Draft

Klickitat Subbasin Summary

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Northwest Power Planning Council

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Location

The Klickitat River is located on the east slope of the Cascade Range in south-central Washington and drains 1,350 square miles in Klickitat and Yakima counties. (See Figure 1.) The Klickitat River is one of the longest undammed rivers in the northwest, flowing about 95 miles south from its source in the Cascades to the Columbia River at river mile (RM) 180.4, 34 miles upstream of Bonneville Dam. The crest of the Cascade Mountains, dominated by 12,000-foot Mt. Adams (Pohta) forms the western boundary of the basin. Basalt ridges and plateaus separate the Klickitat from other river basins on the north and east.

Climate

Climate over the entire watershed can be characterized as a hybrid of those typically found on either side of the Cascade Range. The watershed is subject to a continental climate, but due to its position at the head of the Columbia River Gorge, receives a stronger marine influence than other east side basins. Elevational gradients further contribute to a noticeable climatic shift as one moves from the north and west (cooler, wetter) of the watershed to the south and east (hotter, drier). Typically, summers are hot and dry throughout the watershed and winters cold and wet. Average daily temperatures in the summer range from 55 degrees Fahrenheit (F) in the far north and west portions of the watershed to 70 degrees F in the southeast. Average daily winter temperatures range from 25 degrees F in the north and west to 37 degrees F in the south. Precipitation decreases dramatically from west to east across the basin. The summit of Mt. Adams and the Goat Rocks receive over 100 inches of precipitation annually. Mt. Adams' large snow pack feeds high summer base flows and contributes to a large glacier system. By contrast, east of the Klickitat River, less snow pack accumulates and melt is earlier. Within the Simcoe Range, the eastern watershed divide, elevations between four and six thousand feet receive between 30 and 50 inches. Consequently, 7-day low flows are on the order of a hundred times greater in streams draining Mt. Adams than for streams draining the eastern Klickitat Basin.

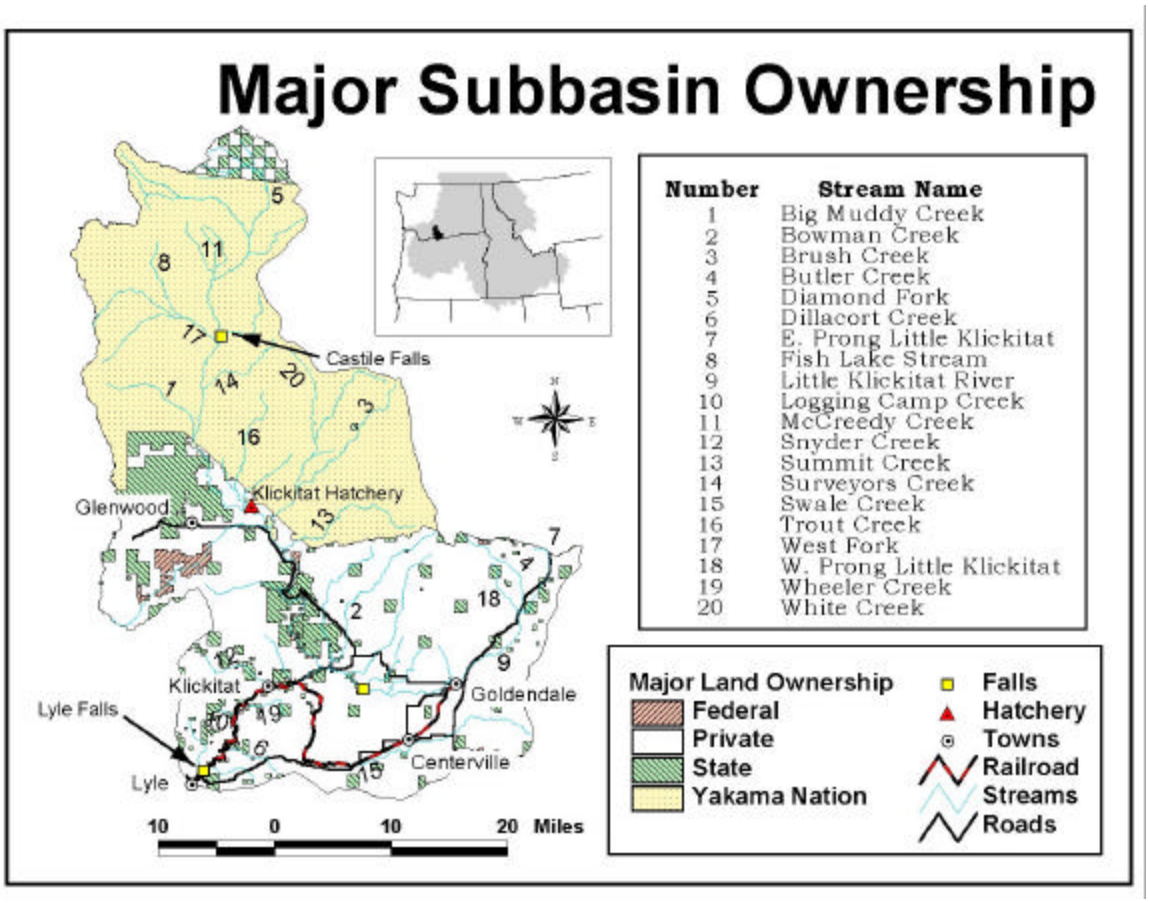

Figure 1. Klickitat Subbasin Map

Geology and Hydrology

The geology of the watershed is dominated by extensive basalt strata having a total thickness of several thousand feet (Cline 1976) Volcanic rocks of four distinct age groups underlie the basin. The Cascade crest is dominated by Mt. Adams, a 12,000-foot dormant volcano with an extensive glacier system that drains into the Klickitat River. At the northwest corner of the basin lie the Goat Rocks, the deeply eroded remnants of an extinct volcano, that reach to about 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 erosion-resistant nature of these strata has resulted in the creation of deep (700 to 1500 feet), steep-walled canyons and has severely constrained alluvial floodplain development over most of the watershed. 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. 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 vary from 0.4 to 0.8 percent downstream of the Klickitat Hatchery (RM 42.4), between 1 and 2 percent from above the hatchery to just beyond Diamond Fork (RM 78), and to 0.5 percent or less from Diamond Fork to the upper extent of McCormick Meadow (RM 85). Above McCormick Meadow, 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, 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%.

Mt. Adams has a distinct influence on both water quantity and water quality in the Klickitat River. Rusk Glacier on the east flank of Mt. Adams is prone to occasional glacial outburst floods that feed torrents of water and volcanic debris into Big Muddy Creek. Typical of Cascade volcanoes, volcanic rock weathering to clay and glacial action combine to deliver a large volume of fine sediment to the river system through Big Muddy Creek and the West Fork Klickitat.

The basalt that underlies most of the Klickitat River basin is highly permeable. The volcanic rocks on the Mt Adams side of the Klickitat River contain both permeable volcanic debris and lava tubes. Cline (1976) estimates that about 60% of the average annual stream flow leaving the Yakama Reservation in the Klickitat River is groundwater discharge. Individual springs discharge up to 40 cfs.

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.

Land Use

The Klickitat watershed is approximately equally divided between Klickitat and Yakima counties. The Yakama Nation Reservation occupies the northern part of the watershed, encompassing 56% of the total watershed area, including the entire portion within Yakima County. 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], US Fish and Wildlife Service [USFWS].

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. Major landowners include the Yakama Nation, WDNR, Champion International, and Boise Cascade. These forestlands 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.

The northern portions of the subbasin, which contain a higher predominance of fir species, have been undergoing a heavy western spruce budworm infestation over the last 15 years. Within the portion of the subbasin falling on the Yakama Reservation, approximately 110,669 acres showed some level of defoliation in 1999. This infestation has resulted in accelerated harvests of fir in the region, and forest managers have been managing for open, pine-dominated forest stands in place of the more dense, fir-dominated stands that have grown over the last 100-150 years. Timber harvests on the Yakama Reservation have shifted from light selective harvest toward heavier use of shelterwood cuts.

Most of the watershed that is not forested 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 25% of the arable land is 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 watershed is approximately 16,000. Urban development is limited to the city of Goldendale (population 3500) 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.

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 2). Table1 lists the LUMAs within the Klickitat subbasin, as well as the acreage and goal of each LUMA.

Table 1. 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)

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 November 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).

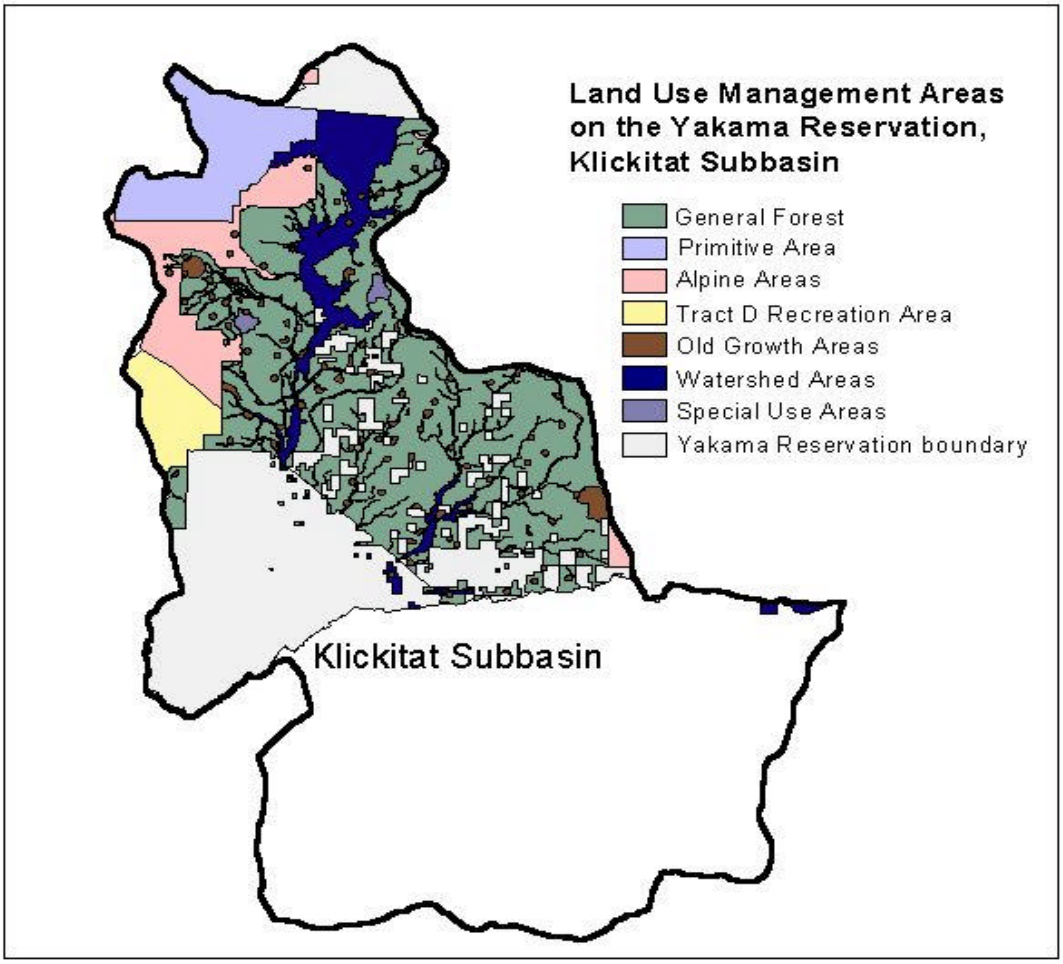

Figure 2. Land Use Management Areas on the Yakama Reservation

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).

Fish and Wildlife Resources

Fish Resources

Spring chinook *(Oncorhynchus tshawytscha)*

Bryant (1949) cited reports of large runs of spring chinook and a significant tribal fishery at Lyle Falls (RM 2.2) prior to about 1920, despite difficult passage at the falls. By 1951, the annual spring chinook run varied from 1,000 adults to 5,000 adults (WDFW 1951). Using Mitchell Act funds, the managers constructed the Klickitat Hatchery and two fishways at Lyle Falls in 1952. Managers trapped spring chinook broodstock each year from 1952 through 1959 or later at the upper fishway (Falls 5). Spring chinook run size estimates have ranged from 1,614 fish to 3,488 fish with a mean of 2,523 fish (adults plus jacks). Currently 600,000 hatchery smolts are released on-station at the Klickitat Hatchery. On average, approximately 150,000 hatchery fry also are outplanted in the upper basin above Castile Falls as a thinning release in late spring.

A comprehensive electrophoretic analysis of genetically distinct stocks of all species and races of salmon and steelhead in the Klickitat was conducted between 1989 and 1994 (Busack 1990). This analysis indicated that hatchery and naturally spawning Klickitat spring chinook were genetically indistinguishable. 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 3 shows distribution of spring chinook in the basin.

