Subbasin Descriptions

Lower Columbia River and Columbia River Estuary Subbasin

Cowlitz River

Lewis River Subbasin

Bonneville Reservoir Subbasin

Wind River Subbasin

Little White Salmon Subbasin

White Salmon Subbasin

Klickitat Subbasin

Subbasin Descriptions

The GPNF and CRGNSA Invasive Plant BA analyzes a large geographic area of over 1.6 million acres. It is bordered on the south by the Columbia River; on the west by the headwaters of the Lewis, North and South Fork Toutle, Cowlitz/Cispus rivers, and the Nisqually River; on the north by Mt. Rainier National Park, and on the east by the Klickitat River. The action area can be broken up into _ general river systems – the Nisqually, the Cowlitz, the Lewis, the lower Columbia River mainstem tributaries below Bonneville Dam, and the lower and mid-Columbia tributaries within the Bonneville pool.

This appendix presents an overview of climatic, geologic and hydrologic conditions so as to set the context for the GPNF and CRGNSA Invasive Plant BA. Much more detailed information for watersheds covered in this Biological Assessment can be found from many sources, including watershed analyses, watershed management plans, and annual agency reports. Between 2000 and 2002, information for each subbasin was comprehensively compiled and summarized for the Northwest Power Planning Council (NWPPC) by various authors and agencies. The information from this chapter are direct excerpts from this summary source as well as a recent Western Washington Watershed Analysis.

Lower Columbia River and Lower Columbia River and Columbia River Estuary Subbasin Summary, 2002, by subbasin team leader Debrah Marriott, Columbia River Estuary Partnership.

Cowlitz River Subbasin Summary, 2002 draft, Wolf Dammers, WA. Department of Fish and Wildlife.

Lewis River

Bonneville Reservoir Subbasin Summary

Wind River Subbasin Summary, 2000 draft, Dan Rawding, WDFW.

Little White Salmon Subbasin Summary, 2000 draft, Dan Rawding, WDFW.

White Salmon

Klickitat

2002 Western Washington Columbia River Tributaries Watershed Analysis

The original documents, authors and cites can be accessed by the web links as provided below:

http://www.cbfwa.org/province.htm

http://www.fs.fed.us/r6/columbia/

Lower Columbia River Subbasin Description

This summary of information covers the Lower Columbia River—Bonneville Dam to RM 34 near Skamokawa, including descriptive information about the mainstem of the Columbia River and the tidally influenced sections of its tributaries.

Basin summary information covering the larger watersheds within this subbasin, such as the Cowlitz, and Lewis Rivers, are included in subsequent, but separate sections, within this chapter.

The study area (limited to the tidally influenced areas) drains about 4,300 square miles. Adding the tributaries that drain into the study area increases the drainage area more than fourfold—to about 18,000 square miles, or about seven percent of the entire Columbia Basin.

Elevations range from near sea level to 4,000 ft on an extreme east-west gradient. The river is relatively narrow at the Bonneville Dam—as little as 0.2 miles wide directly below the dam. It emerges from the steep-walled Columbia Gorge about 20 miles east of Portland. Below Washougal and Troutdale, the river valley widens to include a broad floodplain. Elongated islands divide the river and form sloughs and side channels in the formerly marshy lowlands. The floodplain expands around the Columbia River's confluence with the Willamette River, where they form the sloughs and lakes of North Portland, Sauvie Island, and the Vancouver lowlands. These regions contain the metropolitan area's last major remnants of the swamp riparian system which were nourished by annual flooding of the free-flowing rivers before dams were constructed.

Downstream from the town of St. Helens, the Columbia cuts through the Coast Range, a passage marked by steep-shouldered bluffs and broad alluvial floodplains. The river channel, dotted with low islands of deposited sediments throughout its lower reaches, opens out as it approaches the Pacific Ocean.

The Columbia River runs a varied course along the 146 river miles from Bonneville Dam (RM 146) to the Pacific Ocean. The Willamette River, by far, is the largest tributary to the lower Columbia River. Other major tributaries originating in the Cascades include the Sandy River in Oregon and the Washougal, Lewis, Kalama and Cowlitz Rivers in Washington. Other numerous minor tributaries drain small watersheds. Flows in the lower Columbia River average 273,000 cubic feet per second (cfs) at the mouth, with a former, unregulated minimum of 79,000 cfs and maximum flood flows of over 1 million cfs. Peak flows occur during winter storm events. Spring freshets, once a major source of flooding, are now controlled by upriver dams and occur for longer periods with a lower peak. Late summer and fall flows are generally higher and slower due to regulation, and river water is a few degrees warmer. The flow of the lower Columbia River is strongly influenced by climatic variations and tides. The tidal influence on water surface elevation is evident all the way to Bonneville Dam. During low-flow periods, tides may cause river flow to reverse up to about RM 80. Tidal salinity extends upstream to approximately RM 23.

The lowest river flows generally occur during September and October, when rainfall and snowmelt runoff are low. The highest flows occur from April to June, resulting from snowmelt runoff from the Cascade and Rocky Mountain ranges to tributaries of the upper Columbia. High flows also occur between November and March, caused by heavy winter precipitation in the tributary basins of the lower river, primarily the Willamette in Oregon and the Cowlitz in Washington.

All populations of Columbia Basin adult and juvenile salmonids use this portion of the Columbia River as a migration corridor. Twelve Evolutionarily Significant Units (ESU) of salmon pass through the area and/or spawn. The 12 ESU include:

- Snake River Spring/Summer Chinook
- Snake River Fall Chinook Salmon
- Upper Columbia River Spring-run Chinook Salmon
- Upper Willamette River Chinook Salmon
- Lower Columbia River Chinook Salmon
- Snake River Steelhead
- Middle Columbia River Steelhead
- Upper Willamette River Steelhead
- Lower Columbia River Steelhead
- Columbia River Chum Salmon
- Snake River Sockeye Salmon
- Upper Columbia River Steelhead

The mainstem of the Columbia is also an important production area for white sturgeon, Pacific lamprey eulachon (Columbia River smelt). Numerous islands in the mainstem provide important shoreline aquatic habitat and wintering and nesting habitat for waterfowl and other birds. Major urban metropolitan areas exist on both shores of the lower Columbia, including extensive marine industrial development. The main channel is routinely dredged to maintain access to deep draught port facilities. Major tributaries in Washington include the Grays, Elochoman, Cowlitz, Kalama, Lewis and Washougal rivers. The Cowlitz, Kalama, and Lewis subbasins drain the west slopes of the Cascade Mountains. These systems enter the Columbia River from river mile (RM) 68 to 88. The combined drainage area of these subbasins is approximately 4,000 square miles.

Between the Columbia River Gorge and the mouth of the Columbia River, rainfall ranges from 40 to 140 inches annually. Summers are relatively dry and have only six to nine percent of the total precipitation.

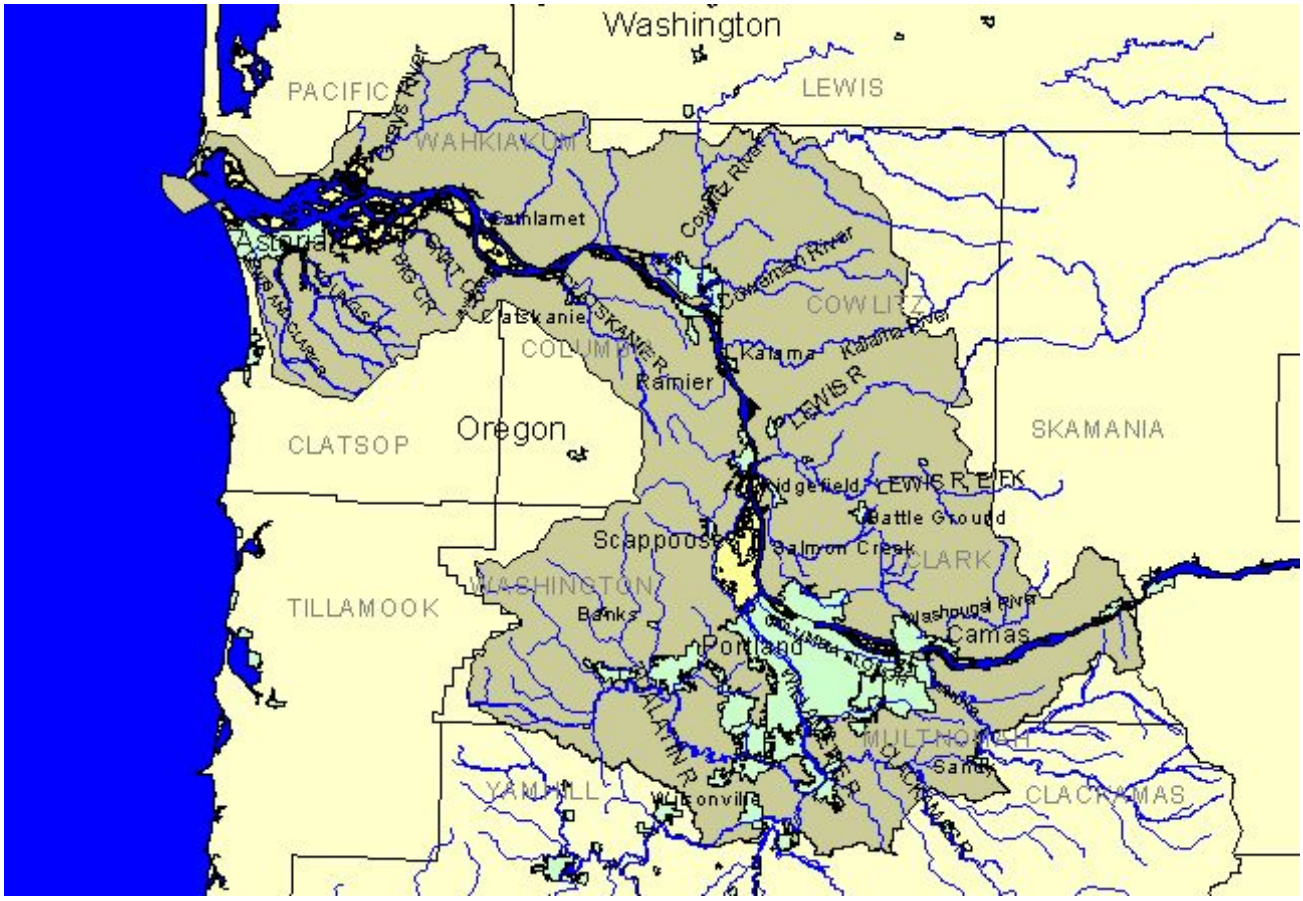

Figure 1. Lower Columbia River & Estuary

The Columbia River began flowing through the Columbia Plateau about 15 million years ago. During the Tertiary Period (70 to 2 mya), the river's down cutting action combined with the uplift of the Cascade Range to form the Columbia Gorge. Catastrophic events continued to shape the region. Toward the end of the Pleistocene (2 mya to 15,000 years ago), cataclysmic flooding through the Columbia Gorge stripped away unconsolidated deposits, widened the canyon floor and created the steep canyon walls. Origins of many of the Gorge waterfalls also date to this period. A large amount of Columbia River floodplain remains, in contrast to the inundated floodplains above Bonneville Dam. Basalt cliffs and accompanying waterfall zones are regionally significant. A unique characteristic of the Gorge is its function as a low-elevation corridor through the Cascade Mountains.

Periodic massive disturbances are an integral part of the natural environment that forms the basis for the ecology and evolution of anadromous fish in the Columbia River Basin. Natural events of large magnitude, such as the Mount St. Helens eruption, which impacted steelhead runs on the Toutle River in Washington, have often occurred in localized regions. The estuarine shoreline in both states consists of rocky, forested cliffs and low, wet floodplain areas that have been diked. A number of minor creeks and rivers with small drainage basins enter the estuary from both shores, but, because of their small size, they do not have much

influence on the Columbia River. The topography of the riverine portion of the two-province area does not vary significantly. The river's shoreline and adjacent lands have been diked and developed extensively for agricultural and industrial development as well as for commercial and residential uses.

The Lower Columbia River and Columbia River Estuary provinces offer a unique profile. A rich variety of sights and uses are encountered along the 146 miles from the Bonneville Dam to the Pacific Ocean.

- Approximately 2.5 million people live in the 18,000 square miles of the lower Columbia River basin. Many more visit for rest, recreation, and business.
- Hundreds of species—175 species of birds alone—use the estuary as permanent or migratory habitat. More than a dozen rare and endangered species depend on the lower river and estuary for survival.
- Six major pulp and paper mills contribute significant dollars and jobs to the regional economy.
- Aluminum plants along the Columbia River produce 43 percent of the nation's aluminum.
- Bonneville Dam generates power for the region and beyond—part of the Columbia River system that constitutes the world's largest hydropower system.
- A portion of the magnificent Columbia River Gorge—a National Scenic Area—lies within the lower Columbia River basin. The waterfall-draped walls of this natural wonder rise 3,000 feet above the river, affording spectacular views for miles.
- Extraordinary recreational opportunities abound, including fishing, boating, swimming and hiking. The Columbia Gorge is considered the windsurfing capital of the world.

==========

Bonneville Reservoir Subbasin Description

Bonneville Reservoir, a mainstem Columbia River impoundment bounded by Bonneville Lock and Dam (closed 1938) at river km 235 and The Dalles Dam (closed 1957) at river km 308, is located approximately 64 km east of Portland, Oregon and Vancouver, Washington. The reservoir is entirely within the Columbia River Gorge National Scenic Area (Figure 2).

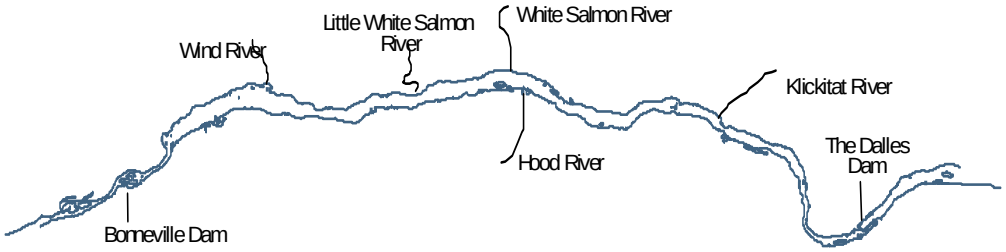

Figure 2. Location of Bonneville Reservoir along the Columbia River (upper graphic) and Bonneville Reservoir and its primary tributaries (lower graphic)

At full pool (22.6 m above sea level), Bonneville Reservoir (see **Error! Reference source not found.**) is a 75 km long, 7,632-ha impoundment that receives water from Columbia River mainstem reservoirs above The Dalles Dam as well as six primary tributaries (i.e., Wind River, WA; White Salmon River, WA; Little White Salmon River, WA; Klickitat River, WA; Fifteen mile Creek, OR; Hood River, OR) and several secondary tributaries (e.g., Rock Creek, WA; Mosier Creek, OR).

Precipitation at Bonneville Dam averages over 30.5 cm in December to a low of 2.0 cm in July. Precipitation at The Dalles, OR averages less that 7.6 cm during December to a low of 0.2 cm in July. Winter temperatures average 4.4° C at Bonneville and 3.3° C at The Dalles. Summer temperatures average 19.4° C at Bonneville in July and frequently reach over 37.8° C at The Dalles. The Columbia Gorge Province is renowned for its winds. Wind velocities of 32.2-48.3 km/h may persist for days, particularly in the summer. Prevailing winds are from the west during the summer months and from the east during winter.

Landscape surrounding Bonneville Reservoir is characterized by steep forested hillsides underlain by basalt up to 1,524 m thick with sedimentary and recent alluvium deposits. Elevations range from about 53 m below mean sea level (the deepest river bed elevation in Bonneville Reservoir) to over 1,150 m on mountains bordering the river just west of Hood River, Oregon.

Bonneville Reservoir is operated by the U.S. Army Corps of Engineers for hydropower production, fish and wildlife protection (anadromous fish passage), recreation (e.g., sport angling, windsurfing, kite skiing, boating, water skiing, sightseeing, bird watching,

swimming, and waterfowl hunting), and navigation. In addition, the reservoir provides tribal subsistence fishing opportunities.

Roads and railroads occupy extensive reaches of land bordering the reservoir. The riprap revetments protecting these form a significant portion of the reservoir shoreline.

Upslope lands in the western portion of the reservoir are primarily forested or urban areas. Agriculture is prominent along the middle and eastern portions of the reservoir, particularly on the southern (Oregon) side of the river. Urbanized uses of the shorelines for commercial and dwelling purposes other than industrial constitute a significant use of lands bordering the reservoir. Extensive alterations to the natural shoreline have been made near the population centers of Stevenson, Washington, Cascade Locks, Oregon, Home Valley, Washington, Bingen, Washington, Hood River, Oregon, and The Dalles.

Seven anadromous and at least 31 resident fish species, of which at least 15 are non-indigenous, have been documented in Bonneville Reservoir. Some native resident fish (e.g. white sturgeon) use the reservoir habitat throughout their life cycle while others (e.g. bull trout) live primarily in tributaries and occasionally use the reservoir habitats for foraging or migrating to other tributaries. The non-game native fish act as a prey-base for native and non-native predators. Non-native fish have become established in suitable habitats throughout the reservoir. Many indigenous and non-indigenous species provide recreational fishing opportunities. Impoundment of the Columbia River inundated mainstem spawning habitats for fall chinook and white sturgeon.

Bonneville and The Dalles dams are barriers to upstream movements by most resident fish. The degree of entrainment of resident fish downstream through the dams is largely unknown. Some upstream passage by white sturgeon through fishways occurs, particularly at the east fishway at The Dalles Dam (Warren and Beckman 1989). Historically, fish elevators at Bonneville Dam were used to pass white sturgeon from the lower Columbia River upstream into Bonneville Reservoir; however, this practice was discontinued in the 1950's.

Cowlitz River Subbasin Description

The Cowlitz River is a second order stream that originates on the west slope of the Cascade Mountain Range in Southwest Washington State. The river flows west from its source, then south to where it empties into the Columbia River at Kelso, Washington, about 68 river miles upstream from the Pacific Ocean (

Figure 3).

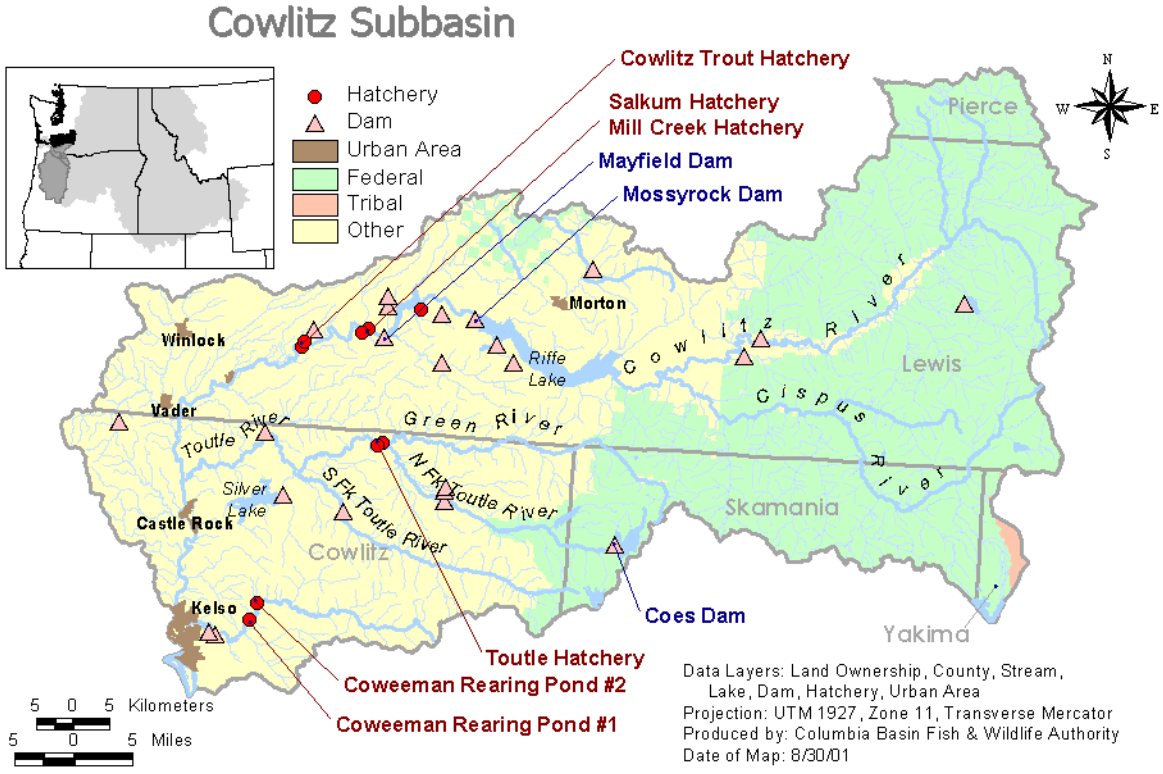

Figure 3. Cowlitz Water Resource Subbasin map.

The Cowlitz River drains approximately 2,480 square miles over a distance of 151 miles. Principle tributaries to the Cowlitz River include the Coweman, Toutle, Tilton, Cispus, Ohanapecosh and the Clear Fork. The Toutle River is the largest, draining 512 square miles and enters the Cowlitz River at RM 20.0. The Cispus River (RM 89.8) is the most significant tributary in the upper Basin and drains 433 square miles. The mainstem above the confluence of the Cispus-Cowlitz River drains 609 square acres.

The climate in the Cowlitz Basin is tempered by the Pacific Ocean, with moderately warm summers and cool, but normally not extremely cold winters. The average summer temperature in the upper valley (Glenoma) is 64 degrees Fahrenheit. The comparable winter average is 38 degrees. During summer, rainfall is relatively light, typically with several

weeks of no precipitation. Rains are more frequent the rest of the year, particularly in late fall and winter. Snow and freezing temperatures are fairly uncommon in the major portion of the watershed, but regularly occur during the winter months at higher elevations. Annual precipitation varies from 45 inches near Kelso to over 150 inches on Mount Rainier, Adams, and St. Helens, with over 69 percent of the annual precipitation falling between October 1st and March 31st.

The Cowlitz River flows generally westward from Mount Rainier, the highest mountain in Washington State at 14,410 feet, to the Columbia River. The eastern part of the Cowlitz River valley is located in the Cascade physiographic province and is characterized by a deeply cut trough and flat bottomlands, terraces, and broad plains. To the north and south of the valley, the uplands have rugged mountainous topography, modified by glacial activity and drained by rivers that trend generally westward. Landscape characteristics include, long steep slopes and relatively straight, parallel drainage-ways. The western portion of the Cowlitz River valley lies within the northern end of the Puget-Willamette Lowlands physiographic province, and has moderate relief with a broad floodplain; elevations seldom exceed 500 feet.

The Cowlitz River originates in the volcanic peaks of the Southern Cascade Mountains. The river flows west through a valley heavily influenced by alpine glaciers, then turns south and flows between the Cascades and the Willapa Hills to the Columbia River. The upper Cowlitz Basin (located in Washington's southern Cascades) are made up primarily of andesite and basalt flows and associated breccias and tuffs. Areas adjacent to volcanic peaks are generally mantled with pumice deposits.

The runoff from portions of Mount Rainier, Mount Adams and Mount St. Helens drains into the Cowlitz River. These normally inactive volcanoes have helped shape the geography of the area. The eruption of Mt. St. Helens on May 18, 1980 sent a tidal wave of melted ice and pulverized rock down the Toutle Valley into the Cowlitz River, and carried so much of this coarse sandy material and debris all the way to the Columbia River that dredging was required to clear the channel before river shipping could be resumed.

Large scale removal of this volcanic material in the Cowlitz River began at the lower end of the Toutle River by July, 1980 and continued on down the Cowlitz River until engineers were reasonably confident that the cleared channel could handle expected winter flows without topping dikes and flooding Castle Rock, Longview and Kelso. A dam to control sediment was then constructed further up the Toutle River by the Corp of Engineers to prevent the re-silting of the dredged sections.

Soils in alluvial deposits along the major west-flowing streams are generally coarse textured soils. The lower half of the basin is generally comprised of Eocene basalt flows and flow breccia. Haplohumults (reddish brown lateritic soils) are the most common under forest vegetation; soils under grasslands are classed as Argixerolls (prairie soils).

Potentially severe erosion would occur on over 83 percent of the land in the Cowltiz Basin if vegetative cover were removed. Over 81 percent of the land with severe to very severe erosion hazard is in commercial forest. The greatest erosion problems are from ground disturbance from road building and other activities associated with logging.

During the Pleistocene (3 million years to 8,000 years ago) several alpine glaciers moved down the Cowlitz River valley depositing till and outwash (glacial river sand and gravel deposits). These glaciers, 1000 feet thick or more, cut down into the former river channel and underlying bedrock. At least six alpine glacial advances have been documented. Glacial outwash sands and gravels form terraces in the vicinity of the Cowlitz River and were deposited by streams from the melting alpine glaciers located up the valley. Silt-loam loess, representing windblown glacial silt, blankets large areas of the basin. The thickness of the loess varies from a few feet to 20 feet.

Following deposition of the youngest glacial deposits, approximately 13,000 to 25,000 years ago, the Cowlitz River eroded and reworked the glacial deposits. The resulting alluvial deposits range from coarse boulders to cobbly gravel to fine sand and silty sand. Thick alluvium is generally confined to the area of the immediate Cowlitz River flood plain.

The forest series or zones in the Cowlitz watershed are typical of those found in the southern Cascades of Washington State. These forest zones are based on the climax tree species of the four major plant communities within the basin (western hemlock, Pacific silver fir, mountain hemlock, and subalpine fir). Above 3,500 feet, forests are generally Pacific silver fir with Douglas fir, western hemlock, mountain hemlock, and lodgepole pine as common associates. Understory is primarily huckleberry, fool's huckleberry, and salal. Below 3,500 feet, climax species are western hemlock, Douglas fir, and western red cedar. Understory species include vine maple, huckleberry, salal, sword fern, and devil's club. Hardwood species (alder, cottonwood, maple, and willow) are concentrated in riparian corridors along larger streams and rivers.

Historically, fire was the strongest natural disturbance influencing vegetation structure and composition within these different plant communities. However, the eruption of Mount St. Helens has shown the potential influence that volcanism can also exert on vegetation composition and structure within the watershed. Logging, and in some areas grazing, have also had substantial impacts on vegetation structure and composition and riparian areas throughout WRIA 26.

The Washington Department of Natural Resources derived vegetation cover for 26 WRIAs in Western Washington, including WRIA 26, using 1988 Landsat 5 TM data (PMR 1993) and updated with 1991 and 1993 TM data (see Lunetta et. al. 1997 for additional details). Forest cover was broadly categorized into four classes based on forest type and age class. The non-forest land cover and most surface water features were then overlaid on the forest-cover classification to discriminate non-forest lands, such as agriculture and urban areas from forest lands (PMR 1993).

Late seral stage vegetation still covers a fairly large percentage of the Cowlitz River basin. USFS (1997a) estimates that 28% of the vegetative cover in the upper Cowlitz River watershed and 19% in the middle Cowlitz watershed is in "large tree" (similar characteristics to late seral stage).

Historically, fire has also been the most significant overall disturbance mechanism in the Cowlitz watershed. Large fires within a watershed will tend to increase siltation through

erosion, alter the timing and quantity of high and low flows, influence stream temperatures, and increase the short-term large woody debris (LWD) supply to streams and decrease the long-term supply. In general, riparian areas tend to have microclimatic effects which somewhat protect them from many wildfire events so that late-seral stands are more prevalent there. This effect is more pronounced in steeper drainages.

Historically, fires in the Cowlitz basin were low in frequency, but high in severity, and had the potential to be quite large. For example, six fires of 1,000 acres or larger burned in the Middle and Upper Cowlitz watershed analysis areas between approximately mid- to- late 1800 to 1920. The largest fire burned approximately 27,000 acres (USFS 1997a). Fire suppression activity since the 1930's has significantly reduced the potential natural wildfire effects for this watershed.

Volcanic activity can have significant influence on aquatic habitats as evidenced by the recent eruption of Mount St. Helens. Mount St. Helens has deposited ash and pumice across portions of the Cowlitz watershed at least twice over the last 4,000 years; it erupted a cluster of times during the Smith Creek Eruptive Stage (3,900 to 3,400 years ago) and again during the 1980 eruptive phase. Mount St. Helens has erupted about once every century for the last 500 years, and is expected to follow a similar pattern in future centuries (USFS 1997b). Mount Rainier is another active volcano in the Cowlitz Basin and is potentially the most dangerous volcano in the Cascade Range. Many debris flows and their distal phases have inundated areas far from the volcano during postglacial time. According to recent hazard maps of the area, most of the upper Cowlitz River valley (floodplain) could be inundated by a mudflow, with or without an associated volcanic eruption.

The 1980 eruption of Mount St. Helens devastated fisheries resources in the North and South Fork Toutle River watersheds (WDW 1990; Lucas 1986; Jones and Salo 1986; Lislie et al. 1982; Collins and Dunne 1981). Tributaries in the upper North Fork Toutle watershed were completely destroyed as massive landslides and debris-flows traveled 21.7 km (13.5 miles) down the North Fork (Jones and Salo 1986). Deposition of debris flows buried 59 km^2 (23 square miles) of terrain to an average depth of 46 meters (150 feet), including more than 43.4 km (27 miles) of anadromous stream habitat (Jones and Salo 1986). Many stream systems that were not directly affected by the debris flows were still blanketed with substantial amounts of ashfall and most of the vegetation in the watershed was blown down by the eruption (Lucas 1986).

Over 74 million cubic yards of material had to be removed from the Cowlitz River within the first year after the 1980 eruption to maintain flood capacity (Cowlitz County 1983). Floodplain and wetland habitat along portions of the lower Cowlitz and Toutle Rivers was filled with the dredge spoils. Stream systems are recovering slowly from the effects of the eruption; however, elevated sediment loads, channel widening, lack of large woody debris and riparian cover all remain problems today.

Primarily, Cowlitz River runoff results from rainfall. During the late spring, however, snowmelt from the headwaters area contributes appreciably to the stream flow. In the upper basin, river flows are influenced by spring snowmelt and dry summer conditions. A few major tributaries drain glaciers on Cascade peaks and contribute glacial meltwater during the

summer months. Stream gages near Kosmos (RM 88.7) show a few peaks in May and June triggered by rapid snowmelt. However, the majority of peak flows occur between November and February, indicating that winter rain or rain-on-snow events trigger most floods in the basin. Flow in small tributary streams in the lower basin is controlled more by rainfall than snowmelt, and peak flows are usually triggered by fall and winter rainstorms.

Three major hydroelectric projects have been constructed on the mainstem Cowlitz River. The first is Mayfield Dam (RM 52.0), followed by Mossyrock Dam (RM 65.5), and furthest upstream is the Cowlitz Falls Dam (RM 88.5). The combination of the Mayfield and Mossyrock dams comprise the Cowlitz River Project owned by Tacoma Power. In addition, Tacoma Power placed a low Barrier Dam below Mayfield to intercept fish as part of the operation of it's salmon hatchery.

Construction began on the Mayfield Dam in 1956, and the Mossyrock Dam was completed in 1968. Riffe Lake, the reservoir behind Mossyrock Dam provides 1,686,000 acre/feet of storage, and has a length of 24 miles. Its surface area is 11,830 acres and the Mayfield Dam reservoir has a surface area of 1,250 acres, and 133,764 acre/feet of storage. The two dams have a combined rated capacity of 1,904,000,000 kilowatt hours annually.

Riffe Lake acts as a huge storage facility to both control flood flows and to hold water for future power generation. Flows out of Mayfield Dam are controlled by managing the storage in Riffe Lake. Riffe Lake is drawn down in the fall to provide flood storage for winter flood flows. Mayfield Lake is generally not drawn down and does not provide significant flood storage. When inflow to Mayfield Lake from the Tilton River and Winston Creek is high, generation at Mossyrock powerhouse can be shut down entirely to minimize flows to the lower river.

Cowlitz Falls Dam, the third hydroelectric dam on the river, is owned and operated by Public Utility District No. 1 of Lewis County under FERC license. It is a smaller run-of-the-river project located just above Riffe Lake and began commercial operation in 1994. The rated capacity is 70 megawatts, with an average generation of less than 30 megawatts. Lake Scanewa, the small reservoir created by the dam, is approximately 11 miles long, with 610 surface acres. The Bonneville Power Administration purchased all the power that will be generated at Cowlitz Falls in an agreement that expires in 2032.

Other dams and major passage barriers within WRIA 26 include:

- The North Fork Toutle River Sediment Retention Structure Project (SRS) is operated by the Army Corps of Engineers (the Corps) to prevent Mt. St. Helens coarse sediments deposits in the lower watershed. The SRS has filled with coarse bedloads to spillway level. Coarse sediments are expected to flow over the SRS spillway during high flows.
- The North Fork Toutle River - Fish Collection Facility, is just downstream from the SRS, and is operated by WDFW. This facility was installed to collect and separate fish. TAG members with the WDFW state that the FCF is inoperable much of the time due to sediment that jams the doors. This has occurred at crucial times during adult fish migration, and they have been unable to allow any adult passage when heavy sediment loads are moving through the system.

- The Barrier Dam is a 12-foot-high, concrete barrier constructed on the Cowlitz River at RM 49.5 in 1969 to divert all adult anadromous migrants into the Cowlitz River Salmon Hatchery. It is the first barrier anadromous fish encounter on the mainstem Cowlitz. Since its completion, the Barrier Dam diverts almost all of the adult migrants into the salmon hatchery. The TAG members state that very few adults get over the Barrier Dam.
- The Mill Creek Hydroelectric Project was constructed in the early 1980s and is operated by Lewis County PUD. It was constructed just over one mile from the mouth and is at or near the historic upstream limit to anadromous fish migration. It operates as a run-of-the-river, non-storage project. (LCSCI 1998).
- The Green River has two hatchery barriers that are a complete block to anadromous fish.
- A private dam on Ferrier Creek is a reported barrier to fish passage.
- The Blue Creek Hatchery forms a complete block to anadromous fish.
- The Silver Lake Water Level Control Structure on Outlet Creek.

Forestry is by far the most dominant land use for all subbasins within WRIA 26 (Wade 2001). In the Cowlitz River floodplain below Mayfield Dam, agriculture and other uses made up only 16 percent of land use in 1974. Some of the percentages have changed since 1974 due to substantial amounts of residential and industrial development within the basin. The percent increase in population for Cowlitz and Lewis County from 1970 through 1996 was 24% and 31% respectively. The most substantial population growth during this period in both counties occurred between 1990 and 1996.

There is a significant amount of the land base in WRIA 26 in public ownership. Tacoma Power also owns 14,514 acres that are designated as wildlife mitigation lands for the hydroelectric projects on the Cowlitz River. Most of the federal and state owned lands are in commercial forestry.

The earliest and most extensive assessment of fish habitat in the Cowlitz River Basin was completed by the Bureau of Fisheries from 1938-1942. These surveys provide exceptional historical information for anyone interested in additional data on the quality and quantity of fisheries habitat within Cowlitz River watershed.

Agriculture has never been a major use of land in either county. Lewis County has a total harvested cropland of 29,440 acres, and Cowlitz County only 8,227 acres. The vast majority of land in of both counties is used for growing trees. Less than 1 percent of the total wages paid in Lewis County in 1994 were related to agriculture, forestry, or fishing. The comparable figure for Cowlitz County was 2.7 percent.

Lewis River Subbasin Description

Located along the Columbia River in Southwest Washington, the Lewis River contains portions of three counties (Clark, Cowlitz, and Skamania) The Lewis River flow into the Columbia River at RM 87. The Lewis River watershed includes two large drainages, the North Fork and East Fork, which converge approximately 3.5 miles upriver from the confluence with the Columbia River.

The Lewis River watershed is approximately 93 miles long, has a total fall of approximately 12,000 feet, and drains an area of about 1,050 square miles (EA Engineering 1999, Figure 4). The headwaters arise on the southern flanks of Mt. Saint Helens and Mt. Adams. The mainstem of the Lewis, also known as the North Fork, flows southwesterly from its source in Skamania County through three impoundments, Swift Reservoir (River Mile 47.9), Yale Reservoir (34.2), and Merwin Lake (RM 19.5). The middle and lower sections of the North Fork Lewis form the boundary between Clark and Cowlitz Counties. A major tributary, the East Fork Lewis River, enters the mainstem at RM 3.5. From this point the mainstem Lewis flows westerly, entering the Columbia River at RM 88. The average annual streamflow for the entire Lewis River system is approximately 6,125 cubic feet per second (cfs). For analysis purposes, this report divides the watershed into the North Fork (mainstem) Lewis River and East Fork Lewis River.

The North Fork Lewis River headwaters arise from the southern flanks of Mt. Adams and Mt. Saint Helens in the Cascade Range. The lower 12 miles of the mainstem and North Fork Lewis River flows through a wide flat valley, much of which is under cultivation and protected from flooding by dikes. The lower 11 miles are a tidally influenced backwater of the Columbia River. Within this area, the flow is sluggish and the sediments are generally composed of sand, silts, and clays typical of lower floodplains.

The valley begins to narrow for the next 8 miles, eventually forming a canyon from the confluence of Cedar Creek (RM 15.7) to Merwin Dam. The 240 foot high Merwin Dam (RM 20) is a major feature on the river, blocking all upstream passage to 80% of the historical anadromous habitat. This is the first of three dams blocking passage on the Lewis River.

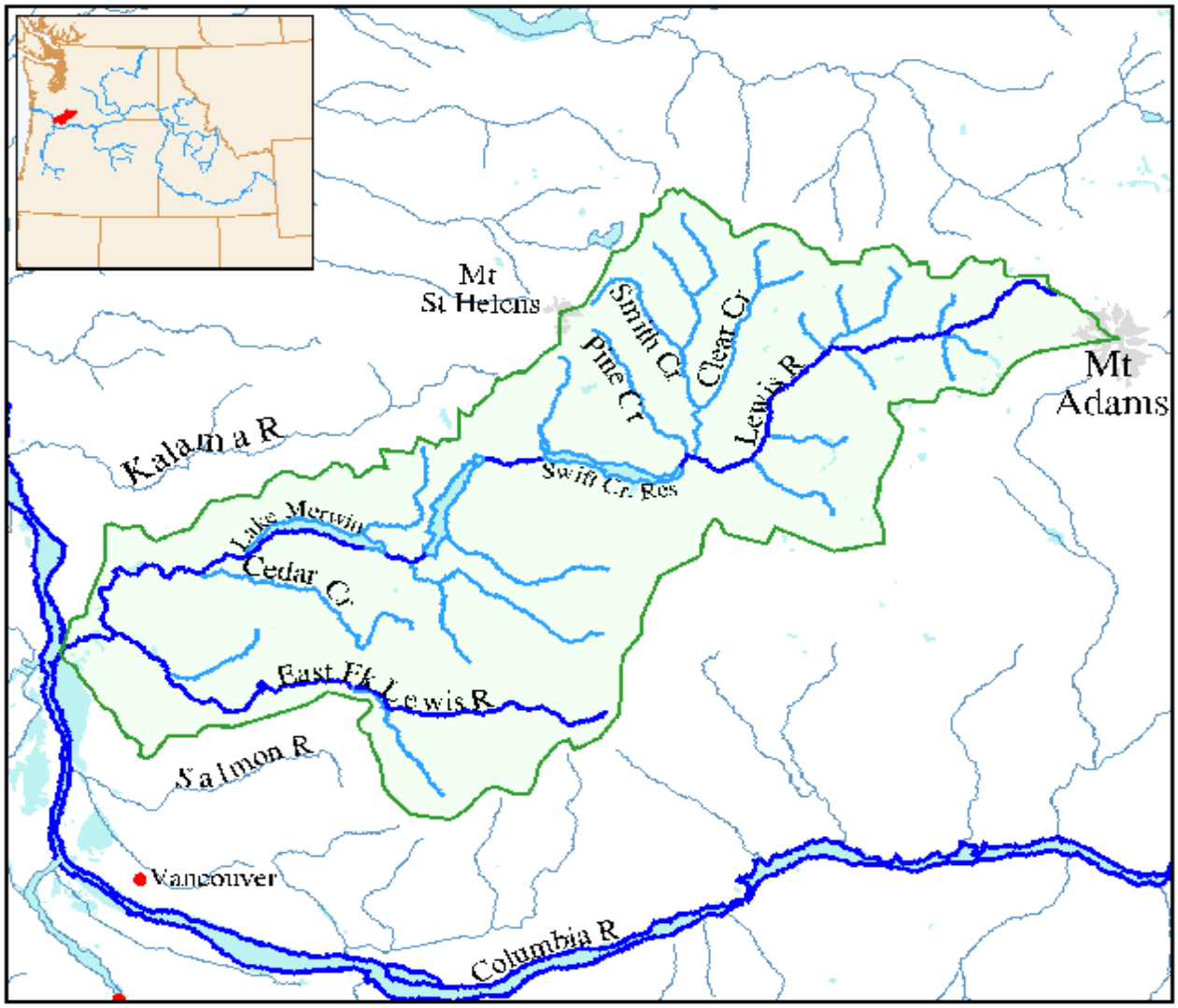

Figure 4 Lewis Subbasin Base Map
Courtesy of Pacific States Marine Fisheries Commission

Before these dams were completed, salmon and steelhead production was the result of natural spawning, with major production of coho, spring chinook, fall chinook, and winter and summer steelhead. Mitigation programs have attempted to reestablish these runs, but pre-dam productivity of the Lewis River is unknown.

The majority of the Lewis River basin is forested, typical of the southern Washington Cascade Mountains. However, an area of approximately 30 square miles within the upper basin was denuded by the May 18, 1980 eruption of Mt. Saint Helens. Most of the basin is within the western hemlock vegetation zone.

The major tributaries within the Lewis River system below Merwin Dam include the East Fork Lewis River, Johnson Creek, and Cedar Creek. Now that the dams block anadromous passage to the upper river, Cedar Creek provides most of the productive tributary habitat for

anadromous salmonids within the North Fork basin. Cedar Creek has a number of tributaries with productive anadromous salmonid habitat including Pup Creek, Bitter Creek, Beaver Creek, and North and South Forks of Chelatchie Creek.

The mainstem of the North Fork, from RM 15 to the Merwin Dam (RM 20) provides an extremely productive spawning area for fall chinook. All three reservoirs (Merwin, Yale, and Swift) have populations of bull trout/Dolly Varden. Three streams provide rearing and spawning habitat for bull trout in the upper river including Pine and Rush Creeks that flow into Swift Reservoir, and Cougar Creek that flows into Yale Reservoir. The East Fork watershed extends approximately 11 miles into Skamania County and the Gifford Pinchot National Forest near Green Lookout Mountain, and reaches an elevation of approximately 4442 feet above sea level. It joins the North Fork of the Lewis River approximately 4000 feet downstream from the Interstate 5 Bridge (Figure 4).

At its headwaters, the East Fork Lewis River generally flows through steep, mountainous terrain, restricted by narrow valley walls. Tributary streams in the headwaters are steep channels dominated by bedrock and boulders. The two largest tributaries in the upper East Fork Lewis River basin are Copper and upper Rock creeks.

Lucia Falls (RM 21.3) is thought to block upstream migration for all anadromous species other than steelhead and an occasional coho. From Lucia Falls downstream to river mile 17 near the mouth of Rock Creek (lower), the East Fork is within a narrow ravine where water velocities are such that the stream is slowly down cutting. Upstream from Lewisville Park at river mile 14, the river cuts through volcanic ash, pyroclastic layers, and basalt lava flows creating waterfalls, small gorges, and cliffs. Downstream from river mile 17 and especially below river mile 11, the valley floor begins to broaden out into a well-defined flood plain. The East Fork's gradient declines from approximately 20 feet per mile, at RM 11, to less than 2 feet per mile at RM 6. Bedload deposition occurs in this section in the form of gravel bars where declining gradient and loss of energy releases gravel, causing bar formation, channel shifting, and increased susceptibility to flooding. Most of the remaining six miles of river is less than ten feet above mean sea level, has minimal slope, and is subject to backwater effects from the Columbia.

The East Fork of the Lewis River contributes, on average, approximately 1000 cubic feet per second to the flow of the Columbia River. Rainfall provides the most significant contribution to streamflow in the basin. Therefore, streamflows are substantially higher during the rainy season, from November to April than from May through October. Overbank flooding can be severe in the lower sections of the East Fork.

Repeated large-scale stand-replacement fires burned large portions of the eastern portions of Clark County between 1902 and 1952, and these disturbances have had significant impacts on the hydrology, the structure, composition, and age-class distribution of the plant communities, as well as riparian and instream habitats along the East Fork system.

The largest fire, the Yacