slight decrease in large cobble slight decrease in pools slight decrease in tailouts slight decrease in small cobble slight decrease in woody debris		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in predation risk medium decrease in riparian function medium loss of salmon carcasses large increase in fish pathology medium increase in fish species introduction large increase in harassment large increase in hatchery outplants slight loss of benthic community richness		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Swale Creek 1		Lower Klickitat
FOCAL SPECIES	Steelhead, Spring chinook	
PHYSICAL HABITAT CONDITIONS		
slight increase in bed scour medium increase in hydro-confinement slight increase in embeddedness slight decrease in HbBckPls slight increase in glides slight decrease in pools slight decrease in tailouts slight decrease in woody debris		
WATER QUALITY CONDITIONS		
slight decrease in tenperature spatial variation slight increase in turbidity medium increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness medium increase in fish pathology medium increase in fish species introduction medium increase in harassment slight loss of benthic community richness medium increase in nutrient enrichment medium decrease in riparian function slight decrease in salmon carcasses		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Swale Creek 2		Lower Klickitat
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Swale Creek 2		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
medium increase in bed scour large increase in hydro-confinement slight increase in embeddedness slight decrease in HbBckPls sligght increase in glides slight increase in large cobble slight decrease in HbChFctr slight decrease in pools slight decrease in tailouts slight decrease in small cobble medium decrease in woody debris		
WATER QUALITY CONDITIONS		
slight increase in turbidity medium increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight loss of benthic community richness medium increase in nutrient enrichment large decrease in riparian funtion slight decrease in salmon carcasses slight decrease in temperature spatial variation slight increase in fish community richness medium increase in fish pathology medium increase in fish species introduction		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Swale Creek 3		
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Swale Creek 3		
FOCAL SPECIES	**Steelhead**	
slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in large cobble slight decrease in small cobble medium decrease in woody debris		
WATER QUALITY CONDITIONS		
slight increase in turbidity slight increase in fine sediment slight decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
slight increase in fish community richness medium increase in fish pathology medium increase in fish species introduction medium increase in nutrient enrichment medium decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Swale Creek 4	**Steelhead**	
FOCAL SPECIES		
PHYSICAL HABITAT CONDITIONS		
medium increase in bed scour slight decrease in HbOfChFctr slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in embeddedness slight increase in pools		
WATER QUALITY CONDITIONS		

REACH	Subwatershed	Assessment Unit
Swale Creek 4	**Steelhead**	
FOCAL SPECIES		
medium increase in fine sediment slight increase in turbidity medium decrease in temperature spatial variation		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in nutrient enrichment medium decrease in riparian function slight increase in fish community richness medium increase in fish pathology medium increase in fish species introduction medium increase in harassment		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 9		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
slight decrease in HbBckPls slight decrease in large cobble slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 9		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
large increase in fish pathology large increase in harassment large increase in hatchery outplants medium decrease in riparian function medium increase in fish species introduction slight increase in predation risk slight decrease in salmon carcasses		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 10		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
medium increase in hydro-confinement slight decrease in HbBckPls slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology large increase in harassment large increase in hatchery outplants slight increase in salmon carcasses slight increase in fish community richness slight decrease in riparian function slight decrease in benthic community richness		

REACH	Subwatershed	Assessment Unit
Klickitat 10		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
COMMENTS		

REACH	Subwatershed	Assessment Unit
Beeks Canyon		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
slight decrease in small cobble slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in hydro-confinement slight increase in large cobble		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in fish species introduction slight decrease in benthic community richness slight decrease in riparian function slight decrease in salmon carcasses		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 11		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 11		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
medium increase in hydro-confinement slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
large increase in fish pathology large increase in harassment slight increase in salmon carcasses slight increase in fish community richness slight decrease in benthic community richness large increase in hatchery outplants medium increase in fish species introduction slight decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Dead Canyon 1		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Dead Canyon 1		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
medium decrease in woody debris slight decrease in HbBckPls slight decrease in HbOfChFctr slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in hydro-confinement slight increase in large cobble		
WATER QUALITY CONDITIONS		
medium increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
slight decrease in salmon carcasses medium increase in fish species introduction medium increase in harassment slight decrease in benthic community richness medium decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Dead Canyon 2		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
PHYSICAL HABITAT CONDITIONS		
medium decrease in woody debris slight decrease in small cobble slight increase in bed scour slight increase in embeddedness slight increase in large cobble		

REACH	Subwatershed	Assessment Unit
Dead Canyon 2		**Lower Klickitat**
FOCAL SPECIES	**Steelhead**	
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
slight increase in low flow		
ECOLOGICAL HABITAT CONDITIONS		
medium increase in fish species introduction slight decrease in riparian function		
COMMENTS		

REACH	Subwatershed	Assessment Unit
Klickitat 12		**Lower Klickitat**
FOCAL SPECIES	**Steelhead, Spring Chinook, Bull trout**	
PHYSICAL HABITAT CONDITIONS		
slight decrease in pools slight decrease in small cobble slight decrease in tailouts slight decrease in woody debris slight increase in bed scour slight increase in embeddedness slight increase in glides slight increase in hydro-confinement		
WATER QUALITY CONDITIONS		
slight increase in fine sediment		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		

REACH	Subwatershed	Assessment Unit
Klickitat 12		Lower Klickitat
FOCAL SPECIES	Steelhead, Spring Chinook, Bull trout	
large increase in fish pathology large increase in harassment large increase in hatchery outplants medium increase in fish species introduction slight decrease in benthic community richness slight decrease in riparian function slight increase in salmon carcasses slight increase in fish community richness		
COMMENTS		

4.8 Synthesis and Interpretation

The following sections discuss the Klickitat River subbsin reaches with the greatest restoration potential with the following objectives:

- Discussion of potential increases of population performance parameters and primary parameter associated with the overall restoration potential rank
- Identification of primary level 3 survival correlates and/or level 2 attributes with greatest impacts to survival and related life stages with highest mortality
- Miscellaneous caveats potentially affecting the overall restoration ranking a reach has received

Reach rankings in order of restoration potential

The overall rankings are based on a summation of individual population performance parameters, which results in several reaches displaying the same overall ranking. Reaches that have the same restoration ranking are grouped together but are not displayed in any order of importance.

4.8.1 Steelhead

Lower Klickitat EDT reaches analysis for restoration potential referencing the overall steelhead population below Castile Falls.

1.) Swale 2

Description: Swale Cr- SE tributary to NW tributary (begins 3.967 miles upstream from the mouth of Swale Creek)

Length: 3.808 mi

Swale 2 exhibits minor potential increases in abundance, productivity and life history diversity but is one of the few reaches that exhibits restoration potential for all three performance parameters. Among all reaches, swale 2 possesses the ability to contribute substantially to the life history diversity index for the lower Klickitat steelhead population, ranking 3rd overall in this category. The EDT model shows a 30% decrease in the life history diversity index for the entire steelhead population below Castile Falls. Of this 30%, the model states that restoration in this reach alone could restore up to 4% of this decline. It also shows a potential increase in abundance and productivity of 2% each.

Because of the physical degradation this reach has undergone due to the railroad prism and in channel work, a combination of level 3 attributes have severely impacted several life stages in the following order: Egg incubation displays an 88.4% decline in productivity from high temperatures, increases in sediment and loss of key habitat. Active rearing life stages show a decrease in productivity by 69.3% from an overwhelming combination of level 3 attributes with major hits from loss of key habitat, high temperatures, potential pathogens, loss of flow and habitat diversity. Fry colonization productivity has decreased by 41.9% primarily from loss of key habitat, temperatures, and habitat diversity. There are no underlining caveats for the ranking of this reach due to severity of degradation it has undergone and the potential it possesses for steelhead.

2.) Klick 12

Description: Klickitat River -- Dead Canyon to Summit Creek

Length: 6.271 mi

Klick 12 restoration potential incorporates substantial potential for increases in productivity (9%) and abundance (4%). The productivity potential ranks 1st among all the reaches and 2nd overall with respect to abundance for the individual categories. The combined effect from the two account for the overall ranking since the model shows no potential increase for in the life history diversity index. A 9% increase in productivity would be a modest improvement in productivity considering the difference in this parameter from historic to current (13.5 to 4.2). This contributes to rationalization of restoration importance of this reach with respect to the overall population performance.

Level 3 correlates contributing to the degradation of this reach is broad with none displaying a dominating affect on productivity. The model illustrates a decrease of survival during the egg incubation life stage due to elevated concentrations of fine sediment. Physical degradations appear on the upper and lower ends of the reach affecting the habitat diversity in the forms of riparian vegetation, hydro confinement and loss of wood. Changes in the biologic community also contribute to the restoration potential this reach displays. Biological effects include an increase in competition and predation from hatchery outplants and species introduction in the rearing life stages. The model also shows a probable increase in mortality from pathogens due to these outplants and the proximity of Klickitat hatchery.

Two caveats exist with the restoration ranking this reach receives: First, this is a rather long reach which correlates to a large capacity (length x channel width). This increase of area will have a slight impact on the magnitude of relative potential increases in the population performance parameters. Second, a high proportion of factors affecting the restoration potential actually lie outside of this reach such as increased levels of turbidity and fine sediment during the late winter, early spring months and biologic community impacts from the hatchery upstream.

2.) Swale 1

Description: Swale Cr- Mouth to SE tributary 3.967 miles upstream

Length: 3.967 mi

Swale 1 also received an overall restoration ranking of 2 with potential increases in abundance by 3%, increases in productivity by 1% and increases in the life history diversity index by 4%. The potential increase in productivity itself ranks fairly low among all reaches associated with the steelhead population compared to the overall rankings for increases in abundance and diversity index. This would lead one to the conclusion that the potential increases in abundance and the diversity index are the primary parameters associated with the overall restoration ranking this reach receives. Another aspect to consider with the potential abundance is its relation to productivity and capacity. Abundance is a function of both productivity and capacity and because the productivity potential is fairly low, one could relate the potential abundance to a decrease in the overall capacity that is associated with the biological response to the amount of available key habitat. The model shows loss of key habitat for nearly every life stage which results in this decrease of capacity encompassing the entire life cycle spent within Swale Creek.

Like Swale 2, this reach exhibits a substantial potential for increasing the life history diversity index by 4%. An interpretation of this hypothesizes that the low survival for the egg incubation and 0 age active rearing life stages have a substantial number of unsuccessful life history trajectories associated with them. These decreases in productivity for the egg incubation life stage are heavily impacted from increased levels of fine sediment over background levels and elevated temperatures. 0 age rearing life stages have major hits from loss of key habitat, elevated temperature, potential pathogens, habitat diversity and low flow. Other life stages have decreases in productivity as well with similar biological affects from habitat diversity, elevated temperatures, loss of late summer flow and decreases in key habitat. The last component to consider with this reach's restoration ranking is its geographic proximity for steelhead utilizing the Swale Cr watershed. All life trajectories in the Swale Cr. watershed are eventually routed through Swale 1. Any decreases in survival for a portion of life stages will affect a greater amount of trajectories than reaches above Swale 1 in the watershed.

3.) Klick 11

Description: Klickitat R- Beeks Canyon to Dead Canyon

Length: 5.518 mi

The overall restoration ranking of 3 for klick 11 from the EDT model has the following potential increases: 4% abundance, 6% productivity and no potential for the life history diversity index. Even without any potential increases in the diversity index this reach ranks fairly high due to the high individual rankings for abundance and productivity. Degradations to the quality and quantity of habitat occur in isolated locations on the right bank of the Klickitat river in this reach. These degradations are strongly linked to the hydro confining affect the Champion haul road has on the river along with the vegetation loss in the form of canopy cover and accelerated bank erosion. These physical factors relate the degradations of quantity and quality of habitat directly to productivity and abundance which is reflected in the loss of key habitat quantity for nearly every single life stage. Biological community affects also contribute to the restoration potential this reach displays. Competition from hatchery outplants have decreased the productivity for the rearing life stages of wild juvenile steelhead along with potential increases in predation. This increase in predation is reflected in the active, inactive, migrant and colonization life stages that are also impacted from species introduction and community richness. Another level 3 biologic attribute contributing to the restoration potential is the presence of pathogens. This value is derived from a synergistic affect from several level 2 attributes. A single level 2 attribute affecting this biological response in the form of species introductions is present so the overall impact is minimal from this level 3 attribute.

4.) Klick 10

Description: Klickitat R- Little Klickitat to Beeks Canyon

Length: 5.510 mi

The overall restoration ranking of 4 this reach received from the EDT model has a potential increase in abundance of 3%, increase of productivity by 5% and a 0% increase in the life history diversity index. This reach receives very similar potentials for productivity and abundance as those in Klick 11. This is not a surprise due to similar degradations these 2 reaches have undergone. Interpretations of physical and biologic level 3 attributes affecting productivity and life stages from Klick 11 could be applied to the restoration potential this reach displays in conjunction with one other level 3 component. The model displays a larger impact to the habitat diversity for several life stages for Klick 10 over Klick 11. Greater decreases in the presence of large woody debris and a higher percent of linear distance confined from the champion haul road result in this additional impact to the marginal habitat diversity. Because of this, one might expect this reach to rank higher than Klick 11 for the overall restoration potential. Klick 11 receives a higher ranking because of its higher capacity that lends itself to greater channel widths, higher percentage of off channel habitat and the unconfined nature of the reach.

4.) Klick 8

Description: Klickitat R- Snyder Cr to Swale Cr

Length: 3.258 mi

The overall restoration ranking of 4 for Klick 8 receives displays a potential increase in abundance by 2%, increase of productivity by 3% and an increase in the life history diversity index of 1%. This reach does not possess the ability to contribute to increases for abundance and productivity to those seen in other reaches with the same restoration ranking but unlike other reaches with the same restoration ranking, the model shows an existing potential to increase the life history diversity by 1% for the overall Klickitat steelhead population. The potential increases in the productivity have a strong case as the primary component driving the overall restoration ranking. Decreases in productivity are related to the quality of available habitat for all life stages occurring within a given reach. The level 3 attribute expression of this is habitat diversity that is a compilation of several physical level 2 attributes. This level 3 parameter has the most significant impact on nearly all existing life stages occurring in this reach. Degradations of the habitat diversity include hydro confinement from the main road paralleling the river along with the old railroad prism in some areas, degraded riparian function in the form of canopy cover and loss of wood which acts as pockets of refugia and channel roughness.

The model also has several biological components contributing to the restoration potential that include the following: competition form hatchery outplants, increased levels of predation and the presence of pathogens. These biological level 3 attributes are present in several but not all life stages and appear to be secondary components with respect to any of the population performance parameters. The model also shows a decrease in the level 3 attribute of food. Of the level 2 attributes that are compiled into this level 3 (biological response), decreases in salmon carcasses appears to be most heavily weighted for a decrease in the food supply. This decrease in the food supply is also related to the sustainable capacity of this reach for all life stages and is reflected in the restoration potential for abundance.

4.) Swale 3

Description: Swale Cr- NW tributary (tributary that overlays the Warwick fault) to a south tributary

Length: 3.438 mi

The overall restoration ranking for this reach has the potential increases for abundance of 2%, increases of productivity equivalent to 1% and potential increases in the diversity index of 3%. This potential increase in the diversity index is the primary population parameter associated with the overall restoration ranking. The individual potential increases for abundance and productivity affect a smaller proportion of life history trajectories for any given life stage than the number in the reaches below which results in a decreased impact to the overall productivity and abundance of the entire population. This is not to say that these are the sole reasons as to why this reach has a lower potential for increases in productivity and abundance (with respect to swale 1 & Swale 2) because other factors are contributing as well. For instance, swale 2 may have loss a greater amount of marginal habitat than swale 3 which contributes to decreases in capacity and abundance. A major limiting factor identified in the EDT reach analysis points to increased temperatures that have substantial impacts to the productivity for the egg incubation, spawning, fry colonization and 0 age active rearing life stage. The other level 3 with the greatest impact on productivities of specific life stages is loss of key habitat for spawning, egg incubation and fry colonization due to the physical changes and historic channel work that has occurred. Other biologic level 3 attributes contribute less but some to the overall restoration potential along with loss of late summer flow. The synergistic affect of elevated temperatures, loss of key habitat quantity and other level 3 attributes has resulted with in reach mortalities for a portion of the trajectories routed through this particular reach. This is reflected in the potential increases of the life history diversity index.

4.) Klick 13

Description: Klickitat R- Summit Cr to White Cr

Length: 2.541 mi

Restoration potential for Klick 13 consists of the following: 2% increase for abundance, 4% increase in productivity and a 1% increase in the life history diversity index. Of the 3 population parameters associated with the overall population performance and restoration ranking, the potential increase displayed in the productivity is substantially larger than the potential for increases in abundance and diversity index. Assessment of the level 3 components having negative impacts on the productivity of a given life stage suggests that the quality of habitat diversity has been degraded in conjunction with increases of fine sediment over background levels. The level 3 analysis also suggests that increases in predation due to hatchery outplants and competition from hatchery outplants has contributed to decreases in productivity for several life stages. Of all the reach rankings, this reach displays the least amount of confidence with its overall ranking. This hypothesis lends itself to the uncertainty associated with the impact of hydro confinement affecting the habitat diversity and channel stability. This is identified because of the confined nature the canyon walls existing along this entire reach. Needless to say, this is not stating that there hasn't been alteration in the canopy and habitat diversity due to the existing road but simply stating that the impact may not be as significant as the model suggests.

5.) White 4

Description: White Cr- Brush Cr To 1st meadow

Length: 4.737 mi

Restoration potential for individual population performance parameters are as follows for White 4: potential increase in abundance of 2%, potential increases in productivity of 1% and potential increases in the life history diversity index of 5%. With respect to the entire lower Klickitat steelhead population below Castile Falls, the potential increases for the life history diversity index is the primary component for the overall restoration ranking. This individual population performance parameter for White 4 ranks first among all other reach potentials.

Level 3 attributes affecting the restoration rankings are primarily physical degradations that the reach has undergone. Degradations in the habitat diversity have negative affects on productivity for almost all life stages. Level 2 attributes with degradations affecting the level 3 attribute of habitat diversity include riparian function, amounts of large woody debris and hydro confinement (or entrenchment). These physical attributes have also resulted in altered habitat types that in turn have decreased the capacity for given habitat type associated with specific life stages. Decreases of late summer flow and elevated temperatures also contribute to the demise of this reach. The overall affect of these level 3 attributes results with reach specific mortalities affecting the trajectories associated with them. Nearly 2/3 of all life history trajectories in the White cr watershed spend some portion of their life cycle in this reach. Because of the relative importance the White cr watershed inherently displays to the overall steelhead population, there is no surprise or caveats associated with this reach's ranking as it should remain top priority for any physical restoration actions.

6.) Klick 5

Description: Klickitat R- Dillacort Canyon to Logging Camp Canyon

Length: 4.001 mi

The overall restoration potential ranking for this reach has the following potential increases: abundance increase of 2%, productivity increase of 3% and an increase of diversity index by 1%. Of the three population performance parameters, none seem to display an overwhelming affect on the overall restoration ranking associated with this reach. Restoration potential for this reach is primarily associated with physical degradations with slight contributions from biological factors and water quality parameters. Habitat diversity has impacted the most life stages over any other level 3 attribute. Level 2 attributes associated with this include Riparian function in the form of canopy cover and vegetation, loss of wood and hydro confinement from proximity of the main road. Level 3 biological attributes having negative impacts on productivity are represented in the form of hatchery outplants resulting in an increased competition for food and space. This biological attribute along with diminished food sources due to declined amounts of salmon carcasses are components contributing to the potential increases of abundance in the form of decreased The last element to consider with this reaches high ranking is related to the high percentage of the populations life history trajectories (97%) routed through the reach through space and time. This reach displays a high sensitivity and increased magnitude of negative affects on a given life stages productivity due to the proximity of the reach.

7.) Klick7

Description: Klickitat R- Wheeler Canyon to Snyder Cr

Length: 3.337 mi

The overall restoration potential ranking for this reach has the following potential increases: abundance increase of 2%, productivity increase of 3% and an increase of diversity index by 0%. The restoration rankings for this particular reach has nearly the same level 3 attributes affecting productivity of life stage as those seen in Klick 5 above. The only discrepancy between the two is the proximity of Klick 7 to or near a human population center of which would be the town of Klickitat. Reach 7 receives a slightly increased affect on the harassment attribute due to this. The reach is ranked just below Klick 5 due to a decreased amount of life history trajectories routed through this reach.

Upper Klickitat EDT reaches analysis for restoration potential referencing the overall steelhead population above Castile Falls.

1.) Klick 30

Description: Klickitat R- Klickitat R meadows (RM 78.2) to Huckleberry Cr

Length: 8.545 mi

Klick 30 restoration potential ranks 1st among the upper Klickitat reaches for steelhead that incorporates substantial potential for increases in productivity (9%), abundance (9%) and Life history diversity index (7%). All three of these population performance parameters are contributing to the overall restoration ranking. Klick 30 has been diagnosed with by the EDT model. The high potential increases for productivity are a function of the quality habitat that has been degraded in isolated areas of this reach. One of the level 3 attributes displaying decreases in productivity related to this is the habitat diversity. In this case, decreases of productivity occur in the colonization, rearing and inactive life stages. The degradation of habitat diversity is a function of deteriorated riparian conditions in isolated locations in the form of decreased canopy and stream bank vegetation, loss of wood and local entrenchment. Local entrenchment has also accelerated bank erosion in some areas and may be the primary contributor to the slight increases of fine sediment over background levels. This is expressed in the level 3 attribute of sediment load of which also has decreased productivity in the egg incubation life stage. Other secondary level 3 attributes contributing to decreased productivity in the egg incubation life stage are slight increases of temperature and decreased channel stability due to local entrenchment.

The high potential increases of abundance for steelhead in this reach are a function of both the potential productivity and capacity. Potential increases and factors affecting productivity are listed in the above paragraph. Potential increases in abundance from decreased capacity are associated with the loss of food resources from decreases of salmon carcasses that primarily impact the fry colonization and early stages of active rearing. The potential displayed for the life history diversity parameter is a result of unsuccessful life history trajectories that result in mortality for fish in this reach. All of the listed degradations above impact this parameter in one form or another. Another factor that may be contributing to the mortality of over wintering life stages could be related to the cold temperatures. This hypothesis speculates the possible decreases of ground water sources offering pockets of refugia for overwintering life stages that will require further research. One caveat exists with this reach's ranking that is related to the stream reaches length. This reach is abnormally longer in length of which results in an increased capacity of area offered for all life stages. This will have increased the individual increases for restoration potential but because all three parameters rank very high individually, this reach would still rank among the top three if had a linear length equivalent to other reaches in the upper Klickitat.

2.) Klick 27

Description: Klickitat R- McCreedy Cr to Piscoe Cr

Length: 3.877 mi

Klick 27 restoration potential ranks 2nd among the upper Klickitat reaches for steelhead that incorporates potential for increases in productivity of 9%, substantial increases in abundance (13%) and increases for Life history diversity index of 4%. The high restoration ranking this reach has received is correlated to the potential increases of abundance primarily, the model also displays a substantial increase in productivity and should be viewed as an important component as well.

Of all the reaches in the upper Klickitat mainstem, this reach has the greatest linear length of hydro confinement due to the main road next to it. The stream bank has been rip rapped to protect the road in areas of which contributes to the simplification of habitat in isolated areas of this reach. From this, the model shows decreases of key habitat for several life stages that ultimately results in decreased capacity. The EDT model also shows a decrease of food resources due to declined number of salmon carcasses. This decrease in food source contributes to the declined capacity for several life stages that is expressed in decreased productivity and overall restoration potential for increases of abundance. Sediment load has been identified as a major limiting factor for several life stages. Egg incubation has the greatest decline in productivity due to fine sediment. Other life stages affected by fine sediment or turbidity include spawning, colonization and migrant life stages.

3.) Klick 25

Description: Klickitat R- Upper end of Castile Falls to Chaparrel Cr.

Length: 3.038 mi

Restoration potential for Klick 25 consists of the following: 8% increase for abundance, 6% increase in productivity and a 1% increase in the life history diversity. Both abundance and productivity are key components for this reaches overall restoration potential. Increases in the life history diversity index from restoration are minimal as compared to the other parameters. This low potential displays the high success rate of life history trajectory paths offered to a given fish. This is also related to the fact that this reach offers a tremendous amount of habitat diversity and has very minimal physical alterations from anthropogenic impacts. Within reach level 3 parameters affecting overall productivity and abundance are food and sediment load. Declined food resources are the result of decreased salmon carcasses affecting colonization and early rearing life stages. The model also identifies sediment load as a major level 3 component affecting productivity for egg incubation, spawning and migrant life stages due to increases of fine sediment and turbidity.

3.) Piscoe 3

Description: Piscoe Cr- piscoe2 to Piscoe road crossing (reach begins 3.65 mi from the mouth)

Length: 2.993 mi

Restoration potential for Piscoe 3 consists of the following: 3% increase for abundance, 2% increase in productivity and a 5% increase in the life history diversity. The overall restoration ranking for piscoe 3 is driven by the potential for increasing the life history diversity relative to the upper Klickitat steelhead population. Several level 3 attributes contribute to the potential this reach displays with sediment load as the key limiting factor expressed in the egg incubation life stage. The model identifies other parameters that consist of habitat diversity, key habitat quantity, channel stability, food resources and elevated temperatures. Of all the top ten reach rankings for the upper Klickitat, this reach exhibits the least confidence and highest uncertainty associated with its overall ranking for 2 reasons. First, available data sources were scarce that addressed piscoe cr and ground truthing was limited due to time constraints. Second, the upper Klickitat has not been thoroughly seeded with steelhead due to passage issues at Castile Falls up until this point. As a result, distribution and future seeding of natural populations of tributaries is not known. Professional biological opinions also have identified other tributaries with higher priorities due to experience and knowledge of that particular area.

4.) Klick 26

Description: Klickitat R- Chaparrel Cr to McCreedy Cr

Length: 2.70 mi

Restoration potential for Klick 26 consists of the following: 8% increase for abundance, 5% increase in productivity and a 1% increase in the life history diversity. The primary population parameter influencing the overall restoration potential is the potential this reach displays for increasing the populations abundance. Degradations undergone in this reach are very similar to the degradations in Klick 27 that is located upstream. In fact, the analysis of klick 27 could be applied to this reach with one exception. This reach has a decreased linear length of stream bank influenced by hydro confinement than the amount in Klick 27. This is expressed in the habitat diversity level 3 attribute. If one was to look at the individual population parameter potentials, you'll notice that Klick 27 has a greater potential for the productivity parameter. This is directly related to the quality of habitat linked to the level 3 correlate habitat diversity. With this one exception, all other level 3 correlates affect similar life stages as those identified in Klick 27.

5.) Klick 28

Description: Klickitat R- Piscoe Cr to Diamond Fork

Length: 1.627 mi

Restoration potential for Klick 28 consists of the following: 4% increase for abundance, 3% increase in productivity and a 1% increase in the life history diversity. The ability of this reach to contribute to the overall steelhead productivity and abundance are the key components driving this overall restoration ranking. A current high success rate of life history trajectories is reflected in the slight potential that exists for the increases in the diversity index. Level 3 components identified by the model that are negatively impacting productivity include sediment load in the form of fines and turbidity, channel stability, and increased predation associated with the presence of hatchery fish. Although the presence of hatchery fish exists due to outplanting of adult spawners and parr, effects are minimal compared to sediment load and decreased food sources. Decreases in food sources identified from the model are a consequence of declined salmon carcasses. This decrease in food resource coupled with a slight decrease of key habitat for several life stages has reduced the overall capacity this reach once exhibited and is identified in the potential increases for abundance.

6.) Diamond 1

Description: Diamond Fork - Mouth pt upstream ~1.58 miles

Length: 1.586 mi

Restoration potential for Diamond 1 consists of the following: 2% increase for abundance, 1% increase in productivity and a 3% increase in the life history diversity. The overall restoration ranking associated with this reach is a product of all three population performance parameters. This reaches limiting factors include declines in productivity for the egg incubation life stage due to fine sediment and elevated temperatures. The overwintering life stage has the largest decline in productivity as a result of decreased habitat diversity and low winter temperatures. The model identifies a loss of key habitat for nearly every life stage which translates to a decrease in the overall capacity and abundance. Other biological level 3 factors have had slight affects are the existence of hatchery fish from a scarce amount of outplantings. Also, 100% of steelhead life history trajectories in the Diamond Fork are routed through this reach at some point so degradations in this reach will affect the sub population of the Diamond Fork.

7.) Diamond 5

Description: Diamond Cr- Butte Meadows Cr to top of last meadow

Length: 2.183 mi

Restoration potential for Diamond 1 consists of the following: 2% increase for abundance, 1% increase in productivity and a 3% increase in the life history diversity. The overall restoration ranking associated with this reach is a product of all three population performance parameters. The model identifies the same limiting level 3 correlates for this reach as Diamond 1. High levels of fine sediment combined with elevated temperatures have substantially decreased productivity for the egg incubation life stage. The model displays major decreases in productivity for the inactive life stages due to decreases of food resources, habitat diversity, and low winter temperatures. Decreases of key habitat for nearly every life stage have negatively influenced the capacity which is reflected in the potential increases for abundance.

8.) Klick 18

Description: Klickitat R- Trout Cr to Big Muddy Cr

Length: 10.865 mi

Restoration potential for Diamond 1 consists of the following: 2% increase for abundance, 1% increase in productivity and a 1% increase in the life history diversity. All 3 of the population parameters contribute to this reaches overall ranking. This reach is located in a relatively isolated area that has not undergone any physical degradation. Restoration potential associated with this reach is reflected and driven by the decrease of food resources. Historically, this reach is thought to have had a higher number of salmon carcasses. The model also displays a slight predation increase do to the presence of hatchery outplants and decreases in productivity for the migrant life stage from elevated concentrations of turbidity during spring runoff months.

9.) Klick 29

Description: Klickitat R- Diamond Fork to bottom Klickitat R meadows

Length: 1.518 mi

Restoration potential for Diamond 1 consists of the following: 3% increase for abundance, 3% increase in productivity and a 0% increase in the life history diversity. The potential increases for abundance and productivity both are driving parameters with the overall restoration potential rank this reach displays. This reach has 1 major limiting factor that has negatively impacted the productivity and appears to be fine sediment. With fine sediment, elevated temperatures work synergistically to decrease to productivity of the egg incubation life stage. Other life stages have minor decreases in productivity due to decreased food resources, decreased habitat diversity and competition with the few hatchery fish that exist in this reach.

4.8.2 Spring Chinook

Lower Klickitat EDT reaches analysis for restoration potential referencing the overall spring chinook population below Castile Falls.

1.) Klick 18

Description: Klickitat R- Trout Cr to Big Muddy Cr

Length: 10.865 mi

Klick 18 ranks 1st for the overall restoration potential associated with the three population performance parameters. This reach displays a potential increase of abundance equal to 7% and a potential increase in productivity equal to 6% and no potential increase for the life history diversity index. The combined affect from the two of this account for the overall ranking since the model shows no potential increase for the life history diversity index. The restoration potential exhibited by this reach is weighted upon the level 3 attribute of food. A decrease in salmon carcasses negatively affect the productivity of the fry colonization, 0,1 age rearing and the inactive wintering life stages of Spring Chinook. This decrease in food source not only results in decreased productivity but diminishes the capacity of the reach as well. Due to the location of this isolated reach, no physical alterations from anthropogenic impacts influence the restoration potential, it is considered to remain in a pristine state. The other level 3 correlate the model has identified impacting survival of several life stages is the sediment load. This sediment load is linked to the increases of concentrations of suspended sediment (turbidity) during the late winter and spring months of the year. Potential sources are located upstream from the reach itself from incoming tributaries displaying resource management implications with road densities. The overall ranking of this reach was a bit unexpected as there are two other factors influencing the reaches ranking of 1. First, this reach is the lowest reach in the system designated as a spawning reach for the Spring Chinook population below Castile Falls. This translates to nearly 100% of the populations life history trajectories either rear or migrate through this reach resulting in exposure to the environmental conditions. Second, this reach is one of the longest reaches in the Klickitat EDT model. This extended length contributes to an increased capacity which magnifies the restoration potential related to this and abundance.

2.) Klick 12

Description: Klickitat R- Dead Canyon to Summit Cr

Length: 6.271 mi

Klick 12 ranks 2nd for the overall restoration potential associated with the three population performance parameters. This reach displays a potential increase of abundance equal to 6% and a potential increase in productivity equal to 4% and no potential increase for the life history diversity index. The combined affect from the two of this account for the overall ranking since the model shows no potential increase for the life history diversity index. Physical degradations appear on the upper and lower ends of the reach affecting the habitat diversity in the forms of riparian vegetation, hydro confinement and loss of wood. Changes in the Biologic community also contribute to the restoration potential this reach displays. Biological affects include an increase in predation from hatchery outplants and species introduction in the migrant and rearing life stages. The model also indicates a decrease in key habitat quanitity affecting the productivity for the rearing life stages in that occur in this reach.

3 .) Klick 10

Description: Klickitat R- Little Klickitat to Beeks Canyon

Length: 5.510 mi

Klick 10 ranks 3rd for the overall restoration potential associated with the three population performance parameters. This reach displays a potential increase of abundance equal to 3% and a potential increase in productivity equal to 2% and no potential increase for the life history diversity index. The model displays a decrease of survival from the habitat diversity level 3 attribute for several life stages. Level 2 attributes affecting the habitat diversity included hydro confinement from the champion haul road, diminished amounts of large woody debris and loss of Canopy cover expressed in the Riparian function attribute. The habitat diversity has affected the quality of habitat and is linked to the restoration parameter of productivity. Decreases of key habitat and food have been identified for several life stages and are articulated in the restoration parameter for abundance. Very little biological influences affect the restoration potential of this reach in the form of hatchery outplants.

3.) Klick 11

Description: Klickitat R- Beeks Canyon to Dead Canyon

Length: 5.518 mi

The overall restoration ranking of 3 for klick 11 from the EDT model has the following potential increases: 3% abundance, 2% productivity and no potential for the life history diversity index. Even without any potential increases in the diversity index this reach ranks fairly high due to the high individual rankings for abundance and productivity. Degradations to the quality and quantity of habitat occur in isolated locations on the right bank of the Klickitat river in this reach. These degradations are strongly linked to the hydro confining affect the Champion haul road has on the river along with the vegetation loss in the form of canopy cover and accelerated bank erosion. These physical factors relate the degradations of quantity and quality of habitat directly to productivity and abundance which is reflected in the loss of key habitat quantity for several life stages. Biological community affects contribute little to the decreases of productivity for rearing and migrant life stages in the form of predation. Hatchery outplants act as the modifying component influencing this level 3 correlate.

3.) Klick 13

Description: Klickitat R- Summit Cr to White Cr

Length: 2.541 mi

Restoration potential for Klick 13 consists of the following: 3% increase for abundance, 2% increase in productivity and a 0% increase in the life history diversity index. Of the 3 population parameters associated with the overall population performance and restoration ranking, the potential increase displayed in the productivity and abundance are obviously the key components to the ranking since the diversity index potential is 0. Assessment of the level 3 components having negative impacts on the productivity of a given life stage suggests that the quality of habitat diversity has been degraded in conjunction with increases of fine sediment over background levels. The level 3 analysis also suggests that increases in predation due to hatchery outplants and competition from hatchery outplants has contributed to decreases in productivity for several life stages. Of all the reach rankings, this reach displays the least amount of confidence with its overall ranking. This hypothesis lends itself to the uncertainty associated with the impact of hydro confinement affecting the habitat diversity and channel stability. This is identified because of the confined nature the canyon walls existing along this entire reach. Needless to say, this is not stating that there hasn't been alteration in the canopy and habitat diversity due to the existing road but simply stating that the impact may not be as significant as the model suggests.

Upper Klickitat EDT reaches analysis for restoration potential referencing the overall spring chinook population above Castile Falls.

1.) Klick 30

Description: Klickitat R- Klickitat R meadows (RM 78.2) to Huckleberry Cr

Length: 8.545 mi

Klick 30 restoration potential ranks 1st among the upper Klickitat reaches for steelhead that incorporates substantial potential for increases in productivity (30%), abundance (21%) and no potential increases for the Life history diversity index (0%). The high potential increases for productivity are a function of the quality habitat that has been degraded in isolated areas of this reach. One of the level 3 attributes displaying decreases in productivity related to this is the habitat diversity. In this case, decreases of productivity occur in the colonization, migrant and inactive life stages. The degradation of habitat diversity is a function of deteriorated riparian conditions in isolated locations in the form of decreased canopy and stream bank vegetation, loss of wood and local entrenchment. Local entrenchment has also accelerated bank erosion in some areas and may be the primary contributor to the slight increases of fine sediment over background levels. This is expressed in the level 3 attribute of sediment load of which also has decreased productivity in the egg incubation life stage. Other secondary level 3 attributes contributing to decreased productivity in the egg incubation life stage are slight increases of temperature and decreased channel stability due to local entrenchment.

The high potential increases of abundance for spring chinook in this reach are a function of both the potential productivity and capacity. Potential increases and factors affecting productivity are listed in the above paragraph. Potential increases in abundance from decreased capacity are associated with the loss of food resources from decreases of salmon carcasses that primarily impact the fry colonization and early stages of active rearing. Another factor that may be contributing to the mortality of over wintering life stages could be related to the cold temperatures. This hypothesis speculates the possible decreases of ground water sources offering pockets of refugia for overwintering life stages that will require further analysis and research. One caveat exists with this reaches ranking that is related to the stream reaches length. This reach is abnormally longer in length of which results in an increased capacity of area offered for all life stages. This will magnify the affects of the individual increases for restoration potential but because two of the three parameters rank very high individually, this reach would still rank among the top three if had a linear length equivalent to other reaches in the upper Klickitat.

2.) Klick 27

Description: Klickitat R- McCreedy Cr to Piscoe Cr

Length: 3.877 mi

Klick 27 restoration potential ranks 2nd among the upper Klickitat reaches for spring chinook that incorporates potential for increases in productivity of 15%, increases in abundance of 11% and no increases for Life history diversity index. The high restoration ranking this reach has received is correlated to the potential increases of productivity primarily, the model also displays a substantial increase in abundance and should be viewed as an important component as well.

Of all the reaches in the upper Klickitat mainstem, this reach has the greatest linear length of hydro confinement due to the main road next to it. The stream bank has been rip rapped to protect the road in areas of which contributes to the simplification of habitat in isolated areas of this reach. From this, the model shows decreases of key habitat for several life stages that ultimately results in decreased capacity. The EDT model also shows a decrease of food resources due to declined number of salmon carcasses. This decrease in food source contributes to the declined capacity for several life stages that is expressed in decreased productivity and overall restoration potential for increases of abundance. Sediment load has been identified as a major limiting factor for several life stages. Egg incubation has the greatest decline in productivity due to fine sediment. Other life stages affected by fine sediment or turbidity include colonization, migrant and prespawning holding life stages.

3.) Klick 26

Description: Klickitat R- Chaparrel Cr to McCreedy Cr

Length: 2.70 mi

Restoration potential for Klick 26 consists of the following: 8% increase for abundance, 11% increase in productivity and a 0% increase in the life history diversity. The primary population parameter influencing the overall restoration potential is the potential this reach displays for increasing the populations productivity. Degradations undergone in this reach are very similar to the degradations in Klick 27 that is located upstream. In fact, the analysis of klick 27 could be applied to this reach with one exception. This reach has a decreased linear length of stream bank influenced by hydro confinement than the amount in Klick 27. This is expressed in the habitat diversity level 3 attribute. If one was to look at the individual population parameter potentials, you'll notice that Klick 27 has a greater potential for the productivity parameter. This is directly related to the quality of habitat linked to the level 3 correlate habitat diversity. With this one exception, all other level 3 correlates affect similar life stages as those identified in Klick 27.

4.) Klick 25

Description: Klickitat R- Upper end of Castile Falls to Chaparrel Cr

Length: 3.038 mi

Restoration potential for Klick 25 consists of the following: 5% increase for abundance, 7% increase in productivity and a 0% increase in the life history diversity. Both abundance and productivity are key components for this reaches overall restoration potential. Within reach level 3 parameters affecting overall productivity and abundance are food and sediment load. Declined food resources are the result of decreased salmon carcasses affecting colonization and early rearing life stages. The model also identifies sediment load as a major level 3 component affecting productivity for egg incubation, spawning and migrant life stages due to increases of fine sediment and turbidity. Sources of increased sediment load occur upstream of this reach in tributaries exhibiting road densities from forest management activities. This reach offers a tremendous amount of habitat diversity with a healthy riparian corridor and wood recruitment that exhibits minimal physical alterations from anthropogenic impacts.

5.) Klick 28

Description: Klickitat R- Piscoe Cr to Diamond Fork

Length: 1.627 mi

Restoration potential for Klick 28 consists of the following: 4% increase for abundance, 5% increase in productivity and a 0% increase in the life history diversity. The ability of this reach to contribute to the overall steelhead productivity and abundance are both key components associated with the overall restoration ranking. Level 3 components identified by the model that are negatively impacting productivity include sediment load in the form of fines and turbidity, channel stability, and increased predation associated with the presence of hatchery fish. Although the presence of hatchery fish exists due to outplanting of adult spawners and parr, effects are minimal compared to sediment load and decreased food sources. Decreases in food sources identified from the model are a consequence of declined salmon carcasses. This decrease in food resource coupled with a slight decrease of key habitat for several life stages has reduced the overall capacity this reach once exhibited and is identified in the potential increases for abundance.

4.9 Fish Key Findings for Subbasin Watershed and Ecosystem Processes

Table 26 Key findings

Key Finding – Observed effect or phenomenon	Cause/ Working Hypothesis	Confidence Effect actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to CausalRelationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Strategy to mitigate effect
Food availability decreased by lack of nutrient transport / carcasses	Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	High	Med (Medium)	Med	Restore fish populations such that escapement is sufficient in number to provide adequate carcasses.	Explicitly include desired carcass numbers within escapement goals to benefit ecosystem processes in population/harvest management decisions. Increase abundance and productivity through in-basin and out-of-subbasin habitat improvements and management changes	Fertilization of streams with artificial carcasses Planting of hatchery carcasses in upstream areas.
	Fluctuations in water quality parameters (Temp, DO, Nutrients) and toxics have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Low	High	High		Study/Characterize productivity. Characterize within framework of Sediment load.	

Key Finding – Observed effect or phenomenon	Cause/ Working Hypothesis	Confidence Effect actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to CausalRelationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Strategy to mitigate effect
Historical hatchery and harvest practices have altered run timing, size, and genetic fitness	Hatchery and harvest practices have lead to changes in run timing, genetic fitness, spawning distribution, pathogen transmission, and spawning success(due to competition with hatchery stocks)	High	Med	Med	Restore indigenous population abundance, productivity and spatial distribution to viable, harvestable and sustainable levels over the next 30 years.	Implement hatchery practices that mimic natural production and minimize ecological interactions with introduced hatchery stocks(see Klickitat Master Plan)	
Spring Chinook populations have been dramatically reduced from pre-settlement abundance levels	Habitat loss and alteration and changes in the biotic community have reduced habitat suitability, which in turn has reduced productivity, abundance, and spatial distribution of the species.	High	High	High	Restore Spring Chinook population abundance, productivity and spatial distribution to viable, harvestable and sustainable levels over the next 30 years.	Coordinated management of populations and habitat improvements including: Ongoing research, Habitat restoration, Population management activities such as harvest management and hatchery supplementation	
Altered thermal regimes have affected fish life histories(such as Natural spawn timing, incubation, rearing etc),	Management activities affecting riparian areas and channel morphology have produced greater summer maxima, and lower winter	High	High	High	Increase winter minima and decrease summer maxima temperatures	Restore riparian conditions and channel morphology.	

Key Finding – Observed effect or phenomenon	Cause/ Working Hypothesis	Confidence Effect actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to CausalRelationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Strategy to mitigate effect
decreased quantity of suitable habitat	minima						
	Naturally occurring cold temperatures in the Upper Klickitat may limit fish production	Med	High	Med			
Juveniles redistribute themselves downstream in the summer and fall after emergence, with highest densities in fall being found well below the major spawning areas	Natural expression of some life histories	High	High	High			
	Decreased areas of perennial flow in tributaries	Med	Med	Med	Increase extent and distribution of perennial habitat	Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	

Key Finding – Observed effect or phenomenon	Cause/ Working Hypothesis	Confidence Effect actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to CausalRelationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Strategy to mitigate effect
Activities associated with the Klickitat Supplementation and Research Facility provide information on the effectiveness of restoration, supplementation technology and effectiveness, and other population management strategies that can benefit fisheries and habitat management in the Klickitat Subbasin and in the Columbia Basin as a whole.	Supplementation can be used to increase natural production and harvest opportunities while keeping genetic and ecological impacts within specified biological limits.	Low	Low	Low	Construct, maintain and operate a specialized research environment to test the hypothesis.	See Klickitat Master Plan	
Coho, fall Chinook, and chum historically utilized available habitat below Lyle Falls, including that now inundated by Bonneville Pool	Supplementation by the Yakama Nation under US v OREGON can contribute to the reestablishment of sustainable populations in the Columbia Basin and provide					See Klickitat Master Plan [Objectives list]	

Key Finding – Observed effect or phenomenon	Cause/ Working Hypothesis	Confidence Effect actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to CausalRelationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Strategy to mitigate effect
	meaningful harvest opportunities while keeping ecological impacts within specified biological limits.						
	A central supplementation facilities and their associated acclimation sites will provide for quality and number of smolt, parr, fingerling or adult hatchery releases to be made to achieve the goal of sustainable populations with meaningful harvest and minimal ecological risk.	High	High	High	Provide adequate culturing facilities in the Klickitat Basin to achieve supplementation goals: Wahkiacus	See Klickitat Master Plan	
Steelhead populations have been dramatically reduced from pre-settlement abundance levels	Habitat loss and alteration and changes in the biotic community have reduced habitat suitability, which in turn has	High	High	High	Restore steelhead population abundance, productivity and spatial distribution to viable, harvestable and	Coordinated management of populations and habitat improvements including: Ongoing research, Habitat restoration, Population management activities such as harvest	

Key Finding – Observed effect or phenomenon	Cause/ Working Hypothesis	Confidence Effect actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to CausalRelationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Strategy to mitigate effect
	reduced productivity, abundance, and spatial distribution of the species.				sustainable levels over the next 30 years.	management and hatchery supplementation	
Population levels of Lamprey have been dramatically reduced from pre-settlement levels.	Poor passage for anadromous forms through the mainstem Columbia River (and possibly in the Subbasin) have severed life history pathways and reduced population abundance, productivity and spatial diversity.	High	High	Med			
	Changes in habitat conditions and reduction in salmon populations within the subbasin have reduced habitat suitability and reduced abundance, productivity and life history diversity. Improvement in	Med	Med	Med	Study specific habitat relationships for lamprey. Implement habitat restoration actions under Subbasin Plan.		

Key Finding – Observed effect or phenomenon	Cause/ Working Hypothesis	Confidence Effect actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to CausalRelationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Strategy to mitigate effect
	habitat conditions for salmonids will improve lamprey populations as well.						
Hydrologic routing in watershed has been modified	Land use management activities have modified flow timing and discharge	High	HIgh	High	Restore hydrologic regimes	Adopt land use practices that mimic natural hydrologic regimes	

4.9.1 Lower Klickitat

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow.	High	High	High	Reduce Temp to near pre-settlement conditions	Increase flows to satisfy depth thresholds, Reconnect Side Channels, Improve Riparian Zone; investigate Areas of groundwater connection; improve floodplain connectivity	
Loss of Habitat Diversity/ thermal refugia by loss of off-channel habitat	Champion Haul Road and 1996 flood deposit effects	Med	High	High	Reconnect 100% of floodplain side channels in this Assessment Unit	Relocate infrastructure where possible to allow natural processes to operate. Re-establish native vegetation on floodplain.	Reconnect side channels. Artificially confined reaches limit side channel habitat, more importantly though, removal of rd and rip rap may reduce bed shear and increase margin habitat complexity
Altered hydrology in Swale Creek	Historic data suggests loss of wetland structure in Upper Swale	Med			Restore historical hydrologic regime and Increase extent and distribution of perennial habitat	Compare to 1860s GLO maps, restore physical and riparian characteristics	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
	Groundwater withdrawals lower base flows decreasing perennial flow area in Lower Swale	Med	Med	Med		Study and monitor groundwater withdrawals in area	
	Increased peak runoff				Restore historical hydrologic regime	Compare to 1860s GLO maps, restore physical and riparian characteristics	
Tributary Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris(Decreased Abundance of LWD)	Logging practices, general agricultural/forest and floodplain developments increased peak flows	Med	Low to Med	High	Implement sustainable agricultural and forest practices, improve road management. Improve watershed management	Implement practices which leave sources of LWD to naturally enter system	
	Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	High	High	Med	Restore viable P. Pine populations to upstream Riparian Zones over the next 20 years (upper forest)	Implement practices to naturally supply sources of LWD	Artificially introduce LWD

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Food web in lower river has been altered/reduced.	Fluctuations in water quality parameters (Temp, DO, Nutrients) and toxics have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Low	High	High		Study/Characterize productivity. Characterize within framework of Sediment load. Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	
	Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Low to Med (High escapeme nt of hatchery fish)	High	Low to Med (High escapement of hatchery fish)	Restore fish populations such that escapement is sufficient in number to provide adequate carcasses.	Explicitly include goals for escapement to benefit ecosystem processes in population/harvest management decisions. Increase abundance and productivity through in-basin and out-of-subbasin habitat improvements and management changes	Fertilization of streams with artificial carcasses Planting of hatchery carcasses in upstream areas.

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Predation Risk to salmonids from native fish (northern pike minnow) is high in vicinity of Klickitat Mouth-	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation.	High	High	Med	Increase abundance of salmonid populations to reduce proportion of predation due to native sp	1) Implement Subbasin planning and other habitat and population restoration programs	Bounty Programs, creation of artificial off-channel habitats.
	Increased habitat for native predators in Col. Mainstem leads to increased pops in lower tribs.	High	High	Med	Reduce population levels in Mainstem Col	Further control and actions on predator populations in mainstem reservoirs	
Predation risk to salmonids from non-native fish (walleye, Smallmouth bass etc) is high	Increased Temps in lower river increase habitat for non-native predators, temps also trigger increase in feeding levels	High	High	Med	Reduced non-native predators	Reduce Habitat suitability for predatory non-native fish	Bounty and increased harvest measures on non-native predators
Predation risk to salmonids from bird populations is elevated	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation	Med	Low	High	Increase abundance of salmonid populations to reduce proportion of predation due to native sp.	Improve flow, cover, available habitat, and habitat diversity to reduce potential for predation by native birds.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Survival of steelhead kelts (mature spawned out fish with the potential to spawn again) migrating out of the Klickitat Basin and through the mainstem Columbia to the ocean is believed to be at or near zero. .	Lack of facilities for downstream passage through the maintem dams for large bodied adults, habitat conditions in the mainstem Columbia.	Med	High	High	Increased adult survival at mainstem Columbia dams for repeat spawners.	Support Corps studies of fish passage at mainstem Columbia dams. Evaluate habitat conditions for survival in the mainstem Columbia habitat.	Implement Kelt Reconditioning in Klickitat. Implement improved passage at Mainstem Columbia dams.
	Capture, rehabilitation, and release of these fish in the Klickitat Basin increases survival and could act as a source of broodstock/genet ic material for reintroduction efforts				Increase kelt survival and repeat spawner success. Increase steelhead productivity.	Fund Kelt reconditioning in Klickitat. Determine breeding success of Kelts.	
Hatchery Fish compete with Natural Origin fish for space and food resources	Out plants of fish from the Klickitat hatchery compete with natural origin fish,	Low	Low	High	Reduce distribution of coho within subbasin(underway); reduce total numbers of coho above Lyle(underway)	See Klickitat Master Plan	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Lyle Falls acted as an upstream fish barrier to some species in low flow conditions	Migration timing of fall chinook, research on capabilities of coho, flow records, and anecdotal evidence suggest difficulties in upstream passage prior to Lyle fish ladder	Med	Med	Med	Improve passage percentage at Lyle Fish Ladder	Improvements to fish ladder design must be made	
	Lyle Falls historically acted as a barrier to aquatic predator species	Med	Med	Med	Maintain barrier to predator species at Lyle Falls	Design passage at ladder to maximize desired species' passage while preventing predator passage	
Human actions have created passage barriers	2,400 foot flume, two culverts, dam, in Snyder Creek form a depth/velocity barrier	High	High	High	Create and maintain passage at mill site	About a third of Baffles are in place, log weirs are all in place; culverts have been replaced; study effectiveness of actions, study utilization by anadromous species; identify maintenance needs	
	Access to Dead Canyon is limited; change in plan form due to undersized road crossing	High	High	High	Improve passage opportunities at Dead Canyon	Remove road fill from alluvial floodplain	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary High Temperatures have resulted in increased susceptibility of native salmonids to pathogens.	Increased temperature stresses the fish and increases chances of initial infection Where current or Historic fish stocking exists	Low	High	Med	Reduce Summer High Temperatures	Study presence of pathogens in juveniles and adults during high temperatures. Restore riparian conditions and channel morphology.	

4.9.2 Little Klickitat

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Little Klickitat falls(RM6.2) acts as an upstream fish barrier under low flow conditions	Height of falls is at upper range of steelhead jump ability(12-16') depending on flow conditions				Improve upstream passage opportunities at falls	Conduct comprehensive study of fish passage window at falls, utilization by steelhead	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
	There are unconfirmed accounts that blasting occurred in the 1950s that has subsequently rerouted low flow from primary jump pool to river right slide without jump pools				Increase upstream passage at falls	Conduct comprehensive study of fish passage window at falls, utilization by steelhead; make necessary alterations in falls	
Historical hatchery and harvest practices have altered run timing, size, and genetic fitness	Little Klickitat Falls presents greater upstream passage challenge than historically				Increase run sizes, Implement hatchery and harvest practices that do not decrease fitness, run size, timing	Implement hatchery and harvest practices that do not decrease fitness, run size, timing	
Predation risk to salmonids from bird populations is elevated	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation	Med	Low	High	Increase abundance of salmonid populations to reduce proportion of predation due to native sp.	Improve flow, cover, available habitat, and habitat diversity to reduce potential for predation by native birds.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow.	High	High	High	Reduce Temp to near pre-settlement conditions	Increase flows to satisfy depth thresholds, Reconnect Side Channels, Improve Riparian Zone; investigate Areas of groundwater connection; improve floodplain connectivity	
Loss of Habitat Diversity/ thermal refugia by loss of off-channel habitat	SR 142, HWY 97, and other infrastructure in watershed have altered floodplain negatively, confined river and tributaries	Med	High	High	Reconnect 100% of floodplain side channels in this Assessment Unit	Relocate infrastructure where possible to allow natural processes to operate. Re-establish native vegetation on floodplain.	Reconnect side channels. Artificially confined reaches limit side channel habitat, more importantly though, removal of rd and rip rap may reduce bed shear and increase margin habitat complexity

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris(Decreased Abundance of LWD)	Logging practices, general agricultural/forest and floodplain developments increased peak flows	Med	Low to Med	High	Implement sustainable agricultural and forest practices, improve road management. Improve watershed management	Implement practices which leave sources of LWD to naturally enter system	
	Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	High	High	Med	Restore viable P. Pine populations to upstream Riparian Zones over the next 20 years; in upper elevations restore to other native stands	Implement practices to naturally supply sources of LWD	Artificially introduce LWD
Food availability decreased by lack of nutrient transport / carcasses	Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	High	Med	Med	Restore fish populations such that escapement is sufficient in number to provide adequate carcasses.	Explicitly include desired carcass numbers within escapement goals to benefit ecosystem processes in population/harvest management decisions. Increase abundance and productivity through in-basin and out-of-subbasin habitat improvements and management changes	Fertilization of streams with artificial carcasses Planting of hatchery carcasses in upstream areas.

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
	Fluctuations in water quality parameters (Temp, DO, Nutrients) and toxics have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Low	High	High		Study/Characterize productivity. Characterize within framework of Sediment load.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Population and ecological effect of Beavers have been significantly reduced and altered	Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform	High	High	High	Increase available habitat in mainstem floodplains, especially urbanized floodplains. Reduce conflicts with infrastructure, set population targets based on desired functions and population connectivity.	Restore “unmanaged” or natural floodplain habitats. Encourage beaver colonization of these areas. Inventory existing and potential habitat, include reintroduction of beaver into restoration actions.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary High Temperatures have resulted in increased susceptibility of native salmonids to pathogens.	Increased temperature stresses the fish and increases chances of initial infection Where current or Historic fish stocking exists	Low	High	Med	Reduce summer highTemperatures	Study presence of pathogens in juveniles and adults during high temperatures. Restore riparian conditions and channel morphology.	
High percentages of Fine Sediment in Little Klickitat Watershed may be a significant limiting factor to fish production	Increased fine sediment percentages limit egg incubation	Med	High	Med	Reduce fine sediment inputs	Study fine sediment inputs. Characterize. Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	

4.9.3 Middle Klickitat

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow.	High	High	High	Reduce Temp to near pre-settlement conditions	Increase flows to satisfy depth thresholds, Reconnect Side Channels, Improve Riparian Zone; investigate Areas of groundwater connection; improve floodplain connectivity	
Food availability decreased by lack of nutrient transport / carcasses	Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	High	Med	Med	Restore fish populations such that escapement is sufficient in number to provide adequate carcasses.	Explicitly include desired carcass numbers within escapement goals to benefit ecosystem processes in population/harvest management decisions. Increase abundance and productivity through in-basin and out-of-subbasin habitat improvements and management changes	Fertilization of streams with artificial carcasses Planting of hatchery carcasses in upstream areas.

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
	Fluctuations in water quality parameters (Temp, DO, Nutrients) and toxics have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Low	High	High		Study/Characterize productivity. Characterize within framework of Sediment load.	
Predation risk to salmonids from bird populations is elevated	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation	Med	Low	High	Increase abundance of salmonid populations to reduce proportion of predation due to native sp.	Improve flow, cover, available habitat, and habitat diversity to reduce potential for predation by native birds.	
Altered thermal regimes have affected fish life histories(such as Natural spawn timing, incubation, rearing etc), decreased quantity of suitable habitat	Management activities affecting riparian areas and channel morphology have produced greater summer maxima, and lower winter minima	High	High	High	Increase winter minima and decrease summer maxima temperatures	Restore riparian conditions and channel morphology.	Reconnect side channels by removal of obstructions.

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris(Decreased Abundance of LWD)	Logging practices, general agricultural/forest and floodplain developments increased peak flows	Med	Low to Med	High	Implement sustainable agricultural and forest practices, improve road management. Improve watershed management	Implement practices which leave sources of LWD to naturally enter system	
	Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	High	High	Med	Restore viable P. Pine populations to upstream Riparian Zones over the next 20 years; in upper elevations restore to other native stands	Implement practices to naturally supply sources of LWD	Artificially introduce LWD

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Population and ecological effect of Beavers have been significantly reduced and altered	Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform	High	High	High	Increase available habitat in mainstem floodplains, especially urbanized floodplains. Reduce conflicts with infrastructure, set population targets based on desired functions and population connectivity.	Restore "unmanaged" or natural floodplain habitats. Encourage beaver colonization of these areas. Inventory existing and potential habitat, include reintroduction of beaver into restoration actions.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary High Temperatures have resulted in increased susceptibility of native salmonids to pathogens.	Increased temperature stresses the fish and increases chances of initial infection Where current or Historic fish stocking exists	Low	High	Med	Reduce summer highTemperatures	Study presence of pathogens in juveniles and adults during high temperatures. Restore riparian conditions and channel morphology.	
Hatchery Fish compete with Natural Origin fish for space and food resources	Out plants of fish from the Klickitat hatchery compete with natural origin fish,	Low	Low	High	Reduce distribution of coho within subbasin(underway); reduce total numbers of coho above Lyle(underway)	See Klickitat Master Plan	
Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces	Can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of Juveniles and or entomb juveniles				Decrease sources of fine sediment	Employ road management actions that reduce fine sediment inputs. Study fine sediment inputs. Characterize. Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	

4.9.4 Upper Klickitat

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Castille Falls historically proved an upstream passage barrier at low flows	Falls measure near end of ability for spring Chinook to pass; blasting in 1960s under Mitchell Act decreased passage; passage improvements almost complete				Maintain passage	Operate and maintain fishladder for passage	
Klickitat Meadows loss of habitat quantity and quality	Road, timber, and grazing management activities have lead to increased sediment supply from incoming tributaries of which has resulted in channel evulsions from inability of stream to transport increased sediment supply and other meadow activities have decreased sinuosity				Increase sinuosity, increase channel roughness	Improve grazing management; increase channel roughness	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow.	High	High	High	Reduce Temp to near pre-settlement conditions	Increase flows to satisfy depth thresholds, Reconnect Side Channels, Improve Riparian health through vegetative planting; investigate Areas of groundwater connection; improve floodplain connectivity	
Loss of Habitat Diversity/ thermal refugia by loss of off-channel habitat	255 Road	Med	High	High	Reconnect 100% of floodplain side channels in this Assessment Unit	Relocate infrastructure where possible to allow natural processes to operate. Re-establish native vegetation on floodplain.	Reconnect side channels. Artificially confined reaches limit side channel habitat, more importantly though, removal of rd and rip rap may reduce bed shear and increase margin habitat complexity
Predation risk to salmonids from bird populations is elevated	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation	Med	Low	High	Increase abundance of salmonid populations to reduce proportion of predation due to native sp.	Improve flow, cover, available habitat, and habitat diversity to reduce potential for predation by native birds.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Tributary Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris(Decreased Abundance of LWD)	Logging,practices, road construction, general agricultural/forest and floodplain developments increased peak flows	Med	Low to Med	High	Implement sustainable agricultural and forest practices, improve road management. Improve watershed management	Implement appropriate practices which leave sources of LWD to naturally enter system	
	Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	High	High	Med	Restore viable P. Pine populations to upstream Riparian Zones over the next 20 years (upper forest)	Implement practices to naturally supply sources of LWD	Artificially introduce LWD

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Population and ecological effect of Beavers have been significantly reduced and altered	Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform	High	High	High	Increase available habitat in mainstem floodplains, especially urbanized floodplains. Reduce conflicts with infrastructure, set population targets based on desired functions and population connectivity.	Restore "unmanaged" or natural floodplain habitats. Encourage beaver colonization of these areas. Inventory existing and potential habitat, include reintroduction of beaver into restoration actions.	
Tributary High Temperatures have resulted in increased susceptibility of native salmonids to pathogens.	Increased temperature stresses the fish and increases chances of initial infection Where current or Historic fish stocking exists	Low	High	Med	Reduce Summer High Temperatures	Study presence of pathogens in juveniles and adults during high temperatures. Restore riparian conditions and channel morphology.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Food availability decreased by lack of nutrient transport / carcasses	Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	High	Med	Med	Restore/supplement fish populations such that escapement is sufficient in number to provide adequate carcasses.	Explicitly include desired carcass numbers within escapement goals to benefit ecosystem processes in population/harvest management decisions. Increase abundance and productivity through in-basin and out-of-subbasin habitat improvements and management changes	Fertilization of streams with artificial carcasses Planting of hatchery carcasses in upstream areas.
	Fluctuations in water quality parameters (Temp, DO, Nutrients, fine sediment input) and toxics have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Low	High	High		Study/Characterize productivity in relation to water quality parameters. Characterize within framework of Sediment load.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive	Strategy to reduce/eliminate or improve/,maintain	Strategy to mitigate effect
Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces	Can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of Juveniles and or entomb juveniles				Decrease sources of fine sediment	Implement road management actions that reduce fine sediment inputs. Study fine sediment inputs. Characterize. Restore riparian conditions and channel morphology. Increase floodplain connectivity. Implement upland management practices that mimic natural runoff and sediment production.	
Thermal regimes have affected fish life histories(such as Natural spawn timing, incubation, rearing etc), decreased quantity of suitable habitat	Naturally occurring cold temperatures in the Upper Klickitat may limit fish production	Med	High	Med		Study thermal regime to assess if productivity is limited by naturally occurring cold temperatures	
	Management activities affecting riparian areas and channel morphology have produced greater summer maxima, and lower winter minima in some tributaries	High	High	High	Increase winter minima and decrease summer maxima temperatures	Restore riparian conditions and channel morphology.	

5 Inventory

5.1.1 Introduction, Purpose, and Scope

The Klickitat River subbasin is owned and managed by a diverse mix of private and public individuals and entities with a broad range of interests and goals. Historically, the natural resources of the basin have provided for timber harvest, agriculture, livestock grazing, and residential and commercial development to support the economic well being of the region. However, these activities have depleted the natural resource base and put fish, wildlife, and other resources at risk. Tribal, federal, state, and local organizations have been charged with the responsibility of managing these valuable resources through protections, plans, programs, and policies that both protect the resource and provide for sustainable development. This task includes balancing the often-conflicting needs and desires of a resource driven society and a natural constituent dependent upon intact and functional environmental processes and systems.

5.1.2 Summary of Inventory

Fisheries

The Yakima Nation Fisheries Program, through the Yakima Klickitat Fisheries Project (YKFP), has been very active in the watershed, often in partnership with other entities. YKFP has completed several fish passage projects, as well as rearing and acclimation facility construction, broodstock collection, adult fish counting, revegetation, sediment retention, channel stabilization, livestock exclusion fencing, grazing management, off-stream livestock watering, habitat acquisition, groundwater recharge efficiency improvement, and data acquisition and management projects.

The YKFP is a supplementation project designed to use artificial propagation in an attempt to maintain or increase natural production while maintaining long-term fitness of the target population and keeping ecological and genetic impacts to non-target species within specified limits. The Project is also designed to provide harvest opportunities. The framework developed by the Regional Assessment of Supplementation Project (RASP 1991) guides the planning, implementation, and evaluation of the Project.

The purposes of the YKFP are to: enhance existing stocks of anadromous fish in the Yakima and Klickitat river basins while maintaining genetic resources; reintroduce stocks formerly present in the basins; and apply knowledge gained about supplementation throughout the Columbia River Basin.

The Central Klickitat Conservation District has engaged in agricultural runoff control, livestock exclusion and riparian restoration projects. Klickitat County is lead entity for the local salmon recovery effort, which is intended to prioritize projects for Washington State Salmon Recovery Board funding.

Wildlife

Since the 1950s, WDFW has surveyed mule deer populations, gathered hunting statistics and has worked with landowners on deer habitat projects that have benefited many species that use shrub steppe habitat. WDFW has conducted periodic surveys and studies of Western gray squirrel populations and habitat. Also, WDFW has conducted annual Oregon spotted frog egg mass survey counts in the spring.

USFWS has completed wetland development projects to improve wetland habitat conditions for breeding frogs.

WDFW and USFWS, with support from the Yakama Nation, have been engaged in ongoing efforts to survey and manage local breeding population of greater sandhill cranes.

Watershed Planning

Watershed planning under the Washington Watershed Planning Act has commenced in the Klickitat watershed and has produced reports, which were used in the assessment portion of this document.

Ecology has monitored water quantity and quality in the watershed, listed waters as impaired under section 303(d) of the clean water act, and as a result established TMDLs for parts of the watershed.

Table 27 Klickitat Fish and Wildlife Projects

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
199705600 Klickitat Watershed Enhancement Project	Yakama Nation Fisheries Program/Yakima Klickitat Fisheries Project	Steelhead	Collection of information pertaining to existing habitat conditions. Research used to guide implement-ation of YKFP habitat restoration efforts in the Klickitat Subbasin	1997-ongoing	Klickitat Subbasin	
Trout Creek Fish Passage Enhance-ment Project	YNFP and Bureau of Indian Affairs Forestry	Steelhead and resident rainbow trout	Replacment of two culverts in the Trout Creek watershed that have been identified as barriers. Replacment will restore unimpeded access to about 9 miles of perennial habitat for rearing and spawning	January 2003-ongoing. Summer/fall 2004 imple-mentation to coincide with a timber sale.	On Trout Creek and a tributary, Bear Creek)	
Swale Creek Ponds	Klickitat County and Central Klickitat County Conservation District	Steelhead and coho	Lower subwater-shed rearing and spawning habitat	Jan 1999-ongoing	Uecer Road to Centerville Highway bridge	
Swale Creek riparian restoration	Klickitat County and Central Klickitat County Conservation District	Steelhead and resident rainbow trout	Vegetation planting in a seasonal tributary to Swale Creek	July 1999 to May 2001	Swale Creek subwater-shed	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Snyder Creek fish passage	Klickitat County, Yakama Nation, Washington Department of Fish and Wildlife	Steelhead and coho salmon	Improve passage in lower half mile of Snyder Creek	May 1999-ongoing	Snyder Creek	
Logging Camp Creek fish passage	Klickitat County	Steelhead and coho salmon	State parks department replaced trestle, which was a fish passage obstruction, with box culvert. Project involves planting trees in riparian area and livestock fencing from the mouth of Logging Camp Creek to the railroad bed.	June 1999-ongoing	Logging Camp Creek	
Lacey in-stream project	Klickitat County/Central Klickitat County Conservation District	Steelhead, resident rainbow trout	Lower sub-watershed rearing and spawning	June 1999 through May 2001		
Water quality com-ponent WRIA 30, Nitrate concentrate and distribution study	Klickitat County		Surface and groundwater quality assessments with key parameters being nitrates in groundwater the Swale Creek subbasin and stream temperature in Swale Creek	February 2003-ongoing	Little Klickitat and Swale Creek	
Multi-purpose storage	Klickitat County		Multipurpose water storage assessment	February 2003-ongoing	Little Klickitat River and Swale Creek	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Little Klickitat River Restoration	Klickitat County	Steelhead and coho salmon	Lower subwater-shed spawning and rearing habitat restoration	May 1999-ongoing	Little Klickitat River	
Swale Creek Riparian Enhance-ment	YNFP and WDFW	Steelhead	Construct riparian fencing, sediment retention ponds, and off-channel livestock watering systems	1999	Upper Swale Creek watershed	
Dead Canyon fencing	YNFP	steelhead	Construction of drifting by NWSA to decreasegrazing impacts to steelhead rearing habitat	May 1999 to July 1999	Dead Canyon Creek and portions of the Klickitat River mainstem	
Snyder Canyon Creek mill site fish passage project	Klickitat County and YNFP	Steelhead	The project will restore passage through a 2,600-foot-long concrete flume, remove a low-head dam and replace two road crossings upstream of the flume. It is expected to restore 2.5 miles of some of the best tributary habitat in the lower Klickitat Basin.	August 2003-ongoing	Snyder Creek	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Dillacourt Creek Acquisition	Columbia Land Trust and YNFP	Steelhead	579 acres acquired by Columbia Land Trust, including 1.25 acres of Klickitat River frontage and 0.9 miles of anadromous-accessible Dillacort Creek.	March 2001 to September 2001	Klickitat River and Dillacourt Creek	
Castile Falls passage improvement	YNFP and NOAA Fisheries	Steelhead and spring chinook	Project intends to re-establish passage through an improperly functioning series of fishways within the Castile Falls reach. Reconstruction of two fishways using proper design and fish passage criteria developed by WDFW and NOAA. Proejt opens 30 to 45 miles of high quality spawning and rearing habitat.	September 1999 to September 2005	Upper Klickitat River	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Lyle Falls Fish Passage Design and Engineering	YNFP and BPA	Steelhead and spring chinook	Cmplete engineering design of improved fish passage facility at Lyle Falls. Design plans include reconstruction of improperly functioning fishway, addition of broodstock collection, and adult enumeration facilities. Design completed using WDFW and NOAA fish passage design criteria.	2002 through January 2004	Lyle Falls	
White Creek Riparian Enhance-ment 1	YNFP	steelhead	Planted 1,960 sedge plugs at selected sites along 1,500 feet of streambank in May 2002. Subsequent visits in summer and fall observed better than 90 percent survival with plugs already spreading their basal coverage.	May 2002	White Creek	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Little Klickitat Riparian Enhancement	YNFP	Steelhead and resident rainbow trout	A half-mile of four-strand barbed wire fence was constructed on the north side of the river to create a separate riparian pasture along 3,000 feet of the stream to provdie better grazing management.	December 2002	Little Klickitat River	
Logging Camp Canyon Phase 1	Columbia Land Trust and YNFP	Steelhead and resident rainbow trout	Columbia Land Trust acquired 292 acres, including 1,000 feet of anadromous-accessible Logging Camp Creek.	May 2002 to February 2003	Logging Camp Creek	
Snyder Swale II Meadow Restoration	Underwood Conservation District and YNFP		The project goal is to restore riparian and wetland functions in low-gradient portions of the headwaters of Snyder Creek (Snyder Swale). Though these reaches are non-fish bearing, the low gradient reaches are critical groundwater recharge areas that are important to anadromous fish-bearing reaches downstream.	September 2002 to November 2002		

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Swale Canyon Assessment	YNFP	Steelhead	A channel stability assessment was conducted to provide the foundation for future restoration work in Swale Canyon by identifying and prioritizing sites that have been impacted by historic railroad construction and maintenance activities.	May 2001 to July 2002	Swale Creek	
Piscoe Meadows Restoration	YNFP	Steelhead		Ongoing	Klickitat subbasin	
Surveyors Creek Passage Enhancement	YNFP and Bia Forestry	Steelhead	The YNFP restored fish passage to at least 8.7 miles of perennial habitat by installing an arch culvert at the lower road crossing.	October 2002	Surveyors Creek	
White Creek Roads Restoration	YNFP	Steelhead and resident rainbow trout	An assessment of the hydrologic connectivity of forest roads was conducted in two subwatersheds White Creek. A total of 85.8 miles of road were inventoried to evaluate increased runoff routing from roads.	May to October 2003	Upper White Creek and upper Tepee Creek	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Klickitat River Meadows Restoration Phase 1	YNFP	Steelhead, resident rainbow trout and spring chinook salmon	Project involves in-channel restoration and grazing management to restore and enhance in-stream habitats degraded by historic grazing practices.	May 2002-ongoing	Upper Klickitat River	
Diamond Fork Meadows Restoration Phase 1	YNFP and WDNR	Steelhead and resident rainbow trout	Project involves in-channel restoration and grazing management to restore and enhance in-stream habitats degraded by historic grazing practices.	October 2000 to October 2003	Diamond Fork	
Klickitat Subbasin - Management, Data and Habitat	YNFP-YKFP		Project provides the management and data infrastructure required to develop, coordinate and implement YKFP and co-managed initiates.	Ongoing	Klickitat subasin	
YKFP Klickitat Subbasin Monitoring and Evaluation	YNPF-YKFP	Steelhead and spring chinook salmon	Project involves the collection of baseline life history information on all anadromous stocks present and existing habitat conditions. Research is used to guide implementaion of YKFP supplementaitoln efforts.	November 1996-ongoing	Klickitat subbasin	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Wahkiacus Acclimation Facility Development	YNPF-YKFP	Coho and fall chinook salmon	Project was to develop coho and fall chinook rearing and acclimation facility in the lower Klickitat basin to replace the Champion Mill site lost in te 1996 flood	October 1999-ongoing	Klickitat subbasin	
Little Klickitat River Basin Fish Habitat Analysis 90-030	Ecology		Conducted an instream flow study in the Little Klickitat River basin using the Instream Flow Incremental Methodology. The study provides fish habitat versus streamflow relationships that Ecology can use in developing minimum instream flows for the Little Klickitat River basin.	1990	Little Klickitat River	
River and Stream Ambient Monitoring Report for Wateryears 1994 (95-349) and 1995 (96-355)	Ecology		Collected monthly water quality information.	1994 and 1995	Klickitat and Little Klickitat Rivers	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Flow monitoring 01-03-006	Ecology		Measured flows and developed continuous stage records at three sites on the Little Klickitat River.	June through November 2000	Little Klickitat River	
Little Klickitat River Watershed Temperature Total Maximum Daily Load 02-03-031	Ecology		The Little Klickitat River and its tributaries - East Prong, West Prong, and Butler Creek - are listed on the 1996 and 1998 Washington State 303(d) list for elevated water temperatures. Fieldwork by Ecology, the Central Klickitat Conservation District, and Yakama Nation Fisheries confirmed further temperature problems throughout the watershed.	Established August 2002.	Little Klickitat River, Bowman Creek, Mill Creek, Blockhouse Creek, Bloodgood Creek, Little Klickitat River, west prong, Little Klickitat River, east prong, Butler Creek	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Enderby project	Cental Klickitat Conservation District and RFEG	Salmonids and resident trout	Involved draining a large pond, re-channeling the stream, planting native shrubs and trees, building a new smaller pond for irritagation purposes, livestock exclusion fencing, gutters on existing barns to prevent runoff from barnyard into creek.	June 2004 through September 2005	Blockhouse Creek headwaters.	
Gregg project	Cental Klickitat Conservation District and Klickitat County	Steelhead and Salmon	Streambank restoration project, which was repaired in the fall of 2003.	October 2002 through September 2004	Little Klickitat	
Watershed Planning under RCW 90.82 in WRIA 30	WRIA 30 Local Planning Unit		The Watershed Management Act to provides a framework for local citizens, interest groups, and government organizations to collaboratively identify and solve water quantity, water quality and habitat related issues in the watershed.	Scheduled to be complete in mid 2005.	Klickitat Subbasin except Yakama nation lands.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
CREP	USDA/FSA/ NRCS		Anadromous streams, voluntary program for landowners, the land enrolled in CREP is removed from production and grazing under 10 or 15-year contracts. In return, landowners plant trees and shrubs to stabilize the stream bank.	1999—2016	Landowners adjacent to over 8,000 miles of streams in Washington are eligible to participate in this program.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Mule deer management	WDFW	Mule deer	Ongoing effort to survey and manage WGS population and associated habitat. Periodic surveys are done to document occurrences in Rock Creek drainage with emphasis in the the upper subbasin. WDFW monitors timber harvest through forest practice regulations and land divisions through county planning dept. BLM is currently funding research project on WGS habitat use. The Nature Conservancy has acquired land in Rock Creek drainage and places emphasis on WGS protection	1950s-ongoing	All Klickitat Subbasin habitats with emphasis on winter range	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Western gray squirrel research and management	WDFW	Western gray squirrel	Ongoing effort to survey and manage WGS population and associated habitat. Periodic surveys are done to document occurrences in Klickitat River drainage with emphasis in the the lower subbasin. WDFW monitors timber harvest through forest practice regulations and land divisions through county planning dept.	1990-ongoing	Lower Little Klickitat and tributaries	
Oregon spotted frog surveys	WDFW and USFWS	Oregon spotted frog	Annual egg mass survey counts in the spring. In addition USFWS has completed wetland development projects to improve weland habitat conditions for breeding frogs	1996-ongoing	Klickitat Subbasin, Lake Trout Creek subwatershed -- wetland-riparian habitat	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Sandhill cranes	WDFW and USFWS-Conboy NWR	Sandhill cranes	Ongoing effort to survey and manage local breeding population of Sandhill cranes - state endangered species. Primary emphasis is nesting surveys on Conboy National Wildlife Refuge and associated private lands near the Glenwood Valley, and the Yakima Indian Reservation. Annual funding is needed to support helicopter surveys of the drainage for nesting cranes. Financial and field support is also provided by the YIN when possible			

6 Management Plan

6.1 Introduction

The management plan integrates the vision for the Klickitat subbasin with the assessment and inventory sections of this document. That vision for the subbasin extends over 10 to 15 years and represents local policy input to the subbasin plan. The selection of objectives and strategies for restoration of fish and wildlife habitat and populations which form the bulk of the Management Plan is derived from that input.

The scope of the management plan is somewhat more narrow than the scope of the assessment or the inventory. The assessment and inventory are designed and may be used to guide restoration and management actions by many parties under their own authorities in the course of ongoing efforts to protect and enhance the fish and wildlife populations and the aquatic and terrestrial ecosystems that exist within the Klickitat Subbasin. The management plan is based on the assessment and inventory, but is specifically designed to act as a draft amendment to the Columbia Basin Fish and Wildlife Program, and to be reviewed and approved by the Northwest Power and Conservation Council (NPCC).

The management plan outlines biological objectives and strategies that the planners feel would most efficiently address primary limits to fish and wildlife production in the subbasin. That road map allows the NPCC and BPA to more effectively meet their obligations in the subbasin to mitigate and protect resources affected by the construction and operation of the Federal Columbia River Power System. As such, it is non-regulatory in nature, and is based on the use of BPA ratepayer funds to construct or improve existing infrastructure, to acquire land or protective easements as a means of habitat protection, to fund personnel to improve management of natural resources, to monitor and research the relationships between management actions and the health of the resource, and to fund other actions that protect or restore the health of natural resources that have been negatively impacted by the FCRPS.

This management plan was developed in a relatively short time frame, as the Klickitat, White Salmon and Lower Middle Mainstem were among the last subbasins to get started in the NPCC subbasin planning process.

The traceable logic displayed below in table form focuses on strategies that benefit focal wildlife species that inhabit the subbasin's terrain and four focal fish species that utilize the Klickitat River mainstem and its tributaries, including the Little Klickitat River.

6.1.1 Vision

We envision healthy self-sustaining populations of indigenous fish and wildlife that support harvest and other purposes. Decisions and recommendations will be made in a community based, open and cooperative process that respects different points of view, and will adhere to all rights and statutory responsibilities. These efforts will contribute to a robust and sustainable economy.

6.1.2 Biological Objectives and Strategies

The Technical Guide for Subbasin Planners recommends that the management plan contain the following elements; biological objectives and strategies.

Biological Objectives should:

- Be consistent with basin-level visions, objectives, and strategies adopted in the program
- Be based on the subbasin assessment and resulting working hypothesis
- Be consistent with legal rights and obligations of fish and wildlife agencies and tribes with jurisdiction over fish and wildlife in the subbasin, and agreed upon by co-managers in the subbasin. Where there are disagreements among co-managers that translate into differing biological objectives, the differences and the alternative biological objectives should be fully presented
- Be complementary to programs of tribal, state and federal land or water quality management agencies in the subbasin
- Be consistent with the Endangered Species Act recovery goals and Clean Water Act requirements as fully as possible
- Be quantitative and have measurable outcomes

Strategies must:

- Explain the linkage of the strategies to the subbasin biological objectives, vision and the subbasin assessment Explain how and why the strategies presented were selected over other alternative strategies (e.g. passive restoration strategies v. intervention strategies)
- Describe a proposed sequence and prioritization of strategies
- Respect all rights and statuatory responsibilities
- If necessary, describe additional steps required to compile more complete or detailed assessment

Planners chose to use tables to link observed effects in the basin to working hypotheses (potential causes of the effect); hypotheses to objectives (to address the cause of the effect); objectives to strategies (to reverse the cause); or effect to strategies (to mitigate the effect if the cause could not be reversed).

These tables are designed to condense the information in the assessment so that the logic path from Key Finding to Strategy can be more easily discerned.

6.2 Management Plan Matrixes–Identification of Subbasin Goals and Strategies for Fish and Wildlife

Monitoring and evaluation activities within the Klickitat Subbasin have invaluably informed and improved habitat projects as well as supplementation efforts. Continued monitoring and evaluation (M & E), along with expansion in targeted areas, is critical to effective action. There are several ongoing actions being taken in the subbasin that have benefited from past M & E efforts. Monitoring and evaluation will continue to play an integral role in adapting projects and programs to meet the most important needs in the subbasin.

A number of conditions are present in the subbasin that limit fish and wildlife populations. There has been an increase in fine sediment delivery into the Klickitat River system over historic conditions. There has also been a significant increase in hydroconfinement. Thirdly, large woody debris has decreased in streams, depriving fish of desired hiding and resting places. Riparian function has deteriorated over time. And salmon carcasses have significantly decreased in number due to diminishing run sizes, effectively limiting critical marine derived nutrients from streams and negatively affecting food availability.

Strategies and actions are identified within the management plan to address the change in ecosystem function as well as address limiting factors for production and abundance in the Klickitat Subbasin. Where possible geographical priorities are identified within the subbasin's four assessment units and ranked as either primary or secondary tier actions.

Positive change is under way. For example, the tunnels at Castile Falls on the Upper Klickitat have been modified to remedy passage impediments, easing access to at least 35 miles of habitat. But operation and maintenance as well as maintenance and evaluation will be needed -- a primary strategy outlined in the subbasin management plan.

Strategies and actions that may be implemented throughout the subbasin include the following: increasing floodplain channel and roughness, reconnecting side channels, improving floodplain connectivity, relocating floodplain infrastructure and roads, improving maintenance, rehabilitating and decommissioning roads as appropriate, re-establishing and/or enhancing native vegetation within floodplain, implementing practices that leaves sources of large woody debris in-stream that occur naturally, and/or artificially introduce LWD. Building fish populations in the upper Klickitat assessment unit and elsewhere would help provide enough carcasses to restore that missing link in the food web. These strategies will improve the lot of both fish and wildlife.

Other primary strategies involve evaluation of lamprey habitat needs and the implementation of restoration actions.

Of the uncertainties within the subbasin, the following were identified as primary needs for study: the presence of pathogens in juvenile and adult fish, assessments of the relative contributions of various sources to increased fine sediment, the significance of native bird predation on fish populations, the frequency and difficulty of passage at Little Klickitat Falls, the effectiveness and utilization of the Castile Falls tunnels.

A general theme across the subbasin is a reduction in the quantity and quality of all types of wildlife habitat that the focal and other species need to flourish.

Riparian wetlands have been lost as floodplain habitats have been converted to human uses. That loss of riparian wetland habitat structure and hydrology reduces or ecological function.

This plan's objectives and strategies recommend efforts to restore riparian wetland habitat in order to bring benefit to both fish and wildlife. Those actions involve both restoring habitat by increasing native vegetation and creating adequate hydrological conditions to reconnect habitats in tributary and mainstem floodplain areas.

Primary strategies in both the fish and wildlife portions of this management plans are strategies to restore beaver habitat were possible to prepare for reintroduction of a species whose numbers are greatly reduced from historic levels. The restored habitat would benefit that focal species, whose activities would in turn benefit the salmon and steelhead that visit the watershed. Beaver dam result in the creation of off channel habitat and increased channel stability.

Among the causes of the diminution and fragmentation of Shrub Steppe / Interior Grasslands habitat are agriculture and other human development, altered fire frequencies and invasive weed species. Habitat quality can be improved by supplementing the ability to control fires and restoring more natural fire cycles, encouraging appropriate grazing practices, prioritizing weed control areas, and implementing native plant restoration. Restoration and protection of habitats are key strategies.

Habitat quality and ecological function in Ponderosa Pine / Oregon White Oak habitat has been reduced because of altered forest species composition and age structure. Harvest practices have resulted in removal of late seral stands and large overstory trees across the landscape.

Objectives include retaining any surviving late seral stands and large decadent wildlife trees and managing stands to restore functional habitat. Such strategies include identifying areas where thinning and/or prescribed burning would help achieve habitat objectives and thinning appropriate stands to decrease stand density.

The montane coniferous wetland habitat suffers from altered plant species composition due to inappropriate grazing, altered fire frequencies, timber activities and off-road vehicle use. The primary strategies recommended to reverse those limiting factors involve fencing off grazing from sensitive areas, avoiding future road building in sensitive areas and relocating roads were practical, that are causing loss of hydrological function. This management plan also calls for storing native riparian tree and shrub habitats necessary for fish and wildlife habitat in degraded river and tributary areas. Another primary strategy is to deny off-road vehicle access to sensitive meadows.

The strategies in the fish and wildlife management plan matrixes attempt to address the limits to fish and wildlife productivity existing in the Klickitat watershed. Biological objectives were not identified because insufficient data and confidence was present for technical committee and planning committee members to identify quantitative measures. Some objectives may have been more clearly identified with a longer planning timeline, with the goal of reaching physical habitat capacities, but were unavailable within the current limitations. Therefore, the left column of the fish matrixes contains strategies and types of actions that address key findings rather than quantitative biological objectives. New assessment activities, comprehensive monitoring and evaluation, and an EDT analysis would be necessary to present quantitative biological objectives with a high level of confidence.

The matrixes for focal fish species has been developed in consideration of the assessment's key uncertainties table as well as the reach assessment forms. The wildlife matrixes were similarly constructed, though in the context of focal species in four focal habitat types. The intent of each matrix is to present actions and strategies which may be implemented to address the key findings and limiting factors. Furthermore, to the extent possible, appropriate geographical locations were identified for certain actions and strategies. The geographical locations were then designated as a primary or secondary tier action area. The definitions for these designations are provided at the head of the fish management plan matrixes.

Areas and actions identified in the primary tier category are able to be implemented within the next five years and have a high likelihood of achieving the targeted biological effect.

An important note about how to read the fish and wildlife tables: The geographical areas in the primary tier of the fish matrixes are the most appropriate areas for that strategy to be employed. The actions identified in the secondary tier category may not be implementable within five years, may have less likelihood of achieving a targeted biological effect, and may be a geographical area for which a particular action is less important than primary tier locations.

Specific biological objectives and strategies for the Klickitat River Subbasin are listed in the tables below.

6.3 Wildlife Biological Objectives and Strategies

6.3.1 Interior Riparian Wetlands

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 28 Interior Riparian Wetlands Biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**		**RL= Research Literature**
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Restore riparian habitat quality by increasing native vegetation in degraded riparian habitat. S: Continue and enhance riparian weed control programs.	Displacement of Native Riparian Vegetation by Non-Native Vegetation	Much of Lower Klickitat AU; Little Klickitat 1 and 2; White Creek Subwatershed; Much of Upper Klickitat AU.		F

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**	**RL= Research Literature**	
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**	**H = Habitat Database**	

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Restore ecologically functional floodplain / riparian wetland habitats. S: Inventory roads near riparian habitat and assess impacts to determine problem areas in need of resolution. S: As appropriate, relocate, remove, or repair roads that are causing loss of hydrological function.	Reduction in Floodplain Acreage	Much of Lower Klickitat AU – esp. Dead Canyon 1, Champion Haul Road, SR 142, Swale Creek; Much of Little Klickitat AU – esp. impacts of SR 142, HWY 97 and other infrastructures; Much of Middle Klickitat AU – esp. White Creek		F

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**		**RL= Research Literature**
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Slow stream flow, restore water table, repair stream banks, restore riparian vegetation and reconnect floodplain. S: Use lease, easement or purchase practices to protect functioning floodplain areas and streams. S: Reintroduce beavers, plant native vegetation and reintroduce large woody debris.	Incised Stream Reaches	subwatershed; Much of Upper Klickitat AU		F, R
O: Protect remaining riparian buffers from inappropriate timber harvesting. O: Utilize timber harvesting to enhance degraded riparian buffers. S: Create / implement guidelines to retain and enhance riparian buffers to a functional status.	Upper Watershed Hydrologic Alteration	White Creek Subwatershed (w/i Middle Klickitat AU); Much of Little Klickitat AU, esp. upper little Klickitat; Lower Klickitat, Swale Creek; Upper Klickitat AU's;.		F

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**RL= Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Increase large woody debris presence in riparian buffers. S: Promote silviculture practices that retain large woody debris within riparian buffers. S: Place large woody debris.	Loss of Stream Complexity and Increased Flows	All Assessment Units (Areas in Middle Klickitat AU not subject to Forest and Fish Agreement). Tributaries, Klickitat 10, 11; Little Klickitat 1-9; White Creek and Trout Creek Subwatersheds; Much of Upper Klickitat AU.	Isolated areas throughout much of Middle Klickitat AU	F
O: Restore and protect remaining riparian buffers from conversion. S: Utilize purchase easements, leases or agreements, for landowners to restore or protect riparian vegetation (e.g. Farm Program partner, etc.).	Loss of Riparian Habitat and Function Fragmentation of Habitat	Much of Lower Klickitat AU; Little Klickitat 1 and 2; Much of Middle and Upper AU's.		F

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**		**RL= Research Literature**
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Restore native riparian tree and shrub habitats degraded by inappropriate grazing. S: Provide incentives through easements, leases or agreements, for landowners to manage livestock in such a way to provide for riparian vegetation restoration (eg. Farm Programs).	Overall Loss of Riparian Vegetation	Much of Lower Klickitat AU (Swale Creek); Much of Little Klickitat AU; White Creek Subwatershed	Much of Upper Klickitat AU.	F

6.3.2 Interior Riparian Wetlands Focal Species (Yellow Warbler and American Beaver)

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Yellow Warbler

Table 29 Yellow Warbler biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**RL= Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		

TIER DEFINITIONS:	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	O = Objective	FO = Field Observation	RL= Research Literature	
	S = Strategy	B = Best Professional Judgment	I = Information Needed	
	F = From Fish Data	L = Local Residential Information	H = Habitat Database	

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Increase quality and quantity of habitat for yellow warblers. O: Restore yellow warbler population numbers to historic levels. S: Inventory existing and potential yellow warbler habitat. S: Create / retain optimal habitat (see assessment).	Reduction in Floodplain Acreage Overall Habitat Loss Fragmentation of Habitat	Data Gap		I,R

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**RL= Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Reduce mortality of food base (insects), needed by yellow warblers, from chemical applications. S: Use alternative control measures for undesirable species in riparian buffers, especially in areas used by yellow warbler.	Reduced Food Base	Data Gap			I

American Beaver

Table 30 American beaver biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**	**RL= Research Literature**	
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**	**H = Habitat Database**	

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Provide suitable habitat for beaver where they were historically found. S: Create optimal habitat (see assessment).	Overall Loss of Riparian Vegetation Fragmentation of Habitat Reduction in Mean Annual Floodplain Acreage	Throughout watershed, in appropriate habitat.		F
O: Restore beaver populations to historical levels. S: Inventory existing and potential beaver habitat. S: Reintroduce beaver where / when appropriate.				

6.3.3 Shrub Steppe / Interior Grasslands Habitat

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 31 Shrub Steppe / Interior Grasslands biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**FO = Field Observation**	**RL= Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
		L = Local Residential Information	**H = Habitat Database**

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Protect remaining deep-soil shrub steppe / grassland sites. S: Use lease, easement or purchase practices to protect high quality areas from land-use conversion.	Loss of Shrub Steppe / Grassland Habitat	Lower Klickitat (Swale Creek); Little Klickitat 1-8		R
O: Restore habitats that provide the functional attributes of shrub steppe and grasslands. S: Augment or support conservation oriented farm programs (e.g. CRP).	Loss of Shrub Steppe / Grassland Habitat	Lower Klickitat (Swale Creek); Little Klickitat 1-8		R

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**RL= Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
		L = Local Residential Information		**H = Habitat Database**	

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Limit expansion of invasive non-native plants and reduce occurrence. O: Restore native plant communities. S: Reduce sources of introduction of non-native seed. S: Continue and enhance shrub steppe / grassland weed control programs.	Displacement of Native Vegetation by Non-Native Vegetation	Swale Creek		I, B

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**		**RL= Research Literature**
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**
		L = Local Residential Information		**H = Habitat Database**
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: In areas of inappropriate grazing, improve grassland vegetation and microbiotic crusts. S: Encourage and support coordinated resource management programs. S: Avoid inappropriate grazing of livestock through rotational grazing regimes. S: Use proper grazing to reduce sagebrush cover to natural cover percentages where excessive.	Loss of Habitat Quality	Swale Creek, Little Klickitat 1-8		I, B

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**FO = Field Observation**	**RL= Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
		L = Local Residential Information	**H = Habitat Database**

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Maintain current ephemeral wetlands in natural condition and where possible restore disturbed areas to natural function.	Loss of Ephemeral Wetlands			
S: Create inventory of historical and current locations of ephemeral wetlands.		Data gap		
S: Augment or support conservation oriented farm programs (e.g., CRP).				I
O: Reduce off road vehicle damage in high trespass areas.	Vegetation and Soil Damage			
S: Remove access of off road vehicles to sensitive areas and enforce closures.		Data Gap		
S: Create public education programs.				I

6.3.4 Shrub Steppe/Interior Grasslands Focal Species (Mule / Black-Tailed Deer, Grasshopper Sparrow)

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 32 Mule / Black-Tailed Deer biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Provide quality habitat for deer. S: Augment or support conservation oriented farm programs (e.g., CRP). S: Use fire, along with understory thinning, to enhance forage in woodland / grassland transition zones.	Loss of Shrub Steppe / Grassland Habitat Within Winter Range	Data Gap			I

Table 33 Grasshopper Sparrow biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Increase quantity of habitat for grasshopper sparrow. S: Inventory existing and potential grasshopper sparrow habitat. S: Augment or support conservation oriented farm programs (e.g. CRP).	Loss of Grassland Habitat within Breeding Range	Data Gap			I

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary		**Secondary**	
O: Increase quality habitat for grasshopper sparrow. O: Create habitats that provide the functional attributes of grasslands. S: Create / retain optimal habitat for the species (see assessment). S: Use proper grazing to reduce sagebrush cover to natural cover percentages where excessive. S: Augment or support shrub steppe / grassland weed control programs.	Loss of Grassland Quality Displacement of Native Vegetation by Non-Native Vegetation	Data Gap			I,R

6.3.5 Ponderosa Pine/Oregon White Oak

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 34 Ponderosa Pine/Oregon White Oak biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Increase average dbh and decrease understory density. S: Encourage silviculture practices that retain large diameter trees and reduce understory density.	Reduction of Large Diameter Trees and Snags	Data Gap			I
O: Retain late seral stands and large decadent trees. S: Create / implement guidelines to retain specified number of large diameter, decadent live trees.	Reduction of Large Diameter Trees and Snags	Data Gap			I

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Decrease stand density of ponderosa pine. O: Decrease stem density of ponderosa pine. S: Reduce fuel loads through forestry practices. S: Reintroduce low intensity, controlled, site-specific fires. S: Manage grazing and forest practices that mimic fire, when necessary.	Increased Stand Density and Decreased Average Tree Diameter	Data Gap		I, B

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Retain existing tracts of late seral forests and reduce future fragmentation. S: Augment and support conservation oriented programs on small private land holdings. S: Use lease, easement or purchase practices to conserve remaining intact pine / oak forests.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Data Gap			I
O: Reduce non-native species presence and reestablish native plant communities. S: Site-specific grazing management plans for habitat improvement.	Loss of Native Understory Vegetation and Composition	Data Gap			I,B

6.3.6 Ponderosa Pine / Oregon White Oak Focal Species (Western Gray Squirrel, Flammulated Owl and White-Headed Woodpecker)

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 35 Western Gray Squirrel biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
		L = Local Residential Information		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Increase quantity of western gray squirrel habitat. S: Increase compliance with forest guidelines for western gray squirrels. S: Retain remaining large, unfragmented tracts of western gray squirrel habitat.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Data Gap			R

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
		L = Local Residential Information		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Increase quality of western gray squirrel habitat. S: Use site-specific fire prescriptions to enhance potential and used western gray squirrel habitat. S: Create site-specific grazing management plans for habitat improvement, including reduction of non-native species and reestablishment of native species. S: Create / retain optimal habitat (see assessment).	Increased Stand Density and Decreased Average Tree Diameter Loss of Native Understory Vegetation and Composition	Data Gap			I,R

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
		L = Local Residential Information		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary		**Secondary**	
O: Retain decadent and other important wildlife trees. S: Encourage woodcutting to be used as a tool for thinning overstocked areas. S: Create public education programs.	Loss of Individual, Late Seral Trees (From Woodcutting)	Data Gap			I
O: Reduce pressure to western gray squirrels from California ground squirrels. S: Create programs to control non-native wildlife and other non-historical species. S: Create public education programs.	Increased Competition with Western Gray Squirrels	Data Gap			I,F

Table 36 Flammulated Owl biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Increase quantity of flammulated habitat. S: Retain remaining large, unfragmented tracts of flammulated owl habitat.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Data Gap			I,R
O: Increase quality of flammulated owl habitat. S: Create / retain optimal habitat (see assessment).	Reduction of Large Diameter Trees and Snags Increased Stand Density and Decreased Average Tree Diameter	Data Gap			I,R
O: Reduce mortality of food base (insects), needed by flammulated owls, from chemical applications. S: Use alternative control measures for undesirable species in riparian buffers, especially in areas used by flammulated owls.	Reduced Food Base	Data Gap			I,R

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**	**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**	**H = Habitat Database**	

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Retain decadent and other important wildlife trees. S: Encourage woodcutting to be used as a tool for thinning overstocked areas. S: Create public education programs.	Loss of Individual, Late Seral Trees (From Woodcutting)	Data Gap		I,R

Table 37 White-headed woodpecker biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Increase quantity of white-headed woodpecker habitat. S: Retain remaining large, unfragmented tracts of white-headed woodpecker habitat.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Throughout upper Rock Creek watershed, data gaps		I,R

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**	**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**	**H = Habitat Database**	

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Increase quality of white-headed woodpecker habitat. S: Increase number of snags and snag recruitment in white-headed woodpecker habitat (review assessment for guidelines on optimal number and diameter of snags needed). S: Use site-specific fire prescriptions to enhance potential and used white-headed habitat. S: Create / retain optimal habitat (see assessment).	Reduction of Large Diameter Trees and Snags Increased Stand Density and Decreased Average Tree Diameter	Data Gap		I,R

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Retain decadent and other important wildlife trees. S: Encourage woodcutting to be used as a tool for thinning overstocked areas. S: Create public education programs.	Loss of Individual, Late Seral Trees (From Woodcutting)	Data Gap			I,R

6.3.7 Montane Coniferous Wetlands Habitat

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 38 Montane Coniferous Wetlands Habitat biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	O = Objective	FO = Field Observation	R = Research Literature

	S = Strategy	B = Best Professional Judgment		I = Information Needed	
	F = From Fish Data	L = Local Residential Information		H = Habitat Database	
Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas			Source
		Primary	Secondary		
O: Remove encroaching conifers from meadows. O: Decrease density of brush within wetland meadows. S: Prescribing low intensity burns for vegetation stimulation and biomass reduction. S: Mechanical removal of invasive trees and shrubs.	Tree and Shrub Encroachment into Wet Meadows	White Creek and Tepee Creek (Cedar Valley) Upper Klickitat (Cow Camp, Caldwell, Prairie, Kesler, McCormick Meadows – diffuse knapweed) Diamond Fork (Klickitat Meadows) Glenwood valley Meadows in Simcoes?			I, FO
O: restore stream channel planform and roughness, restore water table, repair stream banks, restore riparian vegetation and reconnect floodplain. S: Reintroduce beavers. S: Plant native vegetation. S: Reintroduce large woody debris.	Incised Streams and Loss of Wetland Function	White Creek and Tepee Creek (Cedar Valley) Upper Klickitat (Cow Camp, Caldwell, Prairie, Kesler, McCormick Meadows – diffuse knapweed) Diamond Fork (Klickitat Meadows)			I,FO

TIER DEFINITIONS:	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	O = Objective	FO = Field Observation		R = Research Literature	
	S = Strategy	B = Best Professional Judgment		I = Information Needed	
	F = From Fish Data	L = Local Residential Information		H = Habitat Database	
Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas			Source
		Primary	Secondary		
O: Restore historical beaver populations. S: Reintroduce beaver into areas that have suitable habitat. S: Restore areas to prepare for beaver reintroduction.	Loss of Hydrological Function				I, FO
O: Restore native riparian tree and shrub habitats necessary for fish and wildlife habitat on the degraded river and tributary areas. S: Provide incentives through easements, leases or agreements, for landowners to manage livestock in such a way to provide for riparian vegetation restoration. S: Increase habitat quality by treating non-native species.	Displacement of Native Plant Communities by Non-native Plant Species	Upper Klickitat (Cow Camp, Caldwell, Prairie, Kesler, McCormick Meadows – diffuse knapweed) Little klickitat – diffuse knapweed, starthistle, cheatgrass, toadflax			I, FO

TIER DEFINITIONS:	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	O = Objective	FO = Field Observation		R = Research Literature
	S = Strategy	B = Best Professional Judgment		I = Information Needed
	F = From Fish Data	L = Local Residential Information		H = Habitat Database
Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Reduce damage to wetland vegetation from excessive grazing, and water quality due to inappropriate management of livestock grazing. S: Fence out grazers from sensitive meadows. S: Provide incentives through easements, leases or agreements, for landowners to manage livestock in such a way to provide for riparian vegetation restoration.	Overall Loss of Native Vegetation and Wetland Function	White and Tepee Creek (scattered meadows), Oak Springs Meadow, Little Klickitat	Upper Klickitat AU	R, I, FO
O: Reduce damage to wetland hydrology from road presence. S: As appropriate, relocate, remove, or repair roads that are causing loss of hydrological function. S: Avoid future road building activities in sensitive wetland habitats.	Hydrological Alteration	Diamond fork (Klickitat Meadows), Cedar Valley, Tepee Creek		I, FO

TIER DEFINITIONS:	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	O = Objective	FO = Field Observation		R = Research Literature	
	S = Strategy	B = Best Professional Judgment		I = Information Needed	
	F = From Fish Data	L = Local Residential Information		H = Habitat Database	
Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas			Source
		Primary	Secondary		
O: Reduce damage to wetland plants and soil from ORV traffic. S: Remove access to sensitive meadows and enforce closures.	Vegetation and Soil Damage	Diamond Fork, Klickitat meadows Upper reaches of Little Klickitat AU			I, FO
O: Reduce damage to wetland habitat from timber activities. S: Apply current guidelines on maintaining adequate riparian and meadow buffers.	Increased Disturbance	CNWR, refer to refuge plan; Existing habitat in Upper and Middle Klickitat AU's			R, FO

6.3.8 Montane Coniferous Wetlands Habitat Focal Species (Greater Sandhill Crane and Oregon Spotted Frog)

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 39 Greater sandhill crane biological objectives and strategies and tier rankings by geographical areas

<table>
<tr><td rowspan="2">TIER DEFINITIONS:</td><td>Project or Actions:</td><td colspan="3">Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.</td></tr>
<tr><td></td><td colspan="3">Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.</td></tr>
<tr><td rowspan="3">CODES:</td><td>O = Objective</td><td colspan="2">FO = Field Observation</td><td>R = Research Literature</td></tr>
<tr><td>S = Strategy</td><td colspan="2">B = Best Professional Judgment</td><td>I = Information Needed</td></tr>
<tr><td>F = From Fish Data</td><td colspan="2">L = Local Residential Information</td><td>H = Habitat Database</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Target Objectives and Strategies</td><td>Associated Limiting Factor</td><td colspan="2">Tier Rankings by Geographical Areas</td><td>Source</td></tr>
<tr><td></td><td></td><td>Primary</td><td>Secondary</td><td></td></tr>
<tr><td>O: Decreasing density of brush within wetland meadows, important for greater sandhill crane breeding habitat and forage.

S: Remove encroaching conifers from meadows.

S: Where appropriate, prescribe low intensity burns for vegetation stimulation and biomass reduction.</td><td>Tree and Shrub Encroachment into Wet Meadows</td><td></td><td>Much of Upper Klickitat AU</td><td>I, R</td></tr>
</table>

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Restore native riparian tree and shrub habitats necessary for fish and wildlife habitat on the degraded river and tributary areas. S: Increase habitat quality by treating non-native species.	Displacement of Native Plant Communities by Non-native Plant Species				
O: Reduce livestock disturbance to nesting sandhill crane pairs and fledglings. S: Provide incentives to manage grazing around sensitive nesting season (April 1 – August 10). S: Continue to work with private landowners to delay date of haying in sandhill crane habitat until after August 10.	Overall Loss of Native Vegetation Increased Disturbance		Upper Klickitat AU		R

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**	**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**	**H = Habitat Database**	

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	**Secondary**	
O: Reduce disturbance to nesting pairs during sensitive nesting season (April 1 – August 10). S: Create seasonal restrictions to timber / road building activities near breeding habitat.	Increased Disturbance	CNWR, refer to refuge plan; Existing habitat in Upper and Middle Klickitat AU's		R

Table 40 Oregon spotted frog biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**F = Field Observation**		**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Increase quantity of habitat for Oregon spotted frogs. S: Retain current suitable habitat. S: Where appropriate, restore habitat to suitable conditions S: Purchase, lease, or easement practices to protect remaining important wetlands.	Loss of Wetlands			

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**F = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Increase quality of Oregon spotted frog habitat. S: Remove encroaching conifers from meadows. S: Prescribing low intensity burns for vegetation stimulation and biomass reduction. S: Fence out grazers from sensitive meadows. S: Manage grazing around sensitive seasonal breeding (March-May) to protect frog egg masses. S: Provide incentives through easements, leases or agreements, for landowners to manage livestock in such a way to provide for riparian vegetation restoration.	Tree and Shrub Encroachment into Wet Meadows Decrease in Water Quality Displacement of Native Plant Communities by Non-Native Plant Species				

TIER DEFINITIONS:	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**			
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.			
CODES:	**O = Objective**	**F = Field Observation**		**R = Research Literature**	
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**	
	F = From Fish Data	**L = Local Residential Information**		**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**			**Source**
		Primary	**Secondary**		
O: Eliminate bullfrogs from further invasion of montane wetlands and control current invasions. S: Implement control measures for bullfrogs and other identified species.	Competition and Predation by Non-Native Species				

6.4 Fish Strategies and Objectives

6.4.1 Upper Klickitat

Table 41 Upper Klickitat biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to initiate implementtion within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective**	
		Secondary-- Not able to initiate implemention in next 5 years and/or less certainty of achieving biological objective	
	Assessments (Data Gaps, M&E):	**Primary-- Able to initiate implementation within next 5 years and addresses critical uncertainties and/or assumptions**	
		Secondary-- Not able to initiate implementation in the next 5 years and/or addresses less immediately critical uncertainties and/or assumptions	
SOURCE CODES:	**E= EDT**	**F= Field Observation**	**B= Best Professional Judgement**
	RL= Research Literature	**V= Aerial Video Interpretation**	**T= Technical Advisory Group Priority**
	H= Habitat Database	**K= Klickitat Master Plan**	**O= Orthophoto Interpretation**
	M= Misc. Data	**W= WRIA Planning Process**	

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Operate and Maintain fishladder for passage above Castile Falls		Falls measure near end of ability for spring Chinook to pass; blasting, fishway tunnels, and upper most headworks dam in 1960s under Mitchell Act decreased passage	Castile Falls		K, F, RL
Provide Monitoring and Evaluation of passage effectiveness with radio telemetery, video monitoring, and pit tag detection at Castile Falls fishladder		Falls measure near end of ability for spring Chinook to pass; blasting, fishway tunnels, and upper most headworks dam in 1960s under Mitchell Act decreased passage	Castile Falls		K, F, RL

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Restore fish populations such that escapement is sufficient in number to provide adequate carcasses.		Food availability decreased by lack of nutrient transport / carcasses; Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Entire Assessment Unit		RL
Fertilize streams with artificial carcasses		Same as above		Entire Assesent Unit	RL
Improve grazing management		Road, timber, and grazing management activities have lead to increased sediment supply from incoming tributaries of which has resulted in channel evulsions from inability of stream to transport increased sediment supply and other meadow activities have decreased sinuosity		Entire Assessment Unit	RL, F
		Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment			RL, F, B
		Hydrologic routing in watershed has been modified; Land use management activities have modified flow timing and discharge			RL, H, M
Increase floodplain and channel roughness		See one or more above	Common need throughout Assessment Unit		RL, F, B, E
Reconnect side channels		See one or more above	Upper Diamond Fork, Mainstem Klickitat		RL, F, B, E
Improve floodplain connectivity		See one or more above	Common need throughout Assessment Unit		RL, F, B, E

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Relocate floodplain infrastructure, roads; improve maintenance, rehabilitate, decommission as approriate		See one or more above	Common need throughout Assessment Unit		RL, F, B, E, O
Re-establish and/or enhance native vegetation within floodplain		See one or more above	Common need throughout Assessment Unit		RL, F, B, E
Implement appropriate practices which leave sources of Large Woody Debris to naturally enter and remain in the system		Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	Common need throughout Assessment Unit		RL, F, B, E
Artificially introduce Large Woody Debris		See one or more above	Common need throughout Assessment Unit		RL, F, B, E
Inventory existing and potential beaver habitat, include reintroduction of beaver into restoration actions.		Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform		Common throughout Assessment Unit	RL, F, B
Encourage beaver colonization		See one or more above		Common throughout Assessment Unit	RL, F, B
Study presence of pathogens in juveniles and adults during high temperatures.		Tributary High Temperatures have resulted in increased susceptibility of native salmonids to pathogens.	Common need throughout Assessment Unit		RL, F, B, H, M

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Explicitly include desired carcass numbers within escapement goals to benefit ecosystem processes in population/harvest management decisions.		Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Common need throughout Assessment Unit		RL, M, K
Study/Characterize productivity in relation to water quality parameters.		Fluctuations in water quality parameters have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity		Common need throughout Assessment Unit	RL, F, H, M, B
Study and assess sources/attribute relative contributions of sediment load		Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces; Can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of Juveniles and or entomb juveniles	Common need throughout Assessment Unit		RL, M, H, F, B
Implement road management actions that reduce sediment inputs.		See one or more above	Common need throughout Assessment Unit		RL, F, B
Implement upland management practices that mimic natural runoff and sediment production.		See one or more above	Common need throughout Assessment Unit		RL, F, B
Assess significance of predation by native birds		Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation	Common need throughout Assessment Unit		RL, F, B
Study specific habitat relationships for pacific lamprey.		Poor passage for anadromous forms through the mainstem Columbia River (and possibly in the Subbasin) have severed life history pathways and reduced population abundance, productivity and spatial diversity.		Mainstem Klickitat	RL, B

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
		Changes in habitat conditions and reduction in salmon populations within the subbasin have reduced habitat suitability and reduced abundance, productivity and life history diversity. Improvement in habitat conditions for salmonids will improve lamprey populations as well.			RL, B

6.4.2 Middle Klickitat

Table 42 Middle Klickitat biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective	
	Assessments (Data Gaps, M&E):	**Primary-- Able to be implemented within next 5 years and addresses critical uncertainties and/or assumptions**	
		Secondary-- Not able to be implemented in the next 5 years and/or addresses less immediately critical uncertainties and/or assumptions	
SOURCE CODES:	**E= EDT**	**F= Field Observation**	**B= Best Professional Judgement**
	RL= Research Literature	**V= Aerial Video Interpretation**	**T= Technical Advisory Group Priority**
	H= Habitat Database	**K= Klickitat Master Plan**	**O= Orthophoto Interpretation**

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Restore fish populations such that escapement is sufficient in number to provide adequate carcasses.		Food availability decreased by lack of nutrient transport / carcasses; Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.		Common thoughout the Assessment Unit(Exclude Klickitat 13, 14, 15)	RL
Fertilize streams with artificial carcasses		Same as above		Common thoughout the Assessment Unit(Exclude Klickitat 13, 14, 15)	RL

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Increase floodplain and channel roughness		Road, timber, and grazing management activities have lead to increased sediment supply from incoming tributaries of which has resulted in channel evulsions from inability of stream to transport increased sediment supply and other meadow activities have decreased sinuosity	White Creek Subwatershed		RL, F
		Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment			RL, F, B
		Hydrologic routing in watershed has been modified; Land use management activities have modified flow timing and discharge			RL, H, M
Reconnect side channels		See one or more of the above		White Creek Subwatershed	RL, F, B, E
Improve floodplain connectivity		See one or more of the above	White Creek Subwatershed	Isolated areas throughout Assessment Unit	RL, F, B, E
Relocate floodplain infrastructure, roads; improve maintenance, rehabilitate, decommission as approriate		See one or more of the above	White Creek Subwatershed, and common through out tributaries within Assesment unit		RL, F, B, E, O
Re-establish and/or enhance native vegetation within floodplain		See one or more of the above	White Creek Subwatershedit		RL, F, B, E
Implement appropriate practices which leave sources of Large Woody Debris to naturally enter and remain in the system		Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	Areas in Asessment Unit not subject to Forest and Fish Agreement	Areas in Asessment Unit subject to Forest and Fish Agreement	RL, F, B, E
Artificially introduce Large Woody Debris		See above	White Creek and Trout Creek Subwatersheds	Isolated areas throughout Assessment Unit	RL, F, B, E

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Inventory existing and potential beaver habitat, include reintroduction of beaver into restoration actions.		Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform		Common throughout Assessment Unit	RL, F, B
Encourage beaver colonization		See above.		Common throughout Assessment Unit	RL, F, B
Study presence of pathogens in juveniles and adults		Hatchery and harvest practices have lead to changes in run timing, genetic fitness, spawning distribution, pathogen transmission, and spawning success(due to competition with hatchery stocks)	Mainstem Klickitat, West Fork Klickitat	Trout Creek, White Creek Subwatershed	RL, F, B, H, M
Explicitly include desired carcass numbers within escapement goals to benefit ecosystem processes in population/harvest management decisions.		Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Common need throughout the assessment unit		RL, M, K
Study/Characterize productivity in relation to water quality parameters.		Fluctuations in water quality parameters have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity		Common need throughout the assessment unit	RL, F, H, M, B
		Increased percentages of fine sediment from background levels in spawning gravels and intersticial spaces; Can severely decrease egg incubation survival, decrease intersticial space affecting inactive rearing stages of Juveniles and or entomb juveniles			RL, M, H, F, B
Study and assess sources/attribute relative contributions of sediment load		Same as above.	Common need throughout the assessment unit		RL, M, H, F, B

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Implement road management actions that reduce sediment inputs.		Same as above.	Tributary watersheds		RL, F, B
Implement upland management practices that mimic natural runoff and sediment production.		Same as above.	Common need throughout the assessment unit		RL, F, B
Assess significance of predation by native birds		Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation (increased bird populations around hatchery)	Mainstem Klickitat 13, 14, 15	Common need throughout the rest assessment unit	RL, F, B
Study specific habitat relationships for pacific lamprey.		Poor passage for anadromous forms through the mainstem Columbia River (and possibly in the Subbasin) have severed life history pathways and reduced population abundance, productivity and spatial diversity.		Mainstem Klickitat	RL, B
		Changes in habitat conditions and reduction in salmon populations within the subbasin have reduced habitat suitability and reduced abundance, productivity and life history diversity. Improvement in habitat conditions for salmonids will improve lamprey populations as well.			RL, B
Implement habitat restoration actions for pacific lamprey.		See above.		Mainstem Klickitat	RL, B

6.4.3 Little Klickitat

Table 43 Little Klickitat biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective	
	Assessments (Data Gaps, M&E):	Primary-- Able to be implemented within next 5 years and addresses critical uncertainties and/or assumptions	
		Secondary-- Not able to be implemented in the next 5 years and/or addresses less immediately critical uncertainties and/or assumptions	
SOURCE CODES:	E= EDT	F= Field Observation	B= Best Professional Judgement
	RL= Research Literature	V= Aerial Video Interpretation	T= Technical Advisory Group Priority
	H= Habitat Database	K= Klickitat Master Plan	O= Orthophoto Interpretation

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Conduct comprehensive study of fish passage window at Little Klickitat falls, utilization by steelhead		Height of falls is at upper range of steelhead jump ability(12-16') depending on flow conditions; There are unconfirmed accounts that blasting occurred in the 1950s that has subsequently rerouted low flow from primary jump pool to river right slide without jump pools	Little Klickitat Falls		RL, F, B, K
Make necessary modifications in Little Klickitat Falls to increase passage		There are unconfirmed accounts that blasting occurred in the 1950s that has subsequently rerouted low flow from primary jump pool to river right slide without jump pools		Little Klickitat Falls	F, B
Increase run sizes, Implement hatchery and harvest practices that do not decrease fitness, run size, timing		Historical hatchery and harvest practices have altered run timing, size, and genetic fitness;Little Klickitat Falls presents greater upstream passage challenge than historically	Entire assessment unit		K, RL, B

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Restore fish populations such that escapement is sufficient in number to provide adequate carcasses.		Food availability decreased by lack of nutrient transport / carcasses; Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Entire assessment unit		RL, K
Fertilize streams with artificial carcasses		Same as above		Entire assessment unit	RL, K
Increase floodplain and channel roughness		Road, timber, and grazing management activities have lead to increased sediment supply from incoming tributaries of which has resulted in channel evulsions from inability of stream to transport increased sediment supply and other meadow activities have decreased sinuosity	Entire assessment unit		RL, F
		Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment			RL, F, B
		Hydrologic routing in watershed has been modified; Land use management activities have modified flow timing and discharge			RL, H, M
		SR 142, HWY 97, and other infrastructure in watershed have altered floodplain negatively, confined river and tributaries			F, B, O, E
Reconnect side channels		Same as above	Middle and Upper assessment unit		RL, F, B, E
Improve floodplain connectivity		Same as above	Middle and Upper assessment unit, Little Klickitat 1 and 2		RL, F, B, E

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Relocate floodplain infrastructure, roads; improve maintenance, rehabilitate, decommission as approriate		Same as above	Middle and Upper assessment unit, Little Klickitat 1		RL, F, B, E, O
Re-establish and/or enhance native vegetation within floodplain		Same as above	Middle and Upper assessment unit, Little Klickitat 1 and 2		RL, F, B, E
Implement appropriate practices which leave sources of Large Woody Debris to naturally enter and remain in the system		Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	Upper assessment unit		RL, F, B, E
		Logging practices, general agricultural/forest and floodplain developments increased peak flows			RL, F, B, E
Artificially introduce Large Woody Debris			Middle and Upper assessment unit, Little Klickitat 1 and 2		RL, F, B, E
Inventory existing and potential beaver habitat, include reintroduction of beaver into restoration actions.		Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform		Entire assessment unit	RL, F, B
Encourage beaver colonization		Same as above.		Entire assessment unit	RL, F, B
Study presence of pathogens in juveniles and adults		Hatchery and harvest practices have lead to changes in run timing, genetic fitness, spawning distribution, pathogen transmission, and spawning success(due to competition with hatchery stocks)	Little Klickitat 1, 2, 3; Canyon 1		RL, F, B, H, M

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Explicitly include desired carcass numbers within escapement goals to benefit ecosystem processes in population/harvest management decisions.		Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Entire assessment unit		RL, M, K
Study/Characterize productivity in relation to water quality parameters.		Fluctuations in water quality parameters have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Entire assessment unit		RL, F, H, M, B
		Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces; Can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of Juveniles and or entomb juveniles			RL, F, H, M, B
Study and assess sources/attribute relative contributions of sediment load		Same as above.	Middle and Upper assessment unit		RL, M, H, F, B
Implement road management actions that reduce sediment inputs.		Same as above.	Middle and Upper assessment unit		RL, F, B
Implement upland management practices that mimic natural runoff and sediment production.		Same as above.	Middle and Upper assessment unit		RL, F, B
Assess significance of predation by native birds		Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation (increased bird populations around hatchery)	Little Klickitat 1, 2, 3; Canyon 1		RL, F, B
Study specific habitat relationships for pacific lamprey.		Poor passage for anadromous forms through the mainstem Columbia River (and possibly in the Subbasin) have severed life history pathways and reduced population abundance, productivity and spatial diversity.	Little Klickitat Mainstem, Canyon 1		RL, B

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
		Changes in habitat conditions and reduction in salmon populations within the subbasin have reduced habitat suitability and reduced abundance, productivity and life history diversity. Improvement in habitat conditions for salmonids will improve lamprey populations as well.			RL, B
Implement habitat restoration actions for pacific lamprey.		See above.	Little Klickitat Mainstem, Canyon 1		RL, B

6.4.4 Lower Klickitat

Table 44 Lower Klickitat biological objectives and strategies and tier rankings by geographical areas

TIER DEFINITIONS	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective	
	Assessments (Data Gaps, M&E):	Primary-- Able to be implemented within next 5 years and addresses critical uncertainties and/or assumptions	
		Secondary-- Not able to be implemented in the next 5 years and/or addresses less immediately critical uncertainties and/or assumptions	
SOURCE CODES:	E= EDT	F= Field Observation	B= Best Professional Judgement
	RL= Research Literature	V= Aerial Video Interpretation	T= Technical Advisory Group Priority
	H= Habitat Database	K= Klickitat Master Plan	O= Orthophoto Interpretation

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Improve passage percentage at Lyle Fish Ladder		Migration timing of fall chinook, research on capabilities of coho, flow records, and anecdotal evidence suggest difficulties in upstream passage prior to Lyle fish ladder	Lyle Falls		K, RL
Design passage at ladder to maximize desired species' passage while preventing predator passage		Lyle Falls historically acted as a barrier to aquatic predator species	Lyle Falls		K, B
In Snyder Creek about a third of Baffles are in place, log weirs are all in place; culverts have been replaced; study effectiveness of actions, study utilization by anadromous species; identify maintenance		2,400 foot flume, two culverts, dam, in Snyder Creek form a depth/velocity barrier	Snyder 1 and 2		F, B, O
Improve passage opportunities at Dead Canyon		Access to Dead Canyon is limited; change in plan form due to undersized road crossing	Dead Canyon 1		F, B, O
Remove road fill from alluvial floodplain			Dead Canyon 1		F, B, O
Restore historical hydrologic regime and Increase extent and distribution of perennial habitat		Historic data suggests loss of wetland structure in Upper Swale	Entire assessment unit		RL, F, B
		Groundwater withdrawals lower base flows decreasing perennial flow area in Lower Swale			RL, F, B
		Increased peak runoff			RL, F, B
Study and monitor groundwater withdrawals in area		Same as above	Entire assessment unit		RL, F, B, O

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Increase abundance of salmonid populations to reduce proportion of predation due to native sp		Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation.	Entire assessment unit		RL, B
		Increased habitat for native predators in Col. Mainstem leads to increased pops in lower tribs.			RL, B
Reduce non-native fish predator population levels in Mainstem Col		Same as above	Out of basin effect		RL, B
Reduce Habitat suitability for predatory non-native fish		Increased Temps in lower river increase habitat for non-native predators, temps also trigger increase in feeding levels	Entire assessment unit		RL, B
		Predation risk to salmonids from non- native fish (walleye, Smallmouth bass etc) is high			RL, B
Support Corps studies of fish passage at mainstem Columbia dams. Evaluate habitat conditions for survival in the mainstem Columbia habitat.		Survival of steelhead kelts (mature spawned out fish with the potential to spawn again) migrating out of the Klickitat Basin and through the mainstem Columbia to the ocean is believed to be at or near zero..	Out of basin effect		Rl, B
Increase kelt survival and repeat spawner success. Increase steelhead productivity.		Capture, rehabilitation, and release of these fish in the Klickitat Basin increases survival and could act as a source of broodstock/genetic material for reintroduction efforts	Entire assessment unit; special consideration of facilities at Wahkiacus		RL, B, K
Fund Kelt reconditioning in Klickitat. Determine breeding success of Kelts.		Same as above	Entire assessment unit; special consideration of facilities at Wahkiacus		RL, B, K

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Increase run sizes, Implement hatchery and harvest practices that do not decrease fitness, run size, timing		Historical hatchery and harvest practices have altered run timing, size, and genetic fitness;Little Klickitat Falls presents greater upstream passage challenge than historically	Entire assessment unit		RL, K
Reduce distribution of coho within subbasin(underway); reduce total numbers of coho above Lyle(underway)		Hatchery Fish compete with Natural Origin fish for space and food resources	Mainstem klickitat		RL, K
Restore fish populations such that escapement is sufficient in number to provide adequate carcasses.		Food availability decreased by lack of nutrient transport / carcasses; Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Entire assessment unit		RL, K
Fertilize streams with artificial carcasses		Same as above	Entire assessment unit		RL, K
Increase floodplain and channel roughness		Road, timber, and grazing management activities have lead to increased sediment supply from incoming tributaries of which has resulted in channel evulsions from inability of stream to transport increased sediment supply and other meadow activities have decreased sinuosity	Entire assessment unit		RL, F
		Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment			RL, F, B
		Hydrologic routing in watershed has been modified; Land use management activities have modified flow timing and discharge			RL, H, M

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
		SR 142 and other infrastructure in watershed have altered floodplain negatively, confined river and tributaries			RL, F, B, E
		Champion Haul Road and 1996 flood deposit effects			RL, F, B, E
Reconnect side channels		Same as above	Klickitat 10, 11		RL, F, B, E, O
Improve floodplain connectivity		Same as above	Entire assessment unit		RL, F, B, E
Relocate floodplain infrastructure, roads; improve maintenance, rehabilitate, decommission as approriate		Same as above	Entire assessment unit		RL, F, B, E
Re-establish and/or enhance native vegetation within floodplain		Same as above	Entire assessment unit		RL, F, B, E
Implement appropriate practices which leave sources of Large Woody Debris to naturally enter and remain in the system		Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	Entire assessment unit		RL, F, B, E
		Logging practices, general agricultural/forest and floodplain developments increased peak flows			RL, F, B
Artificially introduce Large Woody Debris		Same as above	Tributaries, Klickitat 10, 11		RL, F, B

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Inventory existing and potential beaver habitat, include reintroduction of beaver into restoration actions.		Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform		Entire assessment unit	RL, F, B, H, M
Encourage beaver colonization		Same as above.		Entire assessment unit	RL, M, K
Study presence of pathogens in juveniles and adults		Hatchery and harvest practices have lead to changes in run timing, genetic fitness, spawning distribution, pathogen transmission, and spawning success(due to competition with hatchery stocks)	Entire assessment unit		RL, F, H, M, B
Study and assess sources/attribute relative contributions of fine sediment.		Same as above.			RL, M, H, F, B
Implement road management actions that reduce fine sediment inputs.		Same as above.			RL, F, B
Implement upland management practices that mimic natural runoff and sediment production.		Same as above.			RL, F, B
Improve flow, cover, available habitat, and habitat diversity to reduce potential for predation by native birds.		Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation			RL, F, B

Target Strategy or Objective	Life Stage Affected	Associated Key Finding	Tier Rankings by Geographical Areas		Source
			Primary	Secondary	
Study specific habitat relationships for pacific lamprey.		Poor passage for anadromous forms through the mainstem Columbia River (and possibly in the Subbasin) have severed life history pathways and reduced population abundance, productivity and spatial diversity.			RL, B
		Changes in habitat conditions and reduction in salmon populations within the subbasin have reduced habitat suitability and reduced abundance, productivity and life history diversity. Improvement in habitat conditions for salmonids will improve lamprey populations as well.			RL, B
Implement habitat restoration actions for pacific lamprey.		Same as above.			RL, B

6.5 Research, Monitoring and Evaluation

This final section of the subbasin summary outlines current and future monitoring and evaluation programs and needs. Because fish enhancement programs have been ongoing for several years, monitoring plans for many of them have been developed in some detail, including estimates of future needs. Wildlife programs have been more limited and much basic inventory is still needed. The specifics and methods for wildlife monitoring, as a result, have not been developed in detail but will be as project results lead to application of adaptive management principles in project planning and implementation.

6.5.1 Existing Monitoring Programs

6.5.2 Wildlife

As discussed under the "Existing and Past Efforts" section, wildlife inventory, monitoring and evaluation has been occurring at various levels for selected species and habitats. However, this summary identified many habitats and species that warrant further study and/or management actions. Monitoring plans need to be developed for new projects as they are developed. The following identifies both monitoring needs as well as management activities for which monitoring plans would need to be developed as activities are implemented. Some habitat monitoring identified as a near-term need has the potential to meet some needs identified below.

Sandhill Crane

- Monitor long-term population trends on Conboy Refuge, YN and adjacent private lands
- Manage nesting habitat to ensure reproductive success of breeding population
- Identify key lands for conservation easements and/or acquisition

Western Pond Turtle

- Continue "head start" program to augment population
- Improve nesting and foraging habitat through pond and meadow development
- Identify habitat for conservation easements and or acquisition

Oregon Spotted Frog

- Continue long term population monitoring and egg mass counts
- Evaluate water management strategy at Conboy Refuge to benefit spotted frogs and sandhill cranes
- Purchase or develop conservation easements for key habitats adjacent to Conboy Refuge
- Conduct surveys for spotted frogs in the rest of the subbasin – especially potential habitats on the Yakama Reservation

Western Gray Squirrel

- Conduct study of impacts from timber harvest on western gray squirrel habitat use

- Develop methodology to adequately monitor population trends
- Conduct additional surveys on YN for western gray squirrel population distribution
- Identify and acquire important lands to maintain or increase western gray squirrel population and improve travel corridors between key population centers
- Evaluate threat from eastern gray squirrel range expansion in western gray squirrel habitat

Mule / Back-Tailed Deer

- Acquire critical winter range habitat that connects WDFW Klickitat Wildlife Area with YN

American Beaver

- Restore habitat

6.5.3 Fish

The fisheries enhancement program in the Klickitat Basin is in some ways qualitatively different from than its sister program in the Yakima. It is also at a considerably earlier stage of development. The Klickitat program differs from the Yakima in that it entails a major harvest augmentation program as well as supplementation and complementary habitat enhancement. While the basic elements of the harvest augmentation programs for coho and fall chinook are already well established, important elements of the monitoring plan have not yet been implemented. The supplementation program for steelhead and spring chinook is at an even earlier stage of development. The basic elements of these programs--lifestage released, location of release/acclimation sites, time of release; critical reaches for natural production, enhancement actions that must be taken to restore natural production potential--are still being determined. As mentioned previously, the EDT model will play a central role in helping managers to design the initial enhancement plans for steelhead and spring chinook.

At present, most monitoring activities are driven by the need to incorporate the best possible data into the EDT models for spring chinook and steelhead. Accordingly, considerable effort has been expended both on inventorying the quantity and quality of fish habitat within the basin, and on describing fundamental life history patterns and demographics of the natural populations. The only other ongoing "research/monitoring" activities in the basin include engineering studies of measures needed to provide adult passage at Lyle and Castile Falls, inventories of poorly designed culverts that need replacement, engineering plans associated with renovating the Lyle Falls adult fish trap and monitoring site, and measures to determine the effect of various riparian and instream enhancement actions on specific environmental attributes (e.g., sediment deposition, water temperature).

A comprehensive monitoring plan for spring chinook and steelhead supplementation, as well as coho and fall chinook production, is being developed. The conceptual framework for this plan has been completed and is described below in outline form. The Klickitat Basin supplementation monitoring program will rely on the Yakima Basin program wherever possible or appropriate to monitor analogous processes. It will use research findings from the YKFP's Yakima component and adapt procedures demonstrated to be effective in the Yakima. Guidelines developed to direct project activities in the Yakima in the areas of genetics, ecological interactions, natural production, and harvest are expected to be used in the Klickitat when deemed to be non-basin specific.

The Columbia Basin Law Enforcement Council (CBLEC) coordinates state, federal and tribal conservation law enforcement efforts throughout the Columbia Basin. Currently, a consultant for Columbia River Inter-Tribal Fisheries Enforcement is conducting monitoring and evaluation of conservation enforcement in the mainstem Columbia River between Bonneville and McNary Dams, including cooperative enforcement actions in the tributaries.

Production (Coho and Fall Chinook) Monitoring

Smolt-To-Adult Survival By Treatment

The project intends to determine smolt-to-adult survival by rearing/acclimation treatment. We plan to assess the effectiveness of individual acclimation sites at increasing survival. The project currently estimates returns as the sum of expanded catch samples, expanded redd counts, and hatchery returns. A more accurate method must be developed to estimate adult returns. The planned improvements to the Lyle Falls trap and adult passage facility will increase the reliability of these estimates.

Catch By Treatment

The project intends to monitor harvest to correlate adult returns to juvenile release groups. Methods may include, but are not limited to, hands-on monitoring of catch at tribal, sport and commercial fisheries.

Supplementation (Spring Chinook and Steelhead) Monitoring

The following Monitoring and Evaluation outline has been modified from the YKFP spring chinook M & E Plan. Table 3 describes the mechanics of a population undergoing supplementation. The expectation is that, if the characteristics of each factor listed are similar between hatchery and natural fish, then managers can assume that supplementation will be successful. The outline following the table describes ways of monitoring the performance of the supplemented population, to determine if the factors listed in the table are similar between natural and hatchery fish, and to indicate the degree to which factors outside fish managers' control might be limiting success.

Natural Production Monitoring

Intrinsic Factors Affecting Natural Production

NOTE: Intrinsic factors are those factors, such as broodstock collection, over which the fish manager has some control.

Hatchery Fish Quality

1. Survival of released smolts
2. Hatchery smolts/spawner as fish leave acclimation ponds, as well as natural smolts/spawner

- Relative hatchery/wild smolt-adult survival rates
- Comparative hatchery/wild smolt behavior - gross level (e.g., migration rate and timing)

- Relative hatchery/wild residualism rates (e.g., densities of residuals in index sites, subsampling fish leaving acclimation ponds) Develop methods to monitor residual abundance (for supplemented and harvest augmentation stocks)
- Relative hatchery/wild precocialism rates (e.g., number of precocials on redds)
- Relative hatchery/wild smolt loss due to predation inbasin at mouth of Klickitat by northern pikeminnow, smallmouth bass, channel catfish, piscivorous birds, and possibly other species

3. Reproductive Success of Hatchery Fish

- Hatchery/wild comparison of gamete quality measured in hatchery test crosses (hxh,wxw,hxw,wxh) (e.g., fertilization rates, viability, temperature units to hatch, fry size/egg size)
- Comparative hatchery/wild performance of adults for the following demographic and life history characteristics: age, size at age, sex ratio, fecundity at size, migration timing, spawning timing (both in hatchery and on spawning grounds), spawning distribution/habitat utilization, and straying

Long-Term Fitness of Supplemented Population

4. Determine domesticating effect of hatchery environment on the Klickitat stock.

Facility Performance

5. Monitor operations at hatchery, acclimation ponds, monitoring facilities to insure compliance with biological specifications.
6. Develop a Facility Quality Control Plan for the Klickitat Hatchery

Extrinsic Factors Affecting Natural Production

NOTE: Extrinsic factors are those factors outside the control of fish managers. In the Yakima, three factors are being monitored: carrying capacity, harvest, and fluctuating environmental conditions. In the Klickitat, only the first two factors can be monitored because the basin lacks the historical flow and other records that are available in the Yakima Basin.

Carrying Capacity

1. Investigate relationship between spawner abundance and redd superimposition. The existing monitoring program in the Klickitat has indicated that coho and other species are spatially segregated in spawning areas. Continued monitoring of both supplemented and augmented stocks will indicate if interspecific superimposition occurs.
2. Relationship between abundance and length, weight, condition factor of early spring chinook and steelhead parr.
3. Relationship between abundance and size, condition factor, and lipid content of fall spring chinook and steelhead parr.
4. Relationship between abundance and rearing distribution of spring chinook and steelhead juveniles.

5. Relationship between abundance and microhabitat usage of upper Klickitat spring chinook and steelhead juveniles.
6. Relationship between abundance and predation on smolts.

Harvest

1. Columbia River Fisheries
2. Total harvest in lower Columbia gill-net fishery of wild and hatchery spring chinook and steelhead.
3. Total harvest of hatchery and wild spring chinook and steelhead in Zone 6 commercial and sport fishery.
4. Klickitat Basin Fisheries
5. Determine total terminal harvest in tribal and sport fisheries of basin wild and hatchery spring chinook and steelhead
6. Determine incidental harvest of steelhead during fall terminal fisheries for fall chinook and coho

Genetics Monitoring

Genetic Health of the Klickitat Spring Chinook and Steelhead Stocks

Type 1 Risk: Extinction

1. Spawner-recruit relationship for wild and hatchery fish
2. Harvest rates for wild and hatchery fish
3. Other sources of mortality for wild and hatchery fish

Type 2 Risk: Loss of within-population genetic variability

1. Effective number of breeders, estimated from escapement counts and genetic data (allozyme and/or DNA)
2. Genetic variability measures (e.g., heterozygosity, alleles/locus, etc.) (allozyme and/or DNA data)
3. Comparison of means, ranges, and variances of selected quantitative traits (e.g., size, age at maturity, spawning and migration timing) with baseline values in this stock

Type 3 Risk: Loss of adaptation and among-population genetic variability

1. Determine if there are genetically distinct populations of winter and summer steelhead in the basin

Type 4 Risk: Domestication

2. Selection potentials

- Distribution by sex, size, age, and date of capture of prespawning mortality

- Comparison of wild and hatchery spawners at selected traits that are likely to impose or reflect significant selection pressures (e.g., size, age at maturity, fecundity, geographical spawning distribution)
- Comparison of wild and hatchery juveniles at selected traits that are likely to impose or reflect significant selection pressures (e.g., size, migration timing)

3. Genetic trend

- Comparison of means and variances of selected quantitative traits (e.g., size, age at maturity, spawning and migration timing, percentage of winter migrants) with baseline values in this stock and with contemporaneous data in reference stocks

4. Direct measurement of genetic change

- Performance of juveniles generated by test crosses in hatchery (hxh, hxw, wxw) at selected traits

NOTE: This monitoring measure would require a relaxation of the long-standing broodstock collection guideline of wild-only broodstock.

Genetic Health of Other Columbia Basin Spring and Snake Basin Spring/Summer Chinook Stocks

Type 3 Risk: Loss of among-population genetic variability

1. Stray rate of Klickitat hatchery fish onto out-of-basin spawning grounds and hatchery broodstocks, determined by spawning ground surveys and examination of hatchery broodstock

NOTE: This would almost certainly require that the releases be marked with CWTs, or some other mark that would identify them as Klickitat fish compared to out-of-basin samplers.

Ecological Interactions Monitoring

Interactions Affecting Supplementation Success

Interactions with Strong Interactor Taxa

1. Predators: a predation consumption index will be developed that applies to smolt life stages.

- Interactions with spring smolts
    - Fish predators (northern pikeminnow, bass, catfish, trout)
    - Bird predators (mergansers, herons, gulls, terns, cormorants) below release points during the spring migration time for smolts.

2. Pathogens (viruses, bacteria, fungi, parasites)

- Occurrence and infection levels (determined by pathological examination) in adult broodstock.
- Occurrence and infection levels (determined by pathological examination) in spring smolts migrating past the lower Klickitat rotary trapping facility through migration period.

- Occurrence and infection levels (determined by pathological examination) in hatchery smolts exiting acclimation sites.
- Occurrence of and infection levels by external pathogens (determined by routine visual inspection) of all spring chinook and steelhead collected for other monitoring purposes.

3. Competitors (rainbow trout/steelhead, redside shiners, mountain whitefish)
4. Mutualists (beaver, riparian vegetation)

- Distribution, size, and abundance of hydraulic refuges in Klickitat basin created by beaver and riparian vegetation, and composition of riparian vegetation (determined by winter aerial photographs and ground-truthed by floating sections of the Klickitat)

Interactions between hatchery and wild spring chinook

1. Predation

- Proportion of hatchery and wild fish smolts in predator stomachs relative to abundance at lower Klickitat rotary trap.
- Abundance and distribution of predators in relation to hatchery releases
- Proportion of hatchery fish with wild spring chinook in the stomach (fish will also used for stomach fullness work)

2. Competition
3. Migration behavior (pied-piper effect)

- Comparison of migration timing (fry and presmolts/smolts) with and without hatchery fish present at lower Klickitat rotary trap to determine if a spike in wild spring chinook migration occurs concurrent with hatchery releases (supplemented stocks)
- Snorkel observations to determine if wild spring chinook are pulled from feeding stations by migrating hatchery fish

Interactions between spring chinook and steelhead and production stocks

1. Pied piper. Develop methods to determine if the "Pied Piper" effect causes non-smolted juveniles to outmigrate with large groups of hatchery released smolts. Compare timing, age, size distribution of spring chinook and steelhead smolts seen at Lyle, hatchery, and upstream traps.
2. Predation on spring chinook and steelhead fry by coho smolts. Utilize literature and results of studies conducted in the Klickitat, Yakima, and Wenatchee projects to assess potential risks and to guide future predation studies.

Interactions Affecting Stewardship and Utilization Taxa (SUT)

Interactions with bull trout

1. Abundance and size structure in index areas
2. Distribution and spatial overlap with Klickitat spring chinook and steelhead

Completion of bull trout presence/absence and population status inventory work.

Determine the presence or absence of juveniles in the subbasin and document the existence of adfluvial populations, if any. The product of this determination will be geographically based assessments of the distribution and abundance estimates of bull trout in the subbasin by critical life history stages.

1. A limiting factors analysis is required to develop a management plan for bull trout in the subbasin.
2. The genetic make up of the char will be assessed relative to other bull trout stocks in the region.

Environmental Monitoring

Goal C for the subbasin includes a strategy to restore ecological parameters to a properly functioning condition. This section outlines a plan to monitor the success of projects designed to help achieve that goal.

Properly Functioning Condition (PFC) for the Klickitat (as well as the Yakima) is defined in terms of the six distinct parameters that describe the abiotic environment and the four that describe the biotic components. Abiotic elements include the following parameters:

1. **Water quality:** temperature, suspended sediment, and turbidity and chemical pollution/nutrient concentration.
2. **Habitat accessibility:** presence of physical barriers to anadromous salmonids.
3. **Habitat structure:** pool frequency and quality, size distribution of substrate, and the quantity and distribution of large woody debris (LWD), off-channel habitat (e.g., side channels and sloughs) and refugia (near-pristine habitat patches sheltering "core populations").
4. **Channel condition and dynamics:** width-to-depth ratio, streambank stability, floodplain connectivity.
5. **Instream flow/hydrology:** similarity of peak and base flows to normative values, similarity of drainage network to the historical drainage network, mortalities (entrainment, predation, stranding) ultimately caused by irrigation or hydropower diversions.
6. **Watershed conditon:** road density, disturbance history and the quantity and distribution of riparian reserves (habitat patches of natural, late succession riparian vegetation providing normative rates of LWD recruitment, shading, etc.)

The four major biotic elements are:

1. **Predation,** both inter- and intra-specific and hatchery/wild.
2. **Competition**, both inter- and intra-specific (hatchery-wild and between resident and anadromous morphs of the same species, especially *O. mykiss*).
3. **Pathogens/parasites.**

4. **Mutualism**, species which benefit each other, as in the fertilization of infertile streams to the benefit of the entire aquatic community by salmon carcasses, or water retention and the beneficial habitat structure provided by beaver dams. A major mutualistic element, riparian vegetation, has for organization sake been grouped with habitat structure, an abiotic parameter.

Over 40 transects, using Timber, Fish and Wildlife (TFW) Ambient Monitoring Protocol, provide baseline data at the landscape level. Individual project assessment will also occur at a more localized level. Broad monitoring and evaluation criteria are being developed for projects with quantitatively measureable results. Application of criteria will be tailored to individual projects to assess effectiveness relative to project-specific objectives. For example, plant cover and frequency will be measured for re-vegetation projects while morphological criteria will be addressed for projects involving in-channel work. Where possible, relevant criteria will be measured as part of a site-specific baseline inventory prior to restoration or management treatments. Presently, the broad criteria are divided into ground cover and in-channel components.

Vegetation and Ground Cover. Projects consisting entirely or partly of re-vegetation, floodplain protection, or management of existing vegetation will be monitored and evaluated based on three potential criteria. Monitored criteria will be project-specific depending on treatments (e.g. seeding of herbaceous species vs. planting of woody rooted-stock) and objectives (e.g. streambank stabilization, ground cover, stream shading, etc.).

- Survival of woody plantings and/or cuttings (# living/# planted x 100 = % survival). This parameter will be measured yearly for the first three years following implementation. Generally, 30-40% survival is considered good, though site-specific conditions (soil texture, soil organic material, drainage, water holding capacity) will affect site-specific success for a given species. Evaluation will be based on a target survival minimum of 30%, to be qualified by professional judgment of local conditions and species suitability.

- Canopy and ground cover will be measured using permanently marked, 30 m long transects. Woody canopy cover will be measured using the line intercept method (Bonham 1989) while the quadrat method (Daubenmire1959) will be applied to determine herbaceous canopy and ground cover. For projects involving both woody and herbaceous treatments and/or management of existing vegetation, line-intercept and quadrat transects will run along a common line. Transects will be measured annually for the first three years following implementation, every fifth year subsequently. The number of transects per site will depend upon the size the project area.

- Canopy-closure will be measured using the densiometer method described by Rashin et al. (1994). Data will be collected in the second and fourth years initially and every fourth year subsequently. This parameter will be evaluated on the basis of increased stream shading through time.

In-Channel. Projects that include active channel manipulation or stabilization will be monitored based on morphologic and habitat parameters.

- Morphologic monitoring will involve the use of cross-sections permanently marked and surveyed according to Harrelson et al. (1994). Longitudinal stream channel geometry will also be measured. Specific criteria will depend upon valley morphology, but may include: width/depth ratio, entrenchment ratio, belt width, substrate composition, meander width ratio, sinuosity, and gradient.

- Fish Habitat parameters will be measured to provide data for potential population modeling. Residual pool depth, large woody debris frequency (# / river mile), and fine sediment will comprise the three primary habitat parameters. Where project reaches are sufficiently large, new TFW transects may be established.

6.6 New Research, Monitoring and Evaluation

The following guidelines extracted from the Washington State Salmon Recovery Funding Board will be used when preparing project proposals in the future unless project proponents have a specific reason for changing the monitoring and evaluation criteria.

6.6.1 Monitoring and Evaluation

Adapted from the Monitoring and Evaluation Strategy For Habitat Restoration documents published by the Washington Salmon Recovery Funding Board (SRFB), which can be found at http://www.iac.wa.gov/srfb.

The following project types are addressed by this subbasin monitoring and evaluation plan:

- Fish Passage Projects
- Instream Structure Projects
- Riparian Vegetation Restoration Projects
- Livestock Exclusion Projects
- Constrained Channel projects
- Channel Connectivity Projects
- Spawning Gravel Projects
- Habitat Protection projects at the Parcel scale

Fish Passage Projects

The objective for fish passage projects is to increase access to areas blocked by human-cause impediments.

Types of Fish Passage Projects

- Bridge projects, culvert improvements, small dam removals, debris removals, diversion dam passage, fishway construction, weirs, and water management projects.
- Monitoring Goal: Determine whether fish passage projects are effective in restoring upstream passage to targeted fish species.

Questions to be answered

- Have the engineered fish passage projects continued to meet design criteria post-project for at least five years?
- Have fish passage projects as an aggregate demonstrated increased abundance of target species post-project within five years?

Objectives

Before Project Objectives (year 0)

Project managers determine the proper design criteria for meeting the fish passage objectives for the project. Determine fish abundance both in the downstream control reach and impact reach upstream of the fish blockage for the sampled projects.

After Project Objectives (Years 1, 2, And 5)

Determine whether fish passage design criteria are being met at each project monitored. Determine salmon abundance both in the downstream control reach and impact reach upstream of the fish blockage for each project.

Response Indicators

Design Criteria: Project design criteria taken from construction blueprints or pre-project plan.

Abundance Of Salmon Can Be Determined Using Both Adult Spawner And Redd Counts And Juvenile Counts: Adult estimating procedures are found in SRFB Protocol 9. Juvenile estimating procedures are found in SRFB Protocols 7 and 8. The least intrusive monitoring protocol should be used whenever possible. Impact areas will be compared to the controls and to controls and impacts on other streams as well. The metrics used will be numbers per square meter for juveniles and number per kilometer or redds per kilometer for adults depending upon the target species.

Instream Structure Projects

Types of instream structure projects

Channel Reconfiguration, installed deflectors, log and rock control weirs, roughened channels, and woody debris.

The objective for instream projects is to increase instream cover, spawning, and resting areas by constructing artificial instream structures. The basic assumption is creating more diverse pools, riffles, and hiding cover will result in an increase in local fish abundance.

Monitoring Goal: Determine if projects that place artificial instream structures (AIS) into streams are effective in improving stream morphology and increasing local fish abundance in the treated area at the stream reach level.

Questions to be answered

1. Have AIS as designed remained in the stream for up to ten years for the sampled instream structure projects?

2. Has stream morphology improved significantly in the treated stream reach for the sampled instream structure projects within ten years?
3. Has salmon abundance increased significantly in the impact area for the sampled instream structure projects within ten years?

Objectives

Before Project Objectives (Year 0)

Determine the Thalweg Profile in the impact and control areas for each of the instream structure projects sampled. Determine the numbers of adult and juveniles of the targeted salmon species in the control and impact areas for each of the instream structure projects sampled.

After Project Objectives (Years 1, 3, 5, And 10)

Determine the number and location of AIS within the treated area for the sampled instream structure projects. Determine the Thalweg Profile in the control and impact areas for the sampled instream structure projects. Determine the numbers of adult and juvenile of the target salmon species within the control and impact areas for the sampled instream structure projects.

Response Indicators

Number Of AIS Remaining In The Sampled Reach: AIS must be identified using GPS coordinates and other techniques such as tags affixed to LWD in order to track the life of AIS over time. AIS sampling methods are found in Protocol 13 (SRFB 2003).

Thalweg Profile: The Thalweg profile characterizes pool-riffle relationships, sediment deposits, wetted width substrate characteristics, and channel unit-pool forming categories. Stream morphology sampling methods are taken from EMAP (Peck et al. unpubl.), Section 7.4. Protocols summarizing EMAP Table 7-3 and 7-4 are found in Protocols 14, 15, and 16. Sampling is based upon establishing 11 regular transects within each identified stream reach. Pre-project measures of the variation of depth throughout the stream reach and the residual pool volume will be compared to detect post-project changes.

Numbers Of Adult And Juvenile Salmon In The Reach: Abundance of salmon can be determined using both adult counts, redd counts, and juvenile counts. Adult estimating procedures are found in Protocol 9. Juvenile estimating procedures are found in Protocols 7 and 8. The least intrusive monitoring protocol should be used whenever possible. Impact areas will be compared to the controls and to controls and impacts on other streams as well. The metrics used will be numbers per square meter for juveniles and number per mile or redds per mile for adults depending upon the target species.

Riparian Vegetation Restoration Projects

The goal of riparian planting projects is to restore natural streamside vegetation to the stream bank and riparian corridor. The assumption is that riparian vegetation increases shading of the stream, leading to cooler temperatures more desirable for salmon rearing. Vegetative cover also reduces sedimentation and erosion, which can impact egg survival, food organisms, and the ability of salmon to find food.

Monitoring Goal

Determine whether riparian plantings are effective in restoring riparian vegetation, stream bank stability, and reducing sedimentation.

Questions to be answered

- Have at least 50% of the riparian plantings survived for at least 10 years?
- Have the riparian shading and riparian vegetative structure been improved by year 10?
- Has erosion and stream sedimentation been significantly reduced by year 10?

Objectives

Before Project (Year 0)

Determine the proportion of the three layers of riparian vegetation present within the project impact and control areas. Determine the proportion of shading within the project impact and control areas. Determine the proportion of actively eroding stream banks within the project impact and control areas.

After Project (Years 1, 3, 5, And 10)

Determine the overall survival of the species of riparian vegetation planted. Determine the proportion of the three layers of riparian vegetation present within the project impact and control areas. Determine the proportion of shading within the project impact and control areas. Determine the proportion of actively eroding stream banks within the project impact and control areas.

Response Indicators

Number Of Trees And Shrubs Planted: The number of trees and shrubs planted at the time of the project. The Level 1 indicator tracks how many plantings actually survived over time as a measure of project effectiveness.

Riparian Vegetation: Using EMAP protocols (Peck et al. Unpubl.), the percent shading is calculated using a densitometer and the riparian species diversity understory ground cover and canopy can be determined in a consistent manner. One would expect the percent shading and the species diversity to change over time as the plantings grow. The proportion of actively eroding streambanks is an indicator of sedimentation and erosion into the stream. If riparian plantings are effective in creating riparian cover, then bank erosion should decline.

Livestock Exclusion Projects

The goal of livestock exclusion fencing is to exclude cattle from the riparian area of the stream where they can cause severe damage to the stream by breaking down stream banks and increasing erosion, destroying shade producing trees and shrubs, and increasing sedimentation. By excluding cattle with fencing, these adverse impacts can be avoided and restoration of the shoreline can occur.

Monitoring Goal

Determine whether livestock exclusion projects are effective in excluding livestock, restoring riparian vegetation and restoring stream bank stability.

Questions to be answered

- Are livestock excluded from the riparian area?
- Has riparian vegetation been restored in the impact area?
- Has bank erosion been reduced in the impact area?

Objectives

Before Project Objectives (Year 0)

Determine overall use by livestock of the riparian area to be excluded. Determine the total acreage to be fenced. Determine the total kilometers of stream protected. Determine the overall riparian vegetation cover layers and percent shading within the project area.

Determine the overall proportion of stream bank actively eroding.

Post-Project Objectives (Years 1, 3, 5, And 10)

Determine the overall use by livestock of the riparian area excluded. Determine the overall riparian vegetation cover layers and percent shading within the project area.

Determine the overall proportion of stream bank actively eroding.

Response Indicators

Exclusion Effectiveness: Using Protocol 10, the presence or absence of livestock inside the exclusion can be used as a measure of the effectiveness of the fencing design in excluding livestock from the riparian area.

Riparian Indicators: Using EMAP protocols (Peck et al. Unpubl.), the percent shading (using a densiometer) is a metric that can be determined in a consistent manner. This metric was chosen because it has been shown to have one of the highest signal to noise ratios (17) of 18 different parameters measured involving riparian vegetation. Using EMAP protocols, the percent of riparian area containing all three layers of vegetation, canopy layer (.5m high), understory (0.5 to 5m high), and ground cover (0.5m high). This metric was chosen because it has been shown to have one of the highest signal to noise ratios (8) of 18 different parameters measured involving riparian vegetation. Using methods outlined in Protocol #17, the proportion of actively eroding streambanks can be determined within the sampled stream reaches.

Constrained Channel projects

The goal of constrained channel projects is to restore the natural flood flow basin width so that gravel, large wood, and normal stream morphology and fish habitat can be restored. Diking, road construction, fills, and other construction work within the stream’s normal flood line can constrain flow within the normal flow channel leading to scouring effects upon stream gravel, loss of hiding cover and food organisms, and unsuitable habitat for rearing juvenile salmon.

Unconstrained streams dissipate flood flow energy over a broader valley floor and provide slower velocities for preserving stream channel morphology and rearing habitat for salmon.

Types of constrained channel projects:

Dike removal or setback, riprap removal, road removal or setback, and landfill removal.

Monitoring goal

Determine whether projects that remove or set back dikes, riprap, roads, or landfills are effective in restoring stream morphology and eliminating channel constraints in the treated area.

Questions to be answered

- Has removal and/or setback reduced channel constraints and increased flood flow capacity for ten years?
- Has stream morphology improved over ten years?

Objectives

Before Project Objectives (Year 0)

Determine the overall channel capacity and constraints in the impact area. Determine the overall stream morphology using Thalweg Profile in the impact area.

After Project Objectives (Years 1, 3, 5, And 10)

Determine the overall changes in channel constraints and flow capacity in the impact area. Determine the overall stream morphology using Thalweg Profile in the impact area.

Response Indicators

Channel Capacity: Channel capacity as cross-sectional area calculated from mean bankfull width (XBF_W) and height (XBF_H) measures the overall channel flow capacity. When a channel is constrained the velocity of the water increases to compensate for higher volume. Increased velocity scours stream bottom eliminating pools, large wood, and other structures associated with fish habitat.

Thalweg Profile: The Thalweg Profile characterizes pool-riffle relationships, sediment deposits, wetted width substrate characteristics, and channel unit-pool forming categories. Stream morphology sampling methods are taken from EMAP (Peck et al. unpubl.), Section 7.4. Protocols summarizing EMAP Table 7-3 and 7-4 are found in Protocols 15, and 16 (SRFB, 2003). Sampling is based upon establishing 11 regular transects within each identified stream reach. Pre-project measures of the variation of depth throughout the stream reach (RP100) and the residual pool volume (AREASUM) will be compared to detect post-project changes.

Channel Connectivity Projects

Channel connectivity projects and off-channel habitat projects are designed to reconnect flood flow channels, oxbows, and other winter flood flow channels and winter rearing areas for fish and other aquatic organisms. Loss of channel connectivity is most often caused by manmade disturbances such as dikes, roads, fills, etc.

Types of channel connectivity projects

Channel connectivity, off-channel habitat, and wetlands.

The goal of channel connectivity projects is to restore lost channels and side channel rearing areas to active fish production and to dissipate the destructive effects of flood flows upon habitat.

Monitoring goal

Determine whether projects that restore connectivity to channels that have previously been disconnected from the stream are effective in improving stream morphology and increasing fish abundance in the impacted area. This would include side channels, meander bends, old oxbows, and wetlands.

Questions to be answered

1. Has the reconnected channel remained attached to the stream as designed?
2. Has off-channel stream morphology improved over time?
3. Has riparian vegetation in the off-channel impact area changed from upland to wetland species?
4. Has salmon abundance increased in the off-channel impact area over time?

Objectives

Before Project Objectives (Year 0):

Determine the overall size and configuration of the disconnected channel in the impact and control areas. Determine the plant community characteristics in the impact and control areas. Determine the overall stream morphology using Thalweg Profile in the impact and control areas. Determine the overall abundance of targeted fish species in the impact and control areas.

After Project Objectives (Years 1, 2, And 5):

Determine the effectiveness of the connected channel within the impacted area. Determine the plant community characteristics within the impact and control areas. Determine the overall stream morphology using Thalweg Profile in the impact and control areas. Determine the abundance of target fish species within the control and impact areas.

Response Indicators

Connected Channel. The channel connection must remain functional as designed for the project to be considered a success. The response indicator in this case is whether the channel has remained connected to the main channel of the stream thereby meeting design criteria.

Thalweg Profile. The Thalweg profile characterizes pool-riffle relationships, sediment deposits, wetted width substrate characteristics, and channel unit-pool forming categories. Stream morphology sampling methods are taken from EMAP (Peck et al. Unpubl.), Section 7.4. Protocols summarizing EMAP Table 7-3 and 7-4 are found in Protocols 14, 15, and 16 (SRFB, 2003). Sampling is based upon establishing 11 regular transects within each identified stream reach. Pre-project measures of the variation of depth throughout the stream reach and the residual pool volume will be compared to detect post-project changes.

Riparian Species Diversity And Percent Shading: Using EMAP protocols, the percent shading (using a densiometer) and riparian species diversity are metrics that can be determined in a consistent manner. One would expect the percent shading and the species diversity to change over time after the channel has been reconnected.

Numbers Of Adult And Juvenile Salmon In The Reach: Abundance of salmon can be determined using both adult counts and juvenile counts. Adult estimating procedures are found in Protocol 9. Juvenile estimating procedures are found in Protocols 7 and 8. The least intrusive monitoring protocol should be used whenever possible. Impact areas will be compared to the controls and to controls and impacts on other streams as well. The metrics used will be numbers per square meter for juveniles and number per mile or redds per mile for adults depending upon the target species.

Spawning Gravel Projects

Spawning salmon require clean gravel of the proper size in order to spawn successfully. Where the stream is subjected to high sediment loading, gravel that is normally the proper size and location may become embedded into a matrix of silt and clay sediments that do not provide aeration of the redd.

The goal of gravel placement projects is to improve spawning capabilities within the impacted area by artificially placing gravel in the stream. The assumption is that spawning areas are a limiting factor in producing juvenile salmon, and placing gravel in the stream should result in an increase in successful spawning and local juvenile and adult fish abundance.

Monitoring Goal

Determine if projects that place spawning gravel into streams are effective in improving salmon spawning, and increasing local adult fish abundance in the impacted area at the stream reach level.

Questions to be answered

- Has gravel placed in the stream remained in the stream for up to ten years for the sampled gravel replacement projects?
- Has gravel remained usable for spawning over time or has it become embedded with fines?
- Have more adult salmon utilized the new spawning gravel?

Objectives:

Before Project Objectives (Year 0)

Determine the total area of spawning gravel in the impact and control areas for each of the gravel placement projects sampled. Determine how embedded the spawning gravel is in the control and impact areas for the sampled gravel placement projects. Determine the percentage of fines in the gravel in the control and impact areas for the sampled gravel placement projects. Determine the numbers of adult spawners of the targeted salmon species in the control and impact areas for each of the gravel placement projects sampled.

After Project Objectives (Years 1, 3, 5, And 10)

Determine the total area of spawning gravel in the impact areas for each of the gravel placement projects sampled. Determine how embedded the spawning gravel is in the control and impact areas for the sampled gravel placement projects. Determine the percentage of fines in the gravel in the control and impact areas for the sampled gravel placement projects. Determine the numbers of adult spawners of the targeted salmon species in the control and impact areas for each of the gravel placement projects sampled.

Response Indicators

Area of Gravel Remaining in the Sampled Reach. Spawning gravel placed in the stream must be identified using GPS coordinates and other techniques such as streambank markers in order to track the life of the gravel placement over time.

Gravel Characteristics. Gravel characteristics can be quantified using the EMAP protocol for characterizing stream substrate (Peck et al. Unpubl.). This protocol measures size of substrate. Percent of fines is commonly used as a measure of siltation. Embeddedness is also determined (see Protocol 12, SRFB, 2003).

Numbers Of Adult Salmon In The Reach: Abundance of salmon can be determined using adult spawner counts. Adult estimating procedures are found in Protocol 9. The least intrusive monitoring protocol will be used whenever possible.

Habitat Protection projects at the Parcel scale

A Protection project is a property acquired either in fee title or a property protected by a restrictive use agreement or easement for the purpose of:

- Protecting identified blocks of critical habitat that protect fish and wildlife from further population declines.
- Protection of property providing key linkages connecting fragmented habitats.
- Protection of property used to enhance habitat and to offset poor habitat elsewhere in the watershed.

Determine whether habitat protection parcels as a whole and individually are effective in maintaining or improving fish and wildlife habitat and invertebrate species assemblages within the parcel boundaries.

Monitoring Goal

Determine whether habitat protection parcels as a whole and individually are effective in maintaining and/or, improving fish and wildlife and invertebrate species assemblages within the parcel boundaries.

Questions to be answered

- Have the protected properties maintained or improved the riparian habitat benefits for which they were purchased?

- Have the protected properties maintained or improved the upland habitat benefits for which they were purchased?
- Has the biological condition of the macro-invertebrate and fish and wildlife assemblages improved, declined or stayed the same within the protected properties?

Objectives

Baseline (Year 0)

Determine status of instream, riparian and upland habitat within each randomly selected parcel. Determine the biological condition of macro-invertebrate and fish and wildlife species assemblages using a multi-metric index for each randomly selected parcel.

Post-Acquisition Objectives (Years 3, 6, 9, And 12)

Determine trends in instream, riparian and upland habitat within each randomly selected parcel compared to the baseline year. Determine status of macro-invertebrate and fish and wildlife species assemblages using a multi-metric index for each randomly selected parcel.

Response Indicators

Thalweg Profile. The Thalweg profile characterizes pool-riffle relationships, sediment deposits, wetted width substrate characteristics, and channel unit-pool forming categories. Stream morphology sampling methods are taken from EMAP (Peck et al. unpubl), Section 7.4.

Riparian Plants: Riparian condition is determined by measuring the plant density and species composition within the study reach. It is also important to measure stream bank erosion. Streamside riparian habitat sampling methods are taken from EMAP (Peck et al. Unpubl.), Section 7.4.

Upland Plants: Upland plant community sampling methods are taken from the National Park Service “Fire Monitoring Handbook (FMH)”, Chapter 4 Monitoring Program Design, Table 3, Table 4 and Figures 9-14; and Chapter 5 Vegetation Monitoring Protocols Tables 5-10 and Figures 15-20. SFRB Protocols summarizing FMH protocols are found in Protocol X (SRFB, 2003).

Macro-Invertebrate Assemblages: Stream macro-invertebrate species composition and relative abundance of particular groups show strong correlations with water quality and watershed health factors. Changes in macro-invertebrates would indicate that water quality conditions within the parcel have changed over time. Macro-invertebrate sampling methods are taken from EMAP (Peck et al. unpubl), Section 11. Protocols summarizing EMAP Table 11-2, 11-3, and 11-4 are found in Protocols X (SRFB, 2003) and in the Department of Ecology’s “Benthic Macro-Invertebrate Biological Monitoring Protocols for Rivers and Streams”, Publ No. 01-03-028. Indicators considered most sensitive to regional change are compared using a multi-metric index (Karr and Chu, 1999; Wiseman, 2003).

Numbers of Adult and Juvenile Salmon in the Reach: Abundance of salmon can be determined using both adult counts and juvenile counts. Adult estimating procedures are found in Protocol 9. Juvenile estimating procedures are found in Protocols 7 and 8. The least intrusive monitoring protocol should be used whenever possible. Impact areas will be compared to the controls and to controls and impacts on other streams as well. The metrics used will be numbers per square meter for juveniles and number per mile or redds per mile for adults depending upon the target species.

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8 Acronyms and Abbreviations

BLM	Bureau of Land Management
BPA	Bonneville Power Administration
BOR	Bureau of Reclamation
BiOP	Biological Opinion
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
Colville Tribes	Confederated Tribes of the Colville Reservation
CRITFC	Columbia River Inter-Tribal Fish Commission
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
Dbh	Diameter at Breast Height
DOE	U. S. Department of Energy
DOI	U.S. Department of the Interior
EA	Environmental Assessment
Ecology	Washington State Department of Ecology
ECP	Eco-regional Conservation Planning
EDT	Ecosystem Diagnostic & Treatment
EIS	Environmental Impact Statement
EMS	Energy Management System
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information System
HCP	Habitat Conservation Plan
HEP	Habitat Evaluation Procedure
HGMP	Hatchery Genetic Management Plan
huc	habitat

IBIS	Interactive Biological Information System
ISRP	Independent Scientific Review Panel
JFC	Joint Fisheries Committee
LFA	Limiting Factors Analysis
NEPA	National Environmental Policy Act
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPPC	Northwest Power Planning Council
PA	Programmatic Agreement
PHS	Priority Habitats and Species
PIF	Partners in Flight
PUD	Public Utility District
RC&D	North Central Washington Resource Conservation & Development Council
RM	river mile
SSHIAP	Salmon and Steelhead Habitat Inventory and Assessment Project
TMDL	Total Maximum Daily Load
TSS	Total Suspended Sediment
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WQI	water quality index
WDFW	Washington Department of Fish and Wildlife
Yakama Nation	Confederated Tribes and Bands of the Yakama Nation
YFRM	Yakama Fisheries Resource Management

9 Technical Appendices

Appendix A: Lower Middle Mainstem including Rock Creek Subbasin Planners and Contributors

Appendix B: Common and Scientific Names Used in Assessment

Appendix C: Wildlife Species of the Klickitat Subbasin

Appendix D: Rare Plants and Plant Communities of the Rock Creek Watershed Area

Appendix E: EDT Data Sources