The most comprehensive set of spawner survey data covers the last ten years (1990-1999). Based on redd counts, natural escapement has averaged 400 fish over this period. Natural spawning occurs between the base of falls #10 at Castile Falls (RM 64) downriver to the Big Muddy confluence (RM 53.8). Tributary spawning by spring chinook is not known to occur, although juveniles have been found rearing in the lower reaches of several tributaries.

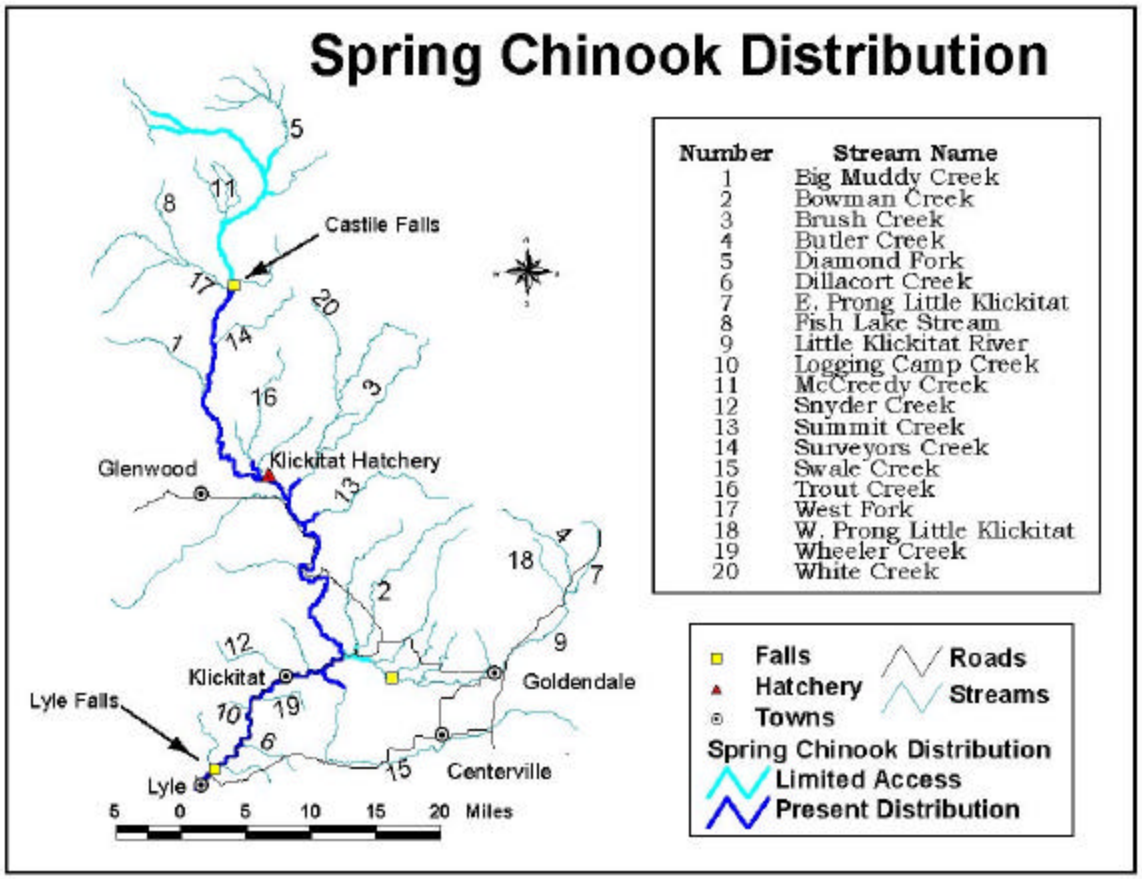

Figure 3. Spring Chinook Distribution in the Klickitat Basin

Fall (URB) chinook *(Oncorhynchus tshawytscha)*

Prior to the first hatchery plants of tule stock fall chinook in 1946, fall chinook were not found in the Klickitat subbasin. Managers and biologists assume that Lyle Falls was impassable to chinook during the low water conditions that generally prevail in late summer and early fall (Bryant 1949). Low egg survival for fall chinook is believed to be the result of glacial sediment from Big Muddy Creek in the Klickitat River.

Beginning in 1986, hatchery production switched from the tule stock to an upriver bright (URB) fall chinook stock (see next section). Currently, 4 million hatchery URB smolts are released on-station annually. Eyed eggs are transferred from Priest and Lyons Ferry hatcheries to the Klickitat Hatchery for final rearing. As would be expected, Busack's 1990 electrophoretic analysis indicated naturally spawning Klickitat fall chinook were genetically indistinguishable from both the Priest Rapids and Lyons Ferry stocks. The last five years (1995-1999) comprise the most comprehensive set of URB spawner surveys. Natural escapement over this period has averaged 2,160 fish. Mainstem spawning occurs between RM 5.2 and RM 42.0. Figure 4 shows fall chinook distribution in the basin.

Fall (Tule) chinook *(Oncorhynchus tshawytscha)*

Tule fall chinook are not indigenous to the Klickitat subbasin (see previous section). Hatchery plants from outside the basin first occurred in 1946, and releases from the Klickitat Hatchery began in 1952 and continued until 1986. Releases have included stocks from Cowlitz, Toutle, Kalama, Washougal, Bonneville, Cascade, and Ringold hatcheries.

The Klickitat fall chinook program was originally developed to rear tule fall chinook from the Spring Creek Hatchery. When the Spring Creek program failed to provide the necessary eggs, the program was changed to URB chinook. This program also was intended to provide a better quality fish for the tribal terminal fishery in the lower Klickitat River. Since 1986, tule production has been entirely natural, although comprised primarily of hatchery strays. Passage improvements and out-of-basin hatchery production have resulted in establishment of a small naturally spawning population in the lower mainstem.

Natural production estimates from recent (1995-1999) spawner surveys indicate an average natural escapement of 675 adults. This spawning occurs in the mainstem between RM 5.2 and RM 42.0. (See Figure 4.)

Summer chinook *(Oncorhynchus tshawytscha)*

Busack's 1990 electrophoretic analysis indicated the existence of a distinct summer chinook race in the Klickitat Basin. The genetic relationship of this stock to other stocks of chinook in both the Klickitat Subbasin and the Columbia Basin generally should be examined by DNA analysis as soon as possible.

Natural production estimates for summer chinook are not available. Spawning distribution is assumed to be similar to that of tule fall chinook.

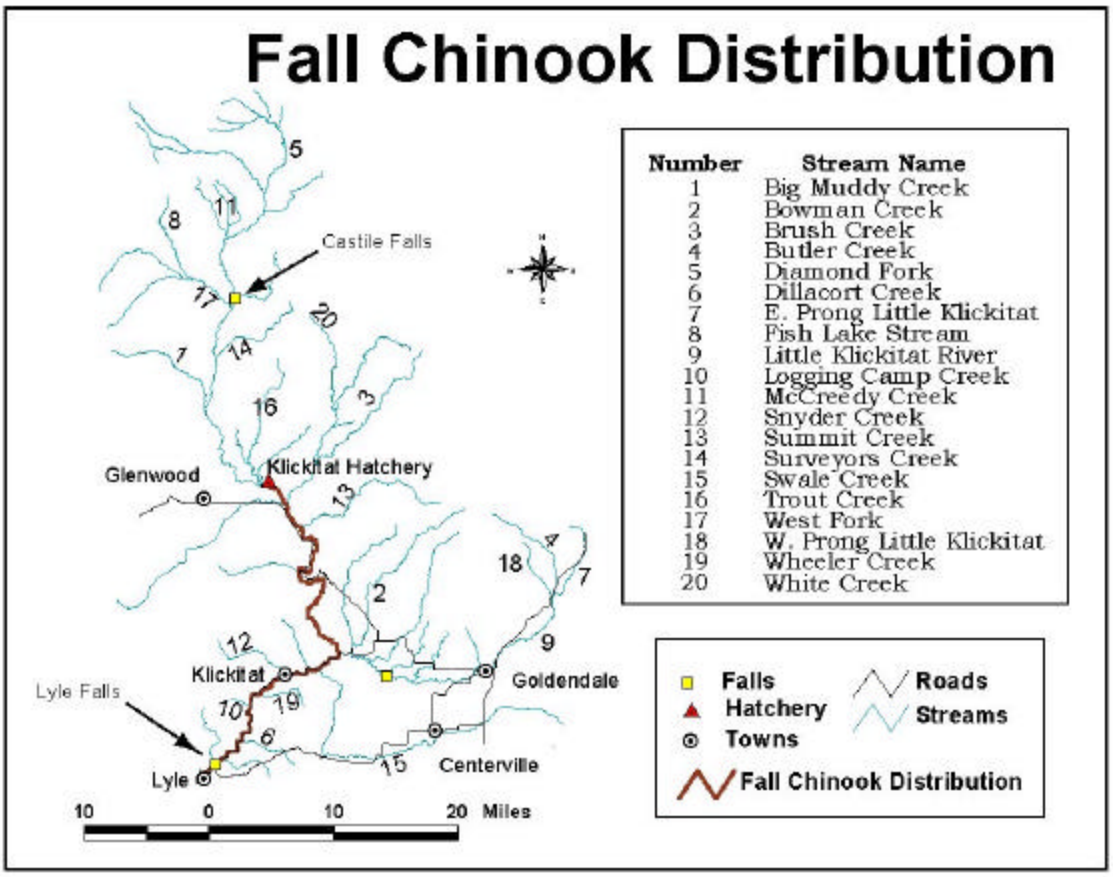

Figure 4. Fall Chinook Distribution in the Klickitat Basin.

Coho *(Oncorhynchus kisutch)*

Like fall chinook, coho are not native to the Klickitat Subbasin. Although the Klickitat Hatchery was not completed until 1952, coho releases apparently began in the Klickitat River in 1951, or earlier, as 29 adults were reported to have returned to the hatchery in 1952. Since 1952, hatchery returns have fluctuated between zero and 4,283 adults. Returns have been less than 1,000 adults every year since 1972. Coho counts at Lyle Falls adult trap peaked at 4,348 fish (adults plus jacks) in 1956. From 1977 through 1985, the average return of coho to the subbasin has been 919 fish, jacks and adults combined.

Current hatchery production of coho is 3.85 million smolts. Hatchery production is comprised primarily of late-run stock transferred from lower Columbia River hatcheries. Of the total, 1.35 million are transferred as either eyed eggs or pre-smolts to Klickitat Hatchery for on-station rearing and release. The remaining 2.5 million smolts are transported from Washougal Hatchery and the majority released directly into the Klickitat River between RM 16 and 37. Efforts continue to develop acclimation sites for all of the coho smolts.

These hatchery releases have resulted in a small population of naturally spawning fish. Recent (1997-1999) spawner surveys indicate an average escapement of 500 hatchery adults. 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 River. Figure 5 shows coho distribution in the basin.

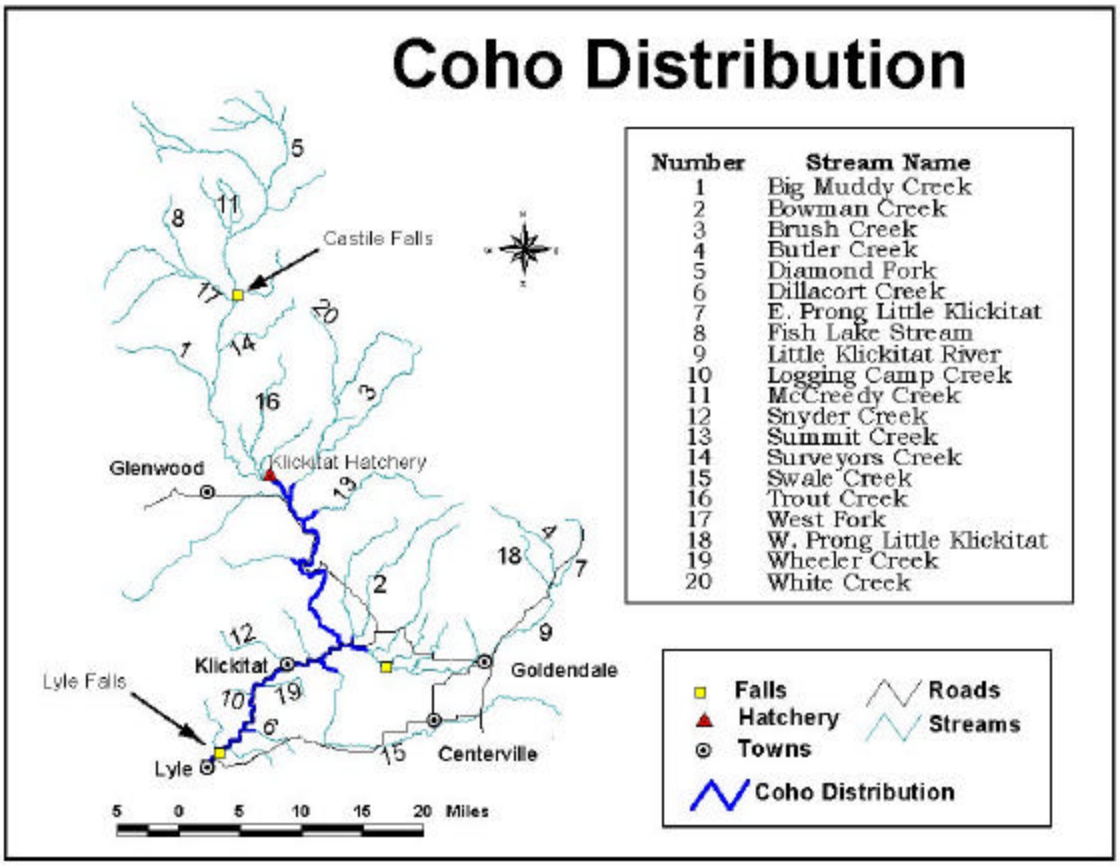

Figure 5. Coho Distribution in the Klickitat Basin

Steelhead (summer and winter) *(Oncorhynchus mykiss)*

Summer steelhead are native to the Klickitat subbasin. Figure 6 shows their distribution. Bryant (1949) stated that "a fairly good run of spring steelhead" had been reported in the Klickitat River. Reliable counts of returning adults are unavailable for the 50s, 60s and 70s, although rough estimates based on harvest data have been made.

Estimates of both sport and treaty harvest of Klickitat summer steelhead (May through February catches) exist for 1981 through 1986. The mean value of these estimates is 4,070 fish. Thirty-two percent of the sampled sport catch in 1979 through 1981 (151 fish) was of natural origin. Of these naturally produced fish, the proportion of one-, two- and three-salt fish was 14, 78 and 5 percent, respectively. An additional 3 percent were repeat spawners ranging in ocean age from three to six. Mean fork lengths of the one-, two- and three-salt fish was 60, 73, and 80 cm, respectively. The mean fork length of the repeat spawners was 77 cm.

The existence of naturally spawning winter steelhead was confirmed in the early 1980s, and winter steelhead are presumed to be indigenous. Howell et al. (1985) recognized both

summer and winter races of steelhead in the Klickitat subbasin, with an adult winter steelhead migration period of January through May and a spawning period of March through June. To protect the winter run, current regulations prohibit sport fishing for steelhead in the Klickitat River from December through May and the treaty fishery is closed from January through March. Both seasons have been longer in previous years. In the Preliminary Information Report (July 8, 1988), March and April steelhead catches were assumed to be winter steelhead and ranged from two fish to 105 fish during the years 1977 through 1986. Hatchery-reared winter steelhead have never been released in the Klickitat Basin.

The last five years (1996-2000) comprise the most comprehensive set of steelhead spawner survey data. Redd counts over these years indicate an average escapement of 260 fish. This figure is undoubtedly an underestimate due to the inherent difficulty in conducting accurate counts during spring flow conditions. 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.

Approximately 120,000 summer-run steelhead from the Skamania Trout Hatchery and Vancouver Hatchery are currently released directly into the Klickitat River. 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 infectious hematopoietic necrosis virus (IHN), 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.

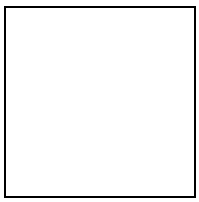

Figure 6. Steelhead Distribution in the Klickitat Basin

Resident Rainbow Trout *(Oncorhynchus mykiss)*

Resident rainbow trout are found throughout the Klickitat subbasin. Naturally reproducing populations exist within the mainstem from RM 85 to the Columbia River confluence and in virtually all tributaries. The Yakama Nation has planted hatchery "catchable" rainbow trout in high mountain lakes in the western portion of the subbasin and at two river locations. Lake-planted rainbow trout have been observed in outlet streams below the planted lakes.

Currently, the hatchery "catchable" on-reservation program consists of 10,000 rainbow trout for releases with 95% planted in high mountain lakes. The Washington Department of Fish

and Wildlife (WDFW) releases hatchery "catchable" rainbow trout into the Little Klickitat River for a youth-only fishery within the city limits of Goldendale.

Bull trout *(Salvelinus confluentus)*

The abundance and distribution of the stock is poorly known. Bull trout are listed as threatened under the Endangered Species Act (ESA). There are insufficient data to make an assessment. However, it appears that there are very few bull trout in the lower- to mid-Klickitat drainage. Bull trout appear to be more abundant in the upper drainage where habitat conditions are more favorable than in the lower drainage. 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 electrofishing surveys in Trappers Creek. (See also "Brook Trout," below.) Portions of the West Fork upstream of Fish Lake Stream contain an isolated naturally reproducing population of bull trout.

Recent evidence indicates both resident and adfluvial 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. Photographic evidence of fish angled in the mid-1980s are of a size associated with adfluvial populations. Additional survey work will be conducted in the upper drainage to determine the distribution and abundance of bull trout in the subbasin.

Cutthroat Trout (*Oncorhynchus clarki*)

Resident cutthroat trout were observed within two tributaries of the Klickitat subbasin, McCreedy and Summit creeks, in limited numbers during census work of the 1980s. In the late 1990s, known locations of resident cutthroat were reinvestigated with no cutthroat trout observed. It is speculated that hybridization with resident rainbow trout and losses in habitat quantity and quality, have led to the elimination of resident cutthroat from their former range. Additional investigation efforts will be needed to determine the status of resident cutthroat trout populations in the Klickitat subbasin.

Coastal cutthroat trout are known to occur in the Klickitat subbasin. The historic and present distribution and status are relatively unknown. Accounts of coastal cutthroat generally occur in the lower subbasin below the Little Klickitat River confluence. Investigations into distribution and population status need to be undertaken.

Brook Trout *(Salvelinus fontinalis)*

Brook trout were introduced into the Klickitat subbasin in the late 1970s and early 1980s. Outplanting was primarily conducted 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). Brook trout are found in the meadow areas of both the Diamond Fork System and mainstem Klickitat River. 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**.**

Pacific lamprey *(Lampetra tridentatus)*

Pacific lampreys are known to occur in the Klickitat subbasin. The historic and present distribution and status are relatively unknown. Juvenile outmigrants are collected at the rotary screw trap station at RM 6.0. Adult pacific lampreys have been observed at RM 57.0. Fine sediment delivery from the Klickitat Glacier provides required rearing conditions during the ammocoete life stage of the pacific lamprey.

Wildlife Resources

A large variety of wildlife species are associated with the Klickitat subbasin because of the subbasin's diverse vegetative and geologic features. Big game include black bear, black-tailed deer, Rocky Mountain elk, and cougar. Mountain goats are associated with the Goat Rocks and are also seen using the breaks of the Klickitat canyon on the Yakama Nation Reservation. Passerine birds, raptors, waterfowl and uplands birds are found in various habitats across the subbasin. 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. Large and small mammals inhabit the various habitats. In recent years, wolverines sightings have been reported in the upper portions of the subbasin, as have unconfirmed sightings of gray wolves. Federal and State listed threatened and endangered species exist in the subbasin.

Sandhill Crane *(Grus canadensis)*

The sandhill crane is a Washington state endangered species. Between 1975 and 1987, a single pair of sandhill cranes nested at Conboy Lake NWR in Klickitat County. Since 1988, 2 to 6 pairs/year are known to have nested on the refuge, and in 1996 there were 9 confirmed breeding pairs (Anderson et al. 1996). Nesting cranes were discovered recently at a second site in Washington on the Yakama Indian Reservation in Yakima County, where 1 pair nested in 1994 and 1995 and 2 pairs nested in 1996 (Leach 1995; R. Leach, Yakama Nation, personal communication). Currently there are approximately 13 breeding pairs of sandhill cranes at Conboy National Wildlife Refuge. A recovery plan for sandhill cranes in Washington is currently being created by WDFW.

Western Pond Turtle (*Clemmys marmorata)*

The western pond turtle is listed by Washington as an endangered species; it has been extirpated from most of its range in Washington. Two populations remain in the Columbia River Gorge. The total number of western pond turtles in known Washington populations is estimated at only 250-350 individuals, approximately half of which went through the "head-start program" at the Woodland Park Zoo. Additional turtles may still occur in wetlands that have not been surveyed in

western Washington and the Columbia Gorge. Currently, WDFW is working on western pond turtle recovery in habitat near the mouth of the Klickitat River.

The recovery objectives are to establish at least 5 populations of more than 200 pond turtles, composed of no more than 70% adults, which occupy habitat that is secure from development or major disturbance. It is also necessary that the populations show evidence of being sustained by natural recruitment of juveniles. The core pond turtle sites should be wetland complexes that may be less susceptible to catastrophes than sites of a single water body. The recovery objectives need to be met before the western pond turtle would be considered for downlisting to threatened. Objectives for downlisting to sensitive are similar, except 7 populations of more than 200 pond turtles will be needed.

Oregon Spotted Frog (*Rana pretiosa)*

The Oregon spotted frog is a Pacific Northwest endemic currently listed as a Washington endangered species. Oregon spotted frogs are almost entirely aquatic in habit, leaving the wetlands only occasionally and for short duration. Wetlands associated with lakes, ponds and slow-moving streams can provide suitable habitat. However, these aquatic environments must include a shallow emergent wetland component to be capable of supporting an Oregon spotted frog population. Historically, this critical element was found in the floodplains of many larger water bodies. Various emergent-wetland and floating aquatic plants are found in abundance in Oregon spotted frog habitat. Adult female and juvenile frogs, in particular, spend summers in relatively warm water of this shallow emergent wetland environment. Two populations currently exist in the state of Washington, one of which is at Conboy National Wildlife Refuge in the Klickitat drainage. No surveys of potential spotted frog habitat have been conducted on the Yakama Nation Reservation.

Western Gray Squirrel *(Sciurus griseus)*

The western gray squirrel was listed as a state threatened species in Washington in 1993, when surveys indicated that the species' distribution was becoming increasingly patchy and disjunct. Small isolated populations remain in south Puget Sound, the Lake Chelan area, the southeast slope Cascade region and the Columbia River Gorge, the latter being the largest in the state. The exact reasons for this decline are unknown. However, changes in the landscape likely play a key role. Many years of fire suppression and selective logging practices have altered Washington's oak-conifer communities and the habitat of the western gray squirrel. On mesic sites, invading Douglas fir overtops the slow-growing, fire-adapted oak. In drier areas, drought and insects further stress overstocked forests. In some areas this has resulted in a wholesale loss of conifer, leading to intensive logging in remaining conifer stands. Dense pockets of conifer in oak woodlands, which frequently contain clusters of western gray squirrel nests, have been subjected to logging at an increasing rate in southwestern Washington.

The core population of the western gray squirrel is currently found in the lower Klickitat drainage from the southern Yakama Reservation boundary to the mouth of the Klickitat River. Surveys of potential habitat within the Klickitat subbasin portion of the Yakama Reservation have not yet been conducted.

Columbian Back-tailed Deer *(Odocoileus hemionus columbianus)*

Black-tailed deer are one of the most important game species in Washington. Within the Klickitat Basin, black-tailed deer provide significant recreational hunting opportunities to the nontribal public, and the deer, known as "Mowich" to the Yakama Nation, has long been an important source of food and ceremonial products to Native Americans of the region. Historically, the Klickitat Basin deer herd was much larger than its current size. By the early 1960s the large deer population and increasing land conversion in the basin created a conflict between private landowners and regional deer managers. Frequent depredations of agricultural lands by deer prompted local landowners to kill large numbers of deer. Continued conflicts eventually led the Washington Department of Game to reduce the herd through liberal hunting and to adopt population goals that were considerably lower than those of the earlier part of the century. Liberal antlerless deer hunting seasons combined with several severe winters produced a dramatic decline in deer numbers, wherein the population reached its lowest historical point in the mid 1980s. Since the adoption of more conservative antlerless deer seasons, the Klickitat Basin herd has rebounded to perhaps as many as 6,000 deer during the high phase of the population cycle.

The Klickitat deer herd is considered unique due to its large-scale migrations that incorporate a very large landscape, which includes federal, state, private and tribal reservation lands. During 1988-94, an intensive research effort conducted by the Yakama Nation focused on movement patterns, habitat use and demographics in the Klickitat Basin deer herd. In recent years, the population has been shown to be highly susceptible to dramatic winterkills during severe winters due to the relative scarcity of quality winter range (much of the historical winter range is now under agricultural or rural development). Productivity of the herd is good and deer numbers typically rebound relatively quickly from massive winterkills when a series of mild winters occur in succession. Most hunting mortality in the herd is associated with non-tribal harvest following fall migration of deer from reservation summer range to off-reservation winter range.

Bald Eagle *(Haliaeetus leucocephalus)*

The bald eagle is a state threatened species in Washington. However, bald eagle populations are recovering toward target levels established by the Pacific States Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service 1986).

Bald eagles are found along marine shorelines and the shorelines of freshwater lakes and rivers. Eagles defend breeding territories to protect their preferred feeding sites and their nest, perch and roost trees (Stalmaster 1987). In Washington, breeding territories include upland woodlands and lowland riparian stands with a mature conifer or hardwood component (Grubb 1976, Garrett et al. 1993, Watson and Pierce 1998). Territory size and configuration are influenced by a variety of factors, including breeding density (Gerrard and Bortolotti 1988) and the types of foraging habitat and prey that are available (Watson and Pierce 1998).

Wintering eagles may roost communally, with 3 or more eagles perching consecutive nights in the same trees. Communal roosting probably enhances food finding on nearby foraging areas (Knight and Knight 1984). Eagles may gather in staging trees located between feeding grounds and roost trees prior to entering the night roost (Hansen et al. 1980, Anthony et at.

1982, Stalmaster 1987). The Klickitat was identified as a significant bald eagle wintering area in southern Washington (Ichisaka 1989). Two primary communal roosts were identified in 1989 along the Klickitat River; one roost is located near the mouth of the river and the other is located on the Klickitat Wildlife Area.

Riparian Avian Guild

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, yellow warbler, yellow-breasted chat, red-eyed vireo, Vaux's swift) continually exhibit declining population trends in this region. Lewis's woodpeckers are closely associated with large cottonwood stands. Historically they were common in the cottonwood habitats of the Columbia River but declines were noted after 1965, and they are now considered extirpated from the Columbia River riparian habitat. The yellow-billed cuckoo is a riparian obligate species that was once common along the Columbia River but has not been reported in this area since 1977. Other species that are marsh obligates include the Virginia rail, sora rail and marsh wren. Loss of riparian and riparian-marsh habitat for these birds resulted from the inundation and alteration of habitats in the Klickitat River subbasin and in the mainstem of the Columbia River.

Northern Spotted Owl (*Strix occidentalis caurina*)

The northern spotted owl is federally listed as threatened, and is listed by Washington state as endangered. In 1993 an analysis of demographic data collected across the range of this subspecies indicated that the population had been declining at a rate of about 4.5% annually over the previous 8 to 10 years, and that the rate of decline appeared to be accelerating (Forsman et al. 1993). The most recent analysis included 5 additional years' data, and indicated that the population continued to decline at 3.9% per year (Franklin et al. 1999). Logging of mature, closed forest habitats has been the main factor in this owl's decline. In recent years the closely related barred owl (*Strix varia*) has expanded its range into the Pacific Northwest, including the Klickitat subbasin (Yakama Nation unpublished data, Smith et al. 1997). Competition with this more aggressive *Strix* species has become a factor of unknown magnitude in the decline of spotted owls. Within the Klickitat subbasin, most spotted owl sites occur on tribally-owned lands on the Yakama Reservation, with some additional sites occurring on state and private lands. The Yakama Nation has been inventorying and monitoring spotted owls since 1991 and conducts annual surveys of known spotted owl sites and upcoming timber sale areas. The Yakama Reservation population appears to be declining at a rate comparable to the range-wide average.

Canada Lynx (*Lynx canadensis*)

The Canada lynx was recently listed as threatened under the Endangered Species Act. Lynx occupy large areas of boreal, sub-boreal, and montane forests, and once occupied a range extending from Alaska across Canada and into portions of the northwestern United States, Great Lakes region and upper New England (Ruediger et el. 1999). Over-harvesting and direct and indirect effects of habitat alteration have led to drastic population declines and range reduction. In Washington, most recent occupancy has been documented in the extreme north, although recent

detections on the Gifford Pinchot National Forest indicate a south-central Washington Cascades population may still exist. Within the Klickitat subbasin, most potential lynx habitat lies within the Yakama Reservation (Stinson 2000), where no surveys have been conducted to date.

Peregrine falcon (*Falco peregrinus*)

Peregrine falcons are listed by the state of Washington as endangered. Peregrines nest on the ledges of steep cliffs, usually along a river, lake or coastline. These birds feed on shorebirds, ducks and songbirds. Peregrines have been seen in the Klickitat drainage, near the Klickitat fish hatchery (D. Anderson, WDFW, personal communication).

Mardon skipper (*Polites mardon*)

The mardon skipper is a small butterfly that is listed by the state of Washington as endangered. It occurs in only four small and geographically disjunct locations in Washington, Oregon, and California. Only 9 of 18 historic sites in Washington are still known to be occupied, and 6 of those sites are in the Klickitat subbasin. The Washington population of mardons is believed to consist of only a few hundred individuals in these 9 isolated locations.

Within the subbasin, mardons have been found in open, fescue grasslands within ponderosa pine savanna/woodlands. Size of the openings varies and can be as small as 1/2 acre. Elevations at which mardons have been found in the southern Cascades range from 1,900 to 5,100 feet. Sites with mardons have ranged from meadows associated with wetlands/ riparian areas to dry, open ridgetops. Idaho and red fescues are important for egg-laying and feeding by larvae (Potter et al. 1999).

Beaver (*Castor canadensis*)

Beaver provide many functional benefits to the ecosystems in which they are (or were) found. Beaver ponds provide rearing and over-wintering habitat for salmon, catch and store sediment, store water that enhances summer flows, enhance nutrient enrichment and primary and secondary stream productivity, and enhance the area and productivity of riparian habitats, among other benefits (Cederholm et al. 2000).

Although beaver are occasionally found in the Klickitat subbasin, their numbers and ecological influence are greatly reduced in comparison to historic levels.

Bighorn Sheep (*Ovis canadensis californiana*)

Bighorn sheep are extirpated from the Klickitat subbasin. The species type for the area was *Ovis canadensis californiana* (Monson and Sumner 1990). Bighorn sheep inhabit open canyonlands that provide steep, rough escape cover. In 1998, Champion International Timberlands attempted to re-introduce bighorn sheep to their lands in the subbasin by turning out 8 sheep (3 rams, 5 ewes). No subsequent releases were conducted and the re-introduction attempt failed.

Amphibians

Amphibians are important components in many ecosystems as both aquatic and terrestrial species, and in some systems comprise a major component of vertebrate biomass. For instance,

tailed frog tadpoles constitute 90% of herbivore biomass in some small streams (Hawkins et al. 1988). Their predators include fish species such as cutthroat trout (Daugherty and Sheldon 1982). Additionally, amphibians can serve the function of biological indicators of ecosystem health (Blaustein et al. 1995). Tailed frogs may be particularly valuable as independent indicators of habitat quality for fish as well as amphibians, as they have the lowest thermal tolerance of North American frogs (Washington State Gap Analysis: http://salmo.cqs.washington.edu/~wagap/herps), and are very sensitive to sedimentation. However, little is known of the distribution, abundance and life histories of amphibians in the Klickitat subbasin.

Bats

Although it is speculated that relationships between bats and salmon may exist, it is unclear at this time what those relationships may be (Cederholm et al. 2000). However, bats depend on many of the same resources, being exclusively insectivorous in this region. At this time, little is known of the distribution, abundance and life histories of bats in the Klickitat subbasin.

Habitat Areas and Quality

Fish Habitat Quality

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 Klicktiat 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 basin tributaries historically provided the majority of wild steelhead spawning and rearing habitat. The habitat within these tributaries has been severely degraded. For example, 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 in the Little Klickitat. Adjacent tributaries in the lower basin 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. Loss of the ability to attenuate higher flows has resulted in higher peaks and more extreme runoff events. Though no data exist, subbasin planners believe that local hydrology has been altered, generating a “flashier” hydrograph with higher peaks and lower base flows. Extreme events are more likely to scour spawning gravels and reduce bank storage that would have been available to ameliorate low flows.

The upper two-thirds of the Klickitat subbasin is forested, and most of that lies within the Yakama Reservation. On the 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.

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.

Cattle and sheep grazing impacts, while decreasing in recent years, still pose stream morphological, channel stability, and riparian cover problems on a smaller but more concentrated scale. The upper Klickitat River flows through McCormick Meadow in the tribally designated Primitive Area, which has been heavily grazed for many years. 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. In spite of its remoteness, this section of river is now poor habitat for resident or anadromous fish. 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.

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. As discussed earlier, this adversely affects natural production for all species that spawn in the mainstem Klickitat below the Big Muddy confluence.

The East Prong, West Prong, and mainstem Little Klickitat River, as well as Butler Creek, a major tributary the Little Klickitat River, are listed as impaired under section 303d of the Clean Water Act (Brock and Stohr 2000). Eight reaches on these water bodies violate thermal water quality standards. Six other reaches on the Little Klickitat (2) , Blockhouse, Bloodgood, Bowman, and Mill creek are considered impaired due to low instream flow concerns (Brock and Stohr 2000). Temperature conditions in the Little Klickitat are believed to create a thermal barrier that prevents or severely limits use by anadromous stocks, particularly steelhead, in most years (YN, unpublished data).

Mainstem Passage Problems

Lyle Falls

Lyle Falls is a series of five falls ranging in height from 4 to 12 feet, located at RM 2.2. Prior to activities to improve passage, Lyle Falls was considered impassable during low water conditions in the summer and early fall; this effectively prevented fall chinook and coho from utilizing the subbasin. In 1952, Washington Department of Fisheries removed rock and constructed two fishways at the falls, with an off-ladder adult trap constructed at the uppermost fishway. Passage

for spring chinook and steelhead was improved as well. However, these improvements proved inadequate to pass fish and do not meet current fish passage design criteria.

Klickitat Hatchery Weir

Until recently (1996), the Klickitat Hatchery weir was considered an obstruction to adult spring chinook migration. Removal of splashboards, followed by damage to the hatchery weir structure during a 1996 flood, has removed impediments to upstream migration. No evidence of spawning displacement below this structure now exists. However, the 1996 flood damage exposed the main hatchery water line to bedload of the Klickitat River.

Castile Falls

While Castile Falls (RM 64.0) has always presented a serious obstacle to adult upstream migration, historic passage through the falls is known to have occurred. The falls complex is a series of 11 falls with an elevation change of approximately 80 feet over one-half mile. 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 creates a barrier to migration. The 12-foot headworks dam has no fish passage or adequate plunge pools.

Tributary Passage Problems

Culverts

Poor design and maintenance of tribal, private, county, and state road crossings inhibit passage of steelhead and resident salmonids in many tributaries basin-wide.

Wildlife Habitat Quality

The subbasin contains a variety of habitat types, including mixed coniferous, deciduous, grassland/meadow, cliffs/canyons, riparian/wetland, riverine, alpine and agricultural. Habitat quality varies, but many habitats have been lost or degraded by past or present land use activities such as logging, agriculture, road building, hydropower development, invasion of non-native plants, and expansion of human development.

Oregon White Oak Habitat (*Quercus garryana)*

Oregon white oak is Washington's only native oak. Although limited and declining, oaks and their associated floras comprise distinct woodland ecosystems. The various plant communities and stand age mixtures within oak forests provide valuable habitat that contributes to wildlife diversity

statewide. In conjunction with other forest types, oak woodlands provide a mix of feeding, resting, and breeding habitat for many wildlife species. More than 200 vertebrate and a profusion of invertebrate species use Washington's oak woodlands. Some species occur in especially high densities, whereas others are not typically found in Washington.

The Klickitat drainage represents the largest assemblage of white oak habitat remaining in the state of Washington. Oregon white oak is considered a state priority habitat that is determined to be of significance because it is used by an abundance of mammals, birds, reptiles and amphibians. Many invertebrates, including various moths, butterflies, gall wasps and spiders are found exclusively in association with this oak species. Oak/conifer associations provide contiguous aerial pathways for animals such as the state threatened western gray squirrel and they provide important roosting, nesting and feeding habitat for wild turkeys and other birds and mammals. Dead oaks and dead portions of live oaks harbor insect populations and provide nesting cavities. Acorns, oak leaves, fungi and insects provide food. Some birds, such as the Nashville warbler, exhibit unusually high breeding densities in oak. Oaks in Washington may play a critical role in the conservation of neotropical migrant birds that migrate through or nest in Oregon.

Riparian Habitat

The majority of terrestrial vertebrate species use riparian habitat for essential life activities and the density of wildlife in riparian areas is comparatively high to other habitat types. Forested riparian habitat has an abundance of snags and downed logs that are critical to many cavity birds, mammals, reptiles and amphibians. This habitat is often characterized by relatively dense understory and overstory vegetation. Cottonwood, alder and willow are commonly dominant tree species in riparian areas. Riparian habitats are often forested; however they may contain important sub-components such as marshes and ponds that provide critical habitat for a number of species (e.g., Virginia rails, sora rails, marsh wren). Riparian habitats also function as travel corridors between and connectivity to essential habitats (e.g., breeding, feeding, seasonal ranges).

Riparian habitat along the mainstem Columbia was the critical link between drainages for a number of species (i.e., blacktail deer, western gray squirrels, neotropical birds). Creation of the Bonneville pool effectively cut off riparian habitat connectivity that linked riparian to rich upland areas that included mixed conifer and oak. This is evident by species extirpation (yellow-billed cuckoo) and current fragmented populations of threatened and endangered and sensitive species in watersheds along the Columbia River. Other species like the bald eagle were undoubtedly common along the riparian sections of the Columbia River. Although numbers of bald eagles have increased in the Columbia River Gorge in the past 10 years, current numbers are considered a small remnant of past population levels. Inundation of the lower reaches of the subbasin resulted in the loss of riparian habitat, but also in the loss of connectivity provided by that habitat along the Klickitat River to the Columbia River and along the Columbia River to other subbasins.

Late-successional Forest Habitat

Late successional habitats within the subbasin have been degraded by logging practices. Past practices removed important components of older forests, such as large diameter trees, snags, multi-layered canopies and dead, down wood. Components of these habitats are important to the viability of species such as spotted owls, white-headed woodpeckers, black-backed woodpeckers, pileated woodpeckers, and pine marten. Large, intact tracts of closed canopy and late successional forest habitat are in short supply within the basin.

Meadows

Meadow habitats provide for a unique assemblage of plant and wildlife species. Fire suppression has allowed trees to encroach into meadows, resulting in a decrease in size or total loss of meadows. Over-grazing has changed species composition of grasses and herbs, introduced non-native plants that out-compete native vegetation, and reduced species diversity. The construction of roads through meadows has altered water flow patterns, effectively draining them and drastically changing the species composition.

Wetlands

Wetlands provide another unique and important habitat for wildlife and fish. Some species, such as sandhill cranes and spotted frogs, depend on this habitat, while many others use these habitats when available. The reduced number of beaver in the subbasin has 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.

The inundation of wetlands from hydropower development also 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.

Winter range

The Klickitat River drainage is considered entirely within the eastside Cascades province. Winter conditions in this area tend to be colder with more frequent snow accumulation. Loss of big game winter range from hydro inundation has impacted big game herds from historic levels due to loss of low elevation riparian habitat. During years of high snow accumulation (i.e. 1996) deer are frequently seen congregating in the lower elevations adjacent to the Columbia River. Current management of black-tailed deer in the Klickitat drainage is primarily associated with land owned by the WDFW and the YN. WDFW owns approximately 9,000 acres in the drainage and manages their lands as a critical deer winter range. A cooperative study between WDFW and the YN provided important data on deer movement patterns between lands owned by the two (McCorquodale 1998). Future protection of the Klickitat drainage deer herd depends on management and protection of habitat controlled by WDFW and the YN.

Watershed Assessment

The following section describes major plans and projects that guide or affect conditions in the Klickitat Basin.

1990 Subbasin Plan

The Northwest Power Planning Council's (NWPPC) Columbia River Basin Fish and Wildlife Program called for long-term planning for salmon and steelhead production. In 1987, the council directed the region's fish and wildlife agencies and Indian tribes to develop a system-wide plan consisting of 31 integrated subbasin plans for major river drainages in the Columbia Basin. The main goal of this planning process was to develop options or strategies for doubling salmon and steelhead production in the Columbia River. The strategies in the subbasin plans were to follow seven policies listed in the Council's Columbia River Basin Fish and Wildlife Program, as well as several guidelines or policies developed by the basin's fisheries agencies and tribes.

The Klickitat Subbasin Plan was one of the 31 subbasin plans that comprise the system planning effort (Yakama Nation 1990). All 31 subbasin plans were developed under the auspices of the Columbia Basin Fish and Wildlife Authority (CBFWA), with formal public input and involvement from technical groups representative of the various management entities in each subbasin. The basin's agencies and tribes have used these subbasin plans to develop the Integrated System Plan, submitted to the Power Planning Council in late 1990. The System Plan guided the adoption of future salmon and steelhead enhancement projects under the Northwest Power Planning Council's Columbia Basin Fish and Wildlife Program.

In addition to providing the basis for salmon and steelhead production strategies in the System Plan, the subbasin plans attempted to document current and potential production. The plans also summarized the agencies' and tribes' management goals and objectives, documented current management efforts, identified problems and opportunities associated with increasing salmon and steelhead numbers and presented preferred and alternative management strategies.

2000 Tribal Restoration Plan

In early 2000 the Yakama Nation (YN) updated Wy-Kan-Ush-Mi Wa-Kish-Wit (the Tribal Restoration Plan) as part of recommended actions to the Northwest Power Planning Council Fish and Wildlife Program for the Phase I Amendment Process. Recommendations for fish and wildlife resources in the Klickitat basin were submitted as one of nine subbasin plans within the YN “ceded area” (CRITFC 2000).

1999 Little Klickitat Watershed Analysis

Boise Cascade Corporation initiated a Level 2 Watershed Analysis under the Forest Practice Act (WAC 222-22-040(3)) in the upper reaches of the Little Klickitat River located in Klickitat County. The watershed analysis area includes the combined Watershed Administrative Units of Brooks, Butler and East Prong creeks. Watershed analysis is an optional regulatory process for state and private lands in the State of Washington adopted to address the cumulative effects of forest practices on three areas of public resources: fish habitat, water quality and public works (public roads, bridges, hatcheries and other public capital improvements) (Boise Cascade 1999).

1996 Preliminary Design for Passage and Habitat Improvement in the Klickitat River

Intergovernmental agreement DE-B179-92BP99846, Project number 88-120 initiated preliminary design work to gather baseline data on fisheries, habitat and passage information within the Klickitat subbasin. Information from this study has been incorporated into the Yakima Klickitat Fisheries Project (YKFP). Information has been used to populate the Ecosystem Diagnosis and Treatment (EDT) model for both Klickitat spring chinook and steelhead and to develop engineering design plans for passage improvements at Lyle and Castile falls. Preliminary design information will be incorporated into a master plan for the Klickitat basin which will be submitted to BPA in the near future.

1999-2000 Ecosystem Diagnosis and Treatment (EDT) Model

The EDT method is a watershed approach to restoration planning that will be used by YN staff to assist in planning and evaluating existing and future supplementation, land use activities and habitat restoration measures. The EDT model is a component of the EDT method, which is a science-based approach for formulating and analyzing actions to maintain or improve the suitability and production of natural resources like salmonids. (Mobrand Biometrics Inc 1996). In fiscal year 2000, the spring chinook and steelhead EDT computer model will be completed. The model evaluates the quantity and quality of their habitat throughout the basin. Initial computer runs of the model are being conducted at the time of this writing

2000 Washington State Conservation Commission Limiting Factors Analysis

This limiting habitat factors analysis was conducted pursuant to RCW 75.46 (Salmon Recovery). The purpose of this analysis was "to identify the limiting factors for salmonids" where limiting factors are defined as "conditions that limit the ability of habitat to fully sustain populations of salmon." It was intended that a locally based habitat project selection committee use the findings of this analysis to prioritize appropriate projects for funding under the state salmon recovery program. This analysis may also be used by local organizations and individuals interested in habitat restoration to identify such projects (Washington State Conservation Commission 2000).

2000 Little Klickitat River Temperature TMDL Study

The Washington Department of Ecology is currently collecting thermal and habitat data throughout the Little Klickitat Watershed to assess the basin-wide degree of thermal departure from state water quality standards. Analysis will integrate data collected by YN, Klickitat County Conservation District, and the Natural Resources Conservation Service to characterize the spatial distribution of temperature impairments. Non-point areas for temperature increase may be identified and the final report will provide recommendations riparian habitat (i.e., canopy/shade, width/depth ratio, etc).

Limiting Factors

Fish

Spring chinook *(Oncorhynchus tshawytscha)*

Several factors have impacted spring chinook natural production in the Klickitat River. First, hatchery domestication of the stock 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. 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. 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. Secondly, passage "improvements" to the falls in the 1960s inadvertently resulted in decreased passage (see Problems Impacting Fish Resources section). Thirdly, over 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.

Fall chinook *(Oncorhynchus tshawytscha)*

Several factors limit URB fall chinook natural production in the Klickitat River. The most severe constraint to establishment of natural production for URB is natural sediment from the Big Muddy drainage. All URB spawning occurs in the mainstem Klickitat below the Big Muddy confluence. Sediment sampling studies were initiated in 1999 to determine egg-to-fry survival. Study results will indicate the level of production needed to maintain the desired harvest regime. The loss in habitat diversity in portions of the Klickitat mainstem through channelization, wood removal, and riparian degradation further limits the quantity and quality of key habitat for the newly emergent fall chinook. Lack of access to many lower subbasin tributaries limits the amount of rearing habitat. Reduced tributary baseflows have created fall season passage problems at tributary mouths.

Fall (Tule) chinook *(Oncorhynchus tshawytscha)*

Constraints to natural production for tule fall chinook are identical to those discussed for the URB stock.

Summer chinook *(Oncorhynchus tshawytscha)*

Because their spawning distribution and life history pattern are similar to that of fall chinook, it is assumed that constraints to natural production are similar as well.

Coho *(Oncorhynchus kisutch)*

Several factors affect coho natural production in the Klickitat River. Lyle Falls passage has, and to a lesser degree continues to be, a hindrance to coho adult migrants. Suitable rearing habitat for yearling coho is in limited supply below Castile Falls. Fall season (low-flow period) access to

tributary habitat is often blocked in the lower basin by low base flows and thermal barriers. Therefore, coho are relegated to spawning on the margins of the mainstem Klickitat River. Sediment impacts from the Big Muddy System are more pronounced along the margins of the river, thus decreasing incubation survival. Sediment studies have been initiated to determine coho natural production potential in the mainstem Klickitat River.

Steelhead (summer and winter) *(Oncorhynchus mykiss)*

Steelhead have been most affected by habitat degradation because they use all portions of the basin through their life cycles. Many factors have impacted steelhead natural production in the Klickitat River. Hatchery hybridization with Skamania stock has undoubtedly occurred. There is historic evidence for steelhead above Castile Falls. After the 1960s modifications to Castile Falls, anecdotal accounts indicated reduced numbers, which were somewhat confirmed by redd counts in the 1970s. Subbasin planners believe the modifications affected a steelhead's ability to negotiate the falls, particularity at the headworks dam above falls #10. Poor road culvert design and maintenance have also affected natural production by reducing habitat availability throughout the subbasin. Riparian degradation and altered tree species composition, through direct harvest and cattle grazing, have led to decreased habitat complexity and absence of channel forming structures. Field and lab studies (including McNeil and Ahnell 1964, Koski 1966, and Phillips, et al. 1975) have shown that sedimentation (which in this area often comes from improperly designed logging roads) results in adverse effects on fish, including incubation losses, embedded substrate, reduced spawning habitat and lack of interstitial over-wintering and refugia habitats. Elevated stream temperatures are common among lower basin tributaries because of riparian degradation (see "Habitat Areas and Quality" section). Intensive forest harvest and loss of wetland habitat in the headwaters and agriculture development in the middle and lower basin tributaries has resulted in alteration of the historic hydrograph. Tributaries now have a more pronounced peak flow, followed by a reduced summer base flow. Habitat complexity is severely reduced with "spiked" flows of this nature.

Resident Rainbow Trout *(Oncorhynchus mykiss)*

The factors affecting steelhead trout are similar to those affecting rainbow trout. Sediment impacts to tributary spawning rainbow trout are considered more severe than for steelhead because micro-spawning habitat for rainbow trout accumulates more fine sediments. In portions of the basin, hatchery rainbow trout have introgressed with the wild component, leading biologists to assume a reduced population fitness.

Westslope Cutthroat Trout (*Oncorhynchus clarki*)

Habitat degradation in the form of reduced instream flows and elevated temperature has contributed to decline of westslope cutthroats throughout most of the Klickitat subbasin. Based on experience in other areas, reduced channel complexity and upslope activities (e.g., grazing, logging, roads) are likely to have resulted in a "flashier" hydrograph which increases redd scouring potential.

Brook Trout *(Salvelinus fontinalis)*

As an introduced species with no mitigation significance, brook trout are not being considered for protection; therefore, no discussion of limiting factors is warranted.

Pacific lamprey *(Lampetra tridentatus)*

Factors limiting pacific lamprey production are primarily associated with adult and outmigrant passage problems at Bonneville Dam. Based on studies in other areas, biologists consider habitat in the subbasin to be of good quality, as the fine sediments delivered from the Klickitat Glacier provide high quality rearing habitat for ammocoetes (Wydoski and Whitney 1979; Close et al. 1995). Additional research in the basin probably is needed, however.

Bull trout *(Salvelinus confluentus)*

Bull trout are most limited by hybridization with brook trout and general habitat degradation. Broodstock are distributed throughout the upper Klickitat mainstem and tributaries within the West Fork drainage. General habitat fragmentation between the Klickitat and Columbia River, as well as between the tributaries and the Klickitat mainstem, have resulted in geographically isolated bull trout populations (Washington State Commission 2000).

Wildlife

Limiting factors vary for each species of wildlife. However, the degradation and loss of habitat is a common theme for all species. Degradation and loss of habitat has been the result of land use activities such as logging, agriculture, road building, hydropower development, invasion of non-native plants, and expansion of human development.

Sandhill Crane (*Grus canadensis*)

Sandhill 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).

Western Pond Turtle (*Clemmys marmorata)*

The western pond turtle is declining throughout most of its range and is highly vulnerable to extirpation in Washington. Limiting factors are loss of habitat (both aquatic and upland nesting), natural juvenile survival and recruitment, and reproductive and population isolation.

Oregon Spotted Frog (*Rana pretiosa)*

Factors leading to the dramatic decline in spotted frogs across the region are not fully understood, nor are the limiting factors for this subbasin. However, the loss and degradation of wetland habitats and the introduction of bullfrogs (*Rana catasbeiana*) are thought to be major factors (Leonard et al. 1993).

Western Gray Squirrel (*Sciurus griseus*)

Current threats include loss of habitat from logging, residential development, and invasion of the eastern gray squirrel.

Columbian Back-tailed Deer *(Odocoileus hemionus columbianus)*

Protection of key wintering habitat in the lower Klickitat River is important to the providing a stable deer population throughout the drainage. Unlike many western big game populations, much of the winter habitat mosaic is under private ownership with very little summer or winter range provided by federal lands. Research has indicated that low elevation oak woodland and oak/pine mixed forest are important wintering habitats, especially where these cover types occur in a mosaic with openings and topographically diverse terrain with abundant south-facing slopes. Such areas are most commonly found associated with the breaks above the Klickitat River canyon. Key wintering habitats for black-tailed deer are currently under development pressure in Klickitat County. Forest, grasslands and agricultural areas are currently being converted to small-scale residential developments. A large number of developments have occurred within the core winter range for the Klickitat herd since the beginning of the Yakama Nation research effort in 1988. Conservation of key wintering habitats is an essential prescription to the long-term viability of the Klickitat Basin deer herd. Restoration of winter habitat through land acquisition and conservation easements may be particularly important strategies for managing this population so it continues to meet the traditional needs of native peoples and the recreational demands of Washington sport hunters.

Bald Eagle *(Haliaeetus leucocephalus)*

Bald eagles are vulnerable to loss of nesting and winter roost habitat and are sensitive to human disturbance from residential development and timber harvest along shorelines.

Riparian Avian Guild

Loss of riparian and riparian-marsh habitat for these birds resulted from the inundation and alteration of habitats in the Klickitat River subbasin and in the mainstem of the Columbia River. Thus, limiting factors within the subbasin are the degradation and loss of riparian-marsh habitat.

Northern Spotted Owl (*Strix occidentalis caurina*)

Within the Klickitat Basin, most spotted owl sites occur on tribally owned lands on the Yakama Reservation, with some additional sites occurring on state and private lands. Under Washington State's Department of Natural Resources' Habitat Conservation Plan (WDNR 1997), nesting, roosting, and foraging habitat for spotted owls will continue to decline on state lands. A draft Habitat Conservation Plan by Champion Pacific Timberlands Inc. would allow additional losses of spotted owl habitat on Champion's inholdings on the Yakama Reservation. Timber harvests by the Bureau of Indian Affairs and Yakama Nation on tribally owned lands implement some light harvest restrictions around occupied spotted owl sites. However, timber harvests are generally designed to produce a more open, pine-dominated state, in contrast to the dense fir that

developed over much of the forest due to fire exclusion. These harvests have reduced the amount of spotted owl habitat within the west-central Klickitat subbasin in recent years. Increased fragmentation of habitat is particularly detrimental to juvenile spotted owls, which suffer high mortality rates from starvation and avian predators when dispersing. Also, barred owls are increasingly common on the Yakama Reservation, and have been detected at some sites concurrently or previously occupied by spotted owls.

Canada Lynx (*Lynx canadensis*)

Lynx trapping is no longer permitted in Washington state, and little direct lynx mortality results from trapping and hunting targeted at other species. Lynx recovery is now limited by natural and human-influenced restrictions in habitat distribution (the latter including habitat alteration by pre-commercial tree thinning, commercial timber harvest, and fire exclusion), and competition with coyotes and other predators. Coyotes were once rare in Washington, but their populations exploded once wolves were extirpated (Stinson 2000). Humans also influence this balance between lynx and their competitors by building roads and openings. In winter, these openings allow snow to crust over, and snowmobiles cause further compaction, thus allowing lynx competitors to access lynx habitat (Ruediger 1999). Lynx are highly dependent on snowshoe hares, and fluctuations in populations of this primary prey species (due to natural cycling or habitat alteration) also limit lynx populations.

Peregrine falcon (*Falco pererinus*)

Studies of abundance, density and life history of peregrine falcons have not been conducted in this subbasin. Thus, factors limiting peregrine populations are not yet known. The lack of wetland habitats to provide prey species for peregrines is a potential factor.

Mardon skipper (*Polites mardon*)

Limiting factors for mardon skippers are the loss and degradation of habitat and poor dispersal /geographic isolation. The major causes of habitat degradation/ loss are development, grazing, agriculture, invasion of habitats by non-native plants, natural succession of meadows to shrubland/forest and the use of herbicides. An additional concern for this subbasin has been the use of chemical and biological insecticides, particularly in relation to its use for control of spruce budworm (Potter et al. 1999).

Beaver (*Castor canadensis)*

Although no studies of beaver have been conducted in the subbasin, the likely limiting factors are the degradation of beaver habitat and past trapping. Trapping removed beavers from the subbasin, resulting in the alteration of their riparian/ wetland habitats. 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.

Bighorn sheep (*Ovis canadensis californiana*)

No studies of limiting factors have been conducted for bighorn sheep in the subbasin. Limiting factors are expected to be the lack of large expanses of secure, suitable habitat and connectivity to other sub-populations. Fragmentation of suitable habitats by development, placement of roads within key habitats such as escape cover, grazing competition from domestic livestock, and potential exposure by livestock to lethal disease vectors such as blue tongue, are all factors likely contributing to the lack of success of bighorn populations in the subbasin.

Amphibians

Studies of abundance, density and life history of amphibian species have not been conducted in this subbasin. Thus, factors limiting their populations are not yet known. The loss and degradation of riparian and wetland habitats from such factors as development, road density and conditions, over-grazing, agricultural practices, and logging are expected to contribute to limiting amphibian populations.

Bats

Studies of abundance, density and life history of bat species have not been conducted in this subbasin, so factors limiting bat populations are not yet known. Contributing factors may the loss of and degradation of habitats and habitat components such as riparian/ wetland habitats and snags for roosting, and the reduction of prey species from such factors as use of insecticides.

Artificial Production

The Klickitat Hatchery, completed in 1952, 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 of the wild Klickitat spring chinook stock began with broodstock collected at Lyle Falls in 1952. Currently, broodstock are collected through a volunteer trap fed by hatchery spring water. The hatchery's current spring chinook program calls for the on-station release of 600,000 smolts at 7 fish per pound. Generally, 200,000 fry, as a thinning release, are available for outplanting in the upper Klickitat subbasin. Smolts are released in mid-March to correspond with Spring Creek National Fish hatchery releases and a period of high spill over Bonneville Dam.

Four million eyed eggs of fall “upriver bright” (URB) chinook stock are delivered to the Klickitat Hatchery for final rearing from Priest and Lyons Ferry hatcheries for an 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 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. The late-run coho also provide for a late fall terminal fishery, as part of the *U.S. v. Oregon* Columbia River Fish Management Plan (CTWSR et al. 1988).

Annually, 120,000 Skamania steelhead smolts are released directly into the lower Klickitat at several locations downstream of the Klickitat Hatchery.

The Hatchery and Genetics Management Plans (HGMPs) for the Klickitat Hatchery's spring chinook, fall chinook, and coho production programs are included in Appendices 1, 2, and 3, respectively. (Note: A draft version of the HGMP Template was used for these documents.)

Existing and Past Efforts

Yakima/Klickitat Fisheries Project (YKFP)

The YKFP, an element of the NWPPC Fish and Wildlife Program, will be the main production program measure in the Klickitat River. The project co-managers, WDFW and the Yakama Nation (as lead agency), have proposed to supplement all of the stocks of anadromous salmonids (spring chinook and steelhead) historically present in the Klickitat River, with continued production for harvest of fall chinook and coho. YKFP activities will be phased over a number of years. The YKFP has initiated use of the EDT model as the primary tool to guide future supplementation efforts in the basin.

Ecosystem Diagnosis and Treatment

Using EDT, a draft stream reach analysis has been completed for both spring chinook and steelhead in the Klickitat basin. Supplementation scenarios will be developed using EDT to establish and refine release numbers, locations, timing and acclimation site placement, and to achieve desired subbasin escapement goals.

Klickitat Hatchery Operation

Klickitat Hatchery has been producing fish since 1952. Details of fish production at this facility are found in the Artificial Production section of this document.

Klickitat Hatchery Transition

To facilitate implementation of YKFP supplementation principles in the Klickitat basin, conversion of the existing hatchery into a supplementation style facility is required. The rationale and logistics of this transition are outlined in "Klickitat Hatchery Facility Management Plan" (Oshie and Ferguson 1998.) Yakama Nation and WDFW are currently in negotiations to facilitate transfer to Yakama Nation.

Lyle Falls Engineering Design Work

In 1952, Washington Department of Fisheries removed rock and constructed two fishways at Lyle Falls, with an off-ladder adult trap constructed at the uppermost fishway. This design proved inadequate to pass fish and does not meet current fish passage design criteria. In addition, the ladder has not been well-maintained over past years. To remedy the problems, BPA has funded engineering design and hydraulic studies at the facility, which currently are 33% complete. The objective of the facility is threefold:

- To carry out YKFP supplementation principles by construction of an adult broodstock collection facility, allowing for collection over the course of the run to maintain genetic viability. This will also allow for the potential creation of locally adapted broodstock from production stocks (coho, fall chinook), thus minimizing straying to other basins.
- To pass adult fish over a wide range of flows and makes passage more efficient for all other stocks of salmonids by development of a fishway.
- To enable the evaluation of supplementation activities through escapement monitoring by construction of a video counting station. Video monitoring will also provide run-timing information to be used by species modelers to guide future supplementation activities under the YKFP, as well as to determine the presence/absence of an adfluvial bull trout population.

Castile Falls Fishway Improvement

In 1999, the YN was awarded funds to improve passage at the facility. The three-year project will focus on the upper ladder first, then progress downriver. The objective is to increase passage over Castile Falls to make available approximately 35 miles of spawning and rearing habitat for spring chinook and approximately 45 miles for steelhead.

The existing conditions at both Castile Falls and Lyle Falls are described in detail in Adult Passage Improvements for Klickitat River at Lyle and Castile Falls 1996, prepared by Summit Technology.

Coho Acclimation Site Development

In 1999, the YN was awarded funds to repair and construct coho acclimation sites in the Klicktiat subbasin over the next three years. In 2000, approximately 24% (600,000) of the 2.5 million direct-river-released coho were reared at three acclimation sites. Additional sites will be developed in order to acclimate the bulk of the 2.5 million coho. Successful acclimation will provide better survival and return rates, providing increased harvest and natural production opportunities. Acclimation sites are being located and constructed to facilitate multi-species usage. Transferring both production and supplemented stocks off-station from the Klicktiat Hatchery will be critical in implementing YKFP principles in a water-limited facility without reducing production levels.

Tribal Harvest

The dip net fishery in the Lyle Falls reach of the Klickitat River has been an important fishery to Indian people since before the arrival of the first white settlers. With the drowning of Celilo Falls, it holds special significance as the one remaining site where Yakama fishers have the opportunity to fish year around using traditional dipnet and jumpnet gears. The Klickitat River is also one of

the last Columbia River subbasins that still have a natural run of summer chinook, and tribal fishers prize these fish, known as "June hogs." This fishery continues to play an important role in meeting the subsistence needs of Yakama Indians, in providing income from fish sales during commercial seasons, and in fulfilling the treaty share of tributary spring chinook harvest in the Columbia Basin. The Klickitat provides one of the few opportunities for spring chinook harvest by tribal members while other Columbia Basin spring chinook stocks remain at low levels of abundance. Enhancement objectives take into account the need for a significant harvest of spring chinook concurrently with efforts to rebuild the run.

The *U.S. v. Oregon* Columbia River Fish Management Plan recognized the importance of tribal harvest in the Klickitat River by mandating releases of 4.0 million fall chinook and 3.85-million coho in the river annually since 1988. With these releases, sales of fall chinook and coho have provided a steady contribution to tribal commercial fall season fisheries, with sales to licensed commercial fish buyers averaging nearly 1,500 fall chinook and 2,000 coho annually since 1989 (Table 2). In addition to this harvest, Yakama Nation fisheries staff estimate that another 1,000 to 3,000 chinook, 500 to 2,500 coho, and 200 to 500 steelhead are harvested annually by tribal fishers and either sold directly to the public or taken home for subsistence use.

Table 2. Commercial Sales of Chinook, Coho, and Steelhead to Licensed Fish Buyers by Yakama Tribal Fishers, 1989 to 1999

Year	Chinook	Coho (Silver)	Steelhead
1989	1,573	5,893	247
1990	1,764	1,894	310
1991	2,230	6,037	1,704
1992	786	46	287
1993	541	165	682
1994	1,018	1,922	747
1995	460	1,250	27
1996	1,533	490	25
1997	1,602	282	239
1998	2,261	1,708	162
1999	1,367	1,946	59
Averages			
1989-99	1,376	1,967	408
1995-99	1,445	1,135	102

Lower Klickitat In-Channel and Riparian Enhancement Project

The Lower Klickitat Riparian and In-Channel Habitat Enhancement Project is a BPA-funded watershed restoration project implemented by the Yakama Nation Fisheries Program (YNFP). The YNFP is working in coordination with WDFW, Natural Resources Conservation Service (NRCS), and the Central Klickitat Conservation District. The project was proposed under the

Northwest Power Planning Council's Fish and Wildlife Program and funded by BPA in 1997. Initial project restoration projects were located within the Swale Creek and Little Klickitat River watersheds. Included in the project scope of work are 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. A monitoring program has been initiated to document project success and guide future restoration activities. The second phase of the project will use EDT modeling output to guide and prioritization restoration activities.

Salmon Recovery Funding Board (SRFB) Projects

Klickitat County, with technical support from the YN, WDFW and NRCS, has been awarded SRFB funds:

- to modify 3/4 mile of abandoned Klickitat Mill concrete flume on Snyder Creek (RM 14) opening 2.0 miles of high quality steelhead habitat,
- for streambank bioengineering of over 3,000 feet at 2 sites in the Little Klickitat basin,
- to construct low flow access to Logging Camp Creek (RM 8.5), providing access to steelhead,
- to construct five sediment retention ponds to provide baseflow amelioration in the Swale Creek basin and
- to complete project maintenance of existing and future SRFB and BPA habitat restoration projects.

The Yakama Nation has been awarded three SRFB habitat restoration grants. Fieldwork will begin during the 2000-01 field seasons on the following projects:

- Klickitat River Meadows Restoration Project. The project will begin to repair 60 years of intensive livestock grazing in a series of wet meadows and will focus on livestock fencing, road abandonment/relocation and wet meadow restoration
- Diamond Fork Meadows Restoration Project will begin to repair and control over 60 years of ongoing livestock grazing in a series of wet meadows and will focus on road abandonment, livestock fencing (WDNR current sheep allotment) and wet meadow restoration
- Surveyors Creek Passage Improvement Project will install two bottomless culverts. These passage problems are a result of poor forestry and roading practices.

Bull Trout Study

In the 1995 Amendment to the 1994 Columbia River Basin Fish and Wildlife Program (10.5A.6), the Northwest Power Planning Council recognized the importance of studying bull trout in the Klickitat system with particular attention to determining presence and abundance of juveniles and adults, comparing genetic makeup with other regional stocks, determining available habitat and limiting factors and developing a management plan. In 2000, the YN, in conjunction with the WDFW, will conduct a cooperative study investigating the Klickitat River bull trout population(s). Field studies will determine stock(s) status and life history patterns present, through

presence/absence investigations, population estimates, habitat analysis and genetic DNA analysis. The Northern Pikeminnow Management Program Project #9007700 has documented three incidental bull trout recoveries at the river mouth. Nez Perce and Yakama crews have also agreed to tag bull trout intercepted in their pikeminnow netting operations. ODFW has agreed to monitor fish recovered at Powerdale Dam on the Hood River for the presence of Washington tagged bull trout and to collect genetic tissue samples. This complements studies of bull trout genetics and habitat needs in Central and North East Oregon Project #9405400 and the Bull Trout Assessment Willamette/McKenzie Study 945300.

On-Reservation Forestry Fish Program

The Yakama Nation uses its own treasury funds to hire a full-time fisheries biologist and technicians to investigate the status of fish populations and habitat in the forested area of the Yakama Reservation and to condition proposed timber sales for the protection of tribal fisheries resources.

Grazing Management

A 1995 YN grazing resolution called for the elimination of livestock grazing on the west bank of the Klickitat River and above the Diamond Fork confluence. Compliance with this resolution needs improvement.

Sheep grazing on Washington State Department of Natural Resources (WDNR) allotment within Tract "C" of the reservation threatens the headwaters of Diamond Fork Creek. Poor compliance monitoring by WDNR under HB1309 standards has led to a degraded riparian and degraded wet meadow system.

Existing and past efforts for wildlife include the following:

Black-tailed Deer

During 1988-94, an intensive research effort conducted by the Yakama Nation focused on movement patterns, habitat use and demographics in the Klickitat Basin deer herd. In recent years, the population has been shown to be highly susceptible to dramatic winterkills during severe winters due to the relative scarcity of quality winter range (much of the historical winter range is now under agricultural or rural development). Productivity of the herd is good and deer numbers typically rebound relatively quickly from massive winterkills when a series of mild winters occur in succession. Most hunting mortality in the herd is associated with nontribal harvest following fall migration of deer from reservation summer range to off-reservation winter range (McCorquodale 1999). The Yakama Nation and WDFW have continued census efforts of this population to the present.

Rocky Mountain Elk

Since 1994, the Yakama Nation has been conducting an intensive research effort focused on movement patterns, habitat use and survival of elk that winter in the Yakima subbasin and migrate primarily to the northern portions of the Klickitat subbasin during the summer.

Black Bear

Since 1996, the Yakama Nation has been conducting an intensive research effort focused on movement patterns, habitat use and survival of black bear. This study is being conducted in the Yakima subbasin and the northern portions of the Klickitat subbasin.

Northern Spotted Owl

Since 1991, the Yakama Nation has been conducting a spotted owl inventory and monitoring project. This study continues to provide information on spotted owl distribution, habitat characteristics, dispersal patterns, and population trends on the Yakama Reservation portion of the Klickitat subbasin.

Bighorn Sheep

In 1998, Champion International Timberlands attempted to re-introduce bighorn sheep to their lands in the subbasin by turning out 8 sheep (3 rams, 5 ewes). No subsequent releases were conducted and the re-introduction attempt failed.

Neo-tropical Migratory Birds

WDFW conducted a study aimed at evaluating neo-tropical bird use of oak and oak-conifer habitats within the drainage. The study identified the value of oak and oak conifer habitat to neo-tropical bird populations.

Western Gray Squirrel

WDFW has been conducting western gray squirrel surveys in the lower drainage of the subbasin. This effort has provided WDFW with important data on distribution and abundance of this species in the Klickitat drainage. Additionally, WDFW and the University of Washington have been cooperating to conduct a research project on western gray squirrels. The results of this work are expected to yield critical ecological information on western gray squirrel use of habitat in Klickitat drainage.

Bald Eagle

The US Forest Service and WDFW have conducted a habitat evaluation of bald eagle habitat. This project provided information on potential locations of winter bald eagle foraging and roosting habitat.

Spotted Frog

The USFWS has been conducting spotted frog surveys and habitat evaluations on the Conboy National Wildlife Refuge. The information that has been obtained has assisted in developing a plan for water management to benefit spotted frog habitat needs.

Sandhill Crane

The USFWS, WDFW and YN have been conducting yearly surveys of potential crane habitat to obtain information on nesting status of cranes on federal, private and YN lands.

Road Management Programs

Within the forested area of the Yakama Reservation, roads are closed to vehicular traffic after completion of timber sales. The goal of the current YN Forest Management Plan is to reduce open road density to 2-3 miles/section.

WDFW has worked cooperatively with Champion International Timberlands and Boise Cascade to prohibit vehicular use of roads within tracts of land owned by these two timber companies. This effort is aimed at providing security for big game.

Klickitat Wildlife Area

The acquisition of Klickitat Wildlife Area by WDFW has benefited a variety of priority species and habitats in the drainage.

Subbasin Management

The following two subsections outline goals, objectives, strategies, and needs for the Klickitat Basin. These constitute the subbasin planners' recommendations for actions that would help improve ecological conditions in the basin. While the individual projects proposed may in some cases be targeted for specific species (e.g., fish passage improvements to benefit spring chinook and steelhead supplementation), most will benefit other species as well (e.g., passage improvements at Lyle Falls are expected to improve fall chinook dispersal into appropriate habitat). As well, many of the strategies and actions outlined under Goal C below, such as improvements in riparian areas, are expected to benefit most anadromous and resident fish, as well as a variety of wildlife species.

The final section of this document outlines current and future monitoring and evaluation programs and needs.

Goals and Objectives

The following section summarizes the goals and objectives for the Klickitat Basin. It is followed by a section that elaborates on strategies and actions needed to implement the goals and objectives.

Overall Subbasin Goal: Protect, Restore and Enhance Fish and Wildlife Species and habitats.

A. Goal: Increase information base necessary to manage fish, wildlife and habitats.

Objectives:

1. Compile and analyze existing data on species distribution and habitat requirements, and identify critical habitat areas.
2. Complete inventory of fish and wildlife habitat baseline (basin-wide).
3. Assess population status, habitat relationships and geographic distribution of species about which little is known.
4. Develop management alternatives based on initial assessments.
5. Implement management alternatives and monitor fish and wildlife populations and responses to management actions.
6. Adjust management actions according to monitoring and evaluations results.

B. Goal: Ensure the exercise of tribal fishing rights and non-tribal fishing opportunities.

Objectives:

1. Establish upward trends in naturally sustaining fish populations.
2. Restore abundance and distribution of fish and other aquatic species across their native ranges.
3. Maintain and enhance the existing terminal fishery for coho and fall chinook.
4. Conserve genetic diversity and allow natural patterns of genetic change to persist.
5. Coordinate fisheries management plans with all other applicable basin-wide management plans.
6. Establish a comprehensive harvest monitoring plan.
7. Increase natural production by improving passage to the upper basin and tributaries.

C. Goal: Restore watershed function, water quality and habitats.

Objectives:

1. Identify proper functioning conditions for fish and wildlife habitats.
2. Prioritize habitats for protection and restoration for salmonids and other aquatic species.
3. Prioritize habitats for protection and restoration for wildlife species.
4. Prioritize areas for protection and restoration of cultural resources.
5. Permanently protect and maintain priority natural and cultural resources.
6. Improve water quality and quantity in prioritized reaches to comply with regulatory standards.
7. Monitor restoration and protection activities and evaluate effectiveness to guide adaptive management.

Strategies and Needs

In this section, subbasin planners recommend specific strategies and actions needed to implement the subbasin goals and objectives outlined in the previous section.

A. Goal: Increase information base necessary to manage fish, wildlife and habitats.

Strategy: Compile existing information and conduct distribution, abundance and habitat relationship studies for fish and wildlife species where data gaps are identified.

1. Conduct literature reviews and contact species experts.
2. Conduct presence/ absence surveys for appropriate species.
3. Conduct distribution, abundance, and habitat relationship studies for appropriate species.
4. Determine distribution and abundance of fish and wildlife habitats.
5. Conduct life history and reproductive fitness studies for appropriate species.
6. Monitor population trends for appropriate species.

Strategy: Develop and implement alternatives for the adaptive management, monitoring and evaluation of fish and wildlife populations.

1. Determine limiting factors and direct management activities to address those factors.
2. Refine and validate modeling tools.

B. Goal: Ensure the exercise of tribal fishing rights and non-tribal fishing opportunities.

Strategy: Institute a supplementation-based production program for spring chinook and steelhead that includes retrofitting the existing Klickitat Hatchery.

The rationale and logistics of this transition are outlined in the "Klickitat Hatchery Facility Management Plan" (Oshie and Ferguson 1998 [Appendix 4]). Yakama Nation and WDFW are currently discussing the transfer of the Klickitat Hatchery to the Yakama Nation and YKFP operation. Any transfer of the facility will be consistent with the existing MOU between the Yakama Nation and WDFW regarding management of the YKFP.

1. Construct broodstock collection facility in the lower Klickitat subbasin (Lyle Falls), in order to preserve genetic integrity for supplemented stocks.

Justification: In 1952, Washington Department of Fisheries removed rock and constructed two fishways at Lyle Falls, with an off-ladder adult trap constructed at the uppermost fishway. This design proved inadequate to pass fish and does not meet current fish passage design criteria.

2. Develop and implement an annual operating plan (AOP), which incorporates YKFP supplementation principles.

3. Develop new water sources at the Klickitat Hatchery and off-station acclimation sites to improve rearing conditions and to increase hatchery production.

Justification: Development of these sites will free up the hatchery water dedicated to coho and fall chinook to rear additional spring chinook and steelhead, while still maintaining the existing level of coho and fall chinook production in the basin. Acclimation facilities will be located in natural production areas for supplemented spring chinook and steelhead, as in the Yakima basin. Acclimation sites will be developed in the lower basin for production stocks of fall chinook and coho. Existing programs for coho and fall chinook will continue to emphasize production for harvest.

4. Develop and implement a disease control program.

5. Construct new personnel housing and support facilities for the Klickitat Hatchery.

Justification: Existing housing at the facility does not provide housing for all hatchery employees. A new hazardous material building is required to comply with applicable regulations.

6. Design and construct on/off-station acclimation sites throughout the basin.

Justification: On/off-station acclimation sites for steelhead and spring chinook are needed to facilitate natural production throughout their native range in the basin.

7. Design M&E plan for monitoring facility effectiveness.

Strategy: Provide harvest opportunities for tribal and non-tribal fishers.

1. Design and develop acclimation facilities for coho and fall chinook.
2. Develop release strategies that optimize survival of coho and fall chinook.
3. Develop and implement a disease control program.
4. Design and implement a comprehensive harvest monitoring program.
5. Use adaptive management to refine release numbers based on survival and harvest needs.

C. Goal: Restore watershed function, water quality and habitats.

Strategy: Conduct basin-wide assessment, prioritization, restoration, and protection of fish and wildlife habitat conditions that includes identification and mitigation of in-channel, riparian, and upland source areas for limiting habitat conditions. **Restore a proper functioning condition for all biotic and abiotic ecological parameters** in the Klickitat subbasin.[1]

1. Incorporate existing habitat, land-use, and ownership data into a Geographic Information System to improve efficiency and facilitate landscape-scale decision-making.

2. Prioritize reaches and upland habitats at the landscape level using GIS, Ecosystem Diagnosis and Treatment (EDT) model or other appropriate tools.

3. Restore reaches and habitats determined to be limiting fish and wildlife populations or otherwise contributing to watershed degradation.
   - Initiate studies to locate and design specific restoration actions (i.e. in-channel structures, rearing alcoves, side channels).
   - Restore floodplain connectivity by installing culverts, breaching and/or relocation of levees, roadways, and other hydraulic blockages.
   - Place in-channel large woody debris (LWD) to enhance rearing habitat in areas where riparian logging or stream-cleaning have occurred.
   - Re-vegetate riparian and wetland habitat to reduce water temperatures and sediment input and to promote ground and stream cover, channel stability, and allocthonous inputs of LWD and Coarse Particulate Organic Matter (CPOM).
   - Manage for greater upland ground cover to promote infiltration and decrease overland flow and sediment transport, which would moderate altered watershed hydrology of many tributaries.
   - Work to provide opportunities for natural physical and biological processes to restore stability and reclaim historic habitat. This may include use of in-channel structures, beaver, native re-vegetation, and/or removal of perturbing influences.
   - Continue funding for the BPA project titled "Lower Klickitat In-Channel and Riparian Enhancement Project," to guide tributary habitat restoration.
   - Abandon and rehabilitate roads that pose passage problems or other watershed hazards.
   - Develop and implement alternatives for the adaptive management, monitoring and evaluation of habitats and watersheds.
   - Enhance conditions for species that perform key ecological functions, such as beaver.

4. Protect reaches and upland parcels in good condition.

[1] Properly functioning condition implies the sustained presence of habitat forming and maintaining processes in a watershed (e.g., normative patterns of riparian succession, bedload transport, channel migration and runoff) such that the long-term survival of the species is ensured over the entire range of natural variation.

- Develop conservation easements or other incentives to encourage landowners to use management practices beneficial to fish and wildlife resources.
- Develop land acquisition strategies based on prioritization process described above.
- Purchase lands with identified key "refugia" reaches including floodplain and side channel habitat.
- Establish and maintain adequate funding for operation and maintenance of habitat acquisitions and restoration projects.

Strategy: Reduce and prevent future anthropogenic impacts from riparian and wetland development, roads, abandoned railroads, agriculture, and forestry.

1. Improve basin-wide road management.
   - Develop binding criteria for new road construction including: location outside of riparian management zones, preferably near ridges, and maintenance and abandonment requirements.
   - Where roads must be kept in the floodplain, improvements such as rocking, paving, and bioengineering of stream banks should be conducted that will minimize sediment delivery to streams.
   - Make the abandonment of logging roads a condition of timber sales, except when explicitly needed for fire control, forest management, or other long-term purposes.
   - Fund monitoring and assessment of forest practices and roads effects on fish and wildlife habitats and stream function throughout the subbasin.
2. Identify and map geologic hazards and incorporate into land-use planning and management.
   - Restrict harvest in identified hazardous areas.
   - Route logging and access roads away from areas of landslide risk.

3. Enforce and monitor compliance of all forest practice activities with Tribal, Federal and State forest practices regulations.
   - Limit road construction in sensitive habitats and unstable or slide-prone areas.
   - Maintain adequate riparian buffers along all streams to provide proper functioning conditions for aquatic and riparian resources.
   - Maintain adequate densities and numbers of large trees, snags, and dead, down wood.
   - Ensure protection of sensitive special habitats (e.g. meadows, caves, wetlands) as per regulations

4. Work cooperatively with landowners and agencies to improve livestock management and eliminate streamside grazing effects.
   - Fence riparian areas and wetlands as distinct units from adjacent uplands
   - Provide off-site water or water-gaps
   - Encourage salting practices to improve livestock distribution

- Where possible, exclude livestock grazing pressure from riparian areas

5. Fund development and compliance monitoring and enforcement of applicable laws governing development and use of critical habitat
   - Promote adoption of an effective county Critical Areas Ordinance that does not permit development within active floodplains.
   - Improve compliance with Clean Water Act and Water Quality Standards for Surface Waters of the State of Washington including mitigation requirements for wetland development and point- and non-point source pollution.

6. Encourage modifications of agricultural use of riparian areas, wetlands, and adjacent uplands to reduce overland runoff, minimize sedimentation, and maximize stream cover.
   - Recruit and pursue landowner enrollment in programs such as the Conservation Reserve (CRP) and Wetland Reserve (WRP) programs
   - Support implementation of no-till farming practices.

7. Implement a broad educational effort to inform agricultural, timber, and development interests about regulations and cost-share opportunities to reduce adverse watershed effects.

Strategy: Integrate conservation law enforcement protection into fish, wildlife and habitat management.

1. Identify and enforce laws and rules pertaining to fish passage, riparian habitat, and water quality protection. Provide information on enforcement actions to the system-wide conservation enforcement monitoring and evaluation project.

2. Identify and enforce laws and rules pertaining to exotic fish transfers.

3. Identify violations of laws and rules pertaining to habitat protection and provide information to appropriate state, federal or tribal law enforcement entity.

4. Increase enforcement of laws and fishing regulations pertaining to illegal take of fish (all life stages).

5. Continue enforcement of wildlife laws and regulations affecting wildlife species and habitat.

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.

Fisheries

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 enhacement. 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

I. 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.

II. 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.

Table 3. Components of Recruitment Rates R_{ww}, R_{hw}, and R_{wh} considered in the spring chinook monitoring plan
Adult Performance--Reproductive Success
Demographic Factors
Sex ratio
Fecundity
Pre-spawning survival
Maturation schedule
Gamete viability
Egg-smolt survival
Behavioral Factors
Migration and spawning timing
Straying
Nest Site selection/habitat utilization
Juvenile Performance--Survival
Survival Rates
Egg-smolt survival
Smolt-adult survival
Winter migrant survival rates

Natural Production Monitoring

I. Intrinsic Factors Affecting Natural Production[2]

A. Hatchery Fish Quality

1. Survival of released smolts

a. *Hatchery smolts/spawner* as fish leave acclimation ponds, as well as natural smolts/spawner
b. *Relative hatchery/wild smolt-adult survival rates*
c. *Comparative hatchery/wild smolt behavior - gross level* (e.g., migration rate and timing)
d. *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)
e. *Relative hatchery/wild precocialism rates* (e.g., number of precocials on redds)
f. *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

2. Reproductive Success of Hatchery Fish

a. 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)
b. 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

B. Long-Term Fitness of Supplemented Population

1. Determine domesticating effect of hatchery environment on the Klickitat stock.

[2] Intrinsic factors are those factors, such as broodstock collection, over which the fish manager has some control.

C. Facility Performance

1. Monitor operations at hatchery, acclimation ponds, monitoring facilities to insure compliance with biological specifications.
2. Develop a Facility Quality Control Plan for the Klickitat Hatchery

II. Extrinsic Factors Affecting Natural Production[3]

A. 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.

B. Harvest

1. Columbia River Fisheries
   a. Total harvest in lower Columbia gill-net fishery of wild and hatchery spring chinook and steelhead.
   b. Total harvest of hatchery and wild spring chinook and steelhead in Zone 6 commercial and sport fishery.

2. Klickitat Basin Fisheries

   a. Determine total terminal harvest in tribal and sport fisheries of basin wild and hatchery spring chinook and steelhead.
   b. Determine incidental harvest of steelhead during fall terminal fisheries for fall chinook and coho.

[3] 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.

Genetics Monitoring

I. Genetic Health of the Klickitat Spring Chinook and Steelhead Stocks

A. 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

B. 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

C. 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

D. Type 4 Risk: Domestication
   1. Selection potentials
      a. Distribution by sex, size, age, and date of capture of prespawning mortality
      b. 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)
      c. Comparison of wild and hatchery juveniles at selected traits that are likely to impose or reflect significant selection pressures (e.g., size, migration timing)
   2. Genetic trend
      a. 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
   3. Direct measurement of genetic change

a. Performance of juveniles generated by test crosses in hatchery (hxh, hxw, wxw) at selected traits[4]

II. Genetic Health of Other Columbia Basin Spring and Snake Basin Spring/Summer Chinook Stocks

A. 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[5]

Ecological Interactions Monitoring

I. Interactions Affecting Supplementation Success

A. Interactions with Strong Interactor Taxa

1. Predators: a predation consumption index will be developed that applies to smolt life stages.

a. Interactions with spring smolts

(1) Fish predators (northern pikeminnow, bass, catfish, trout)

(2) Bird predators (mergansers, herons, gulls, terns, cormorants) below release points during the spring migration time for smolts.

2. Pathogens (viruses, bacteria, fungi, parasites)

a. Occurrence and infection levels (determined by pathological examination) in adult broodstock.

b. Occurrence and infection levels (determined by pathological examination) in spring smolts migrating past the lower Klickitat rotary trapping facility through migration period.

c. Occurrence and infection levels (determined by pathological examination) in hatchery smolts exiting acclimation sites.

d. 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] This monitoring measure would require a relaxation of the long-standing broodstock collection guideline of wild-only broodstock.

[5] 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.

4. Mutualists (beaver, riparian vegetation)
    a. 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)

B. Interactions between hatchery and wild spring chinook
1. Predation
    a. Proportion of hatchery and wild fish smolts in predator stomachs relative to abundance at lower Klickitat rotary trap.
    b. Abundance and distribution of predators in relation to hatchery releases
    c. 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)
    a. 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)
    b. Snorkel observations to determine if wild spring chinook are pulled from feeding stations by migrating hatchery fish

C. 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.

II. Interactions Affecting Stewardship and Utilization Taxa (SUT)

A. Interactions with bull trout
1. Abundance and size structure in index areas
2. Distribution and spatial overlap with Klickitat spring chinook and steelhead

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:

- Water quality: temperature, suspended sediment, and turbidity and chemical pollution/nutrient concentration.
- Habitat accessibility: presence of physical barriers to anadromous salmonids.
- 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").
- Channel condition and dynamics: width-to-depth ratio, streambank stability, floodplain connectivity.
- 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.
- 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:

- Predation, both inter- and intra-specific and hatchery/wild.
- Competition, both inter- and intra-specific (hatchery-wild and between resident and anadromous morphs of the same species, especially *O. mykiss*).
- Pathogens/parasites.
- 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.

Habitat Monitoring and Evaluation Plan

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.

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 (*Sciurus griseus*)

- 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

Columbian Back-tailed Deer

- Acquire critical winter range habitat that connects WDFW Klickitat Wildlife Area with YN

Bald Eagle

- Conduct surveys to identify winter communal roost habitat in drainage
- Develop management plans to protect winter communal roost habitat

Riparian Avian Guild

- Identify priority oak, riparian, and late successional pine forests that provide habitat for avian species currently experiencing declines
- Select key habitats for acquisition and or conservation agreements that protect these species. Reference riparian and eastside Partners in Flight Conservation Plan for priority species and habitat protection. (Altman B. in press).

Peregrine falcon
- Inventory for birds and habitats
- Conduct more assessment of limiting factors

Beaver
- Restore habitat
- Re-introduce beaver

California bighorn sheep
- Assess habitat
- Re-introduce sheep

In addition, inventories, restoration of habitat, and monitoring would be needed for the Mardon skipper, amphibians, and bats.

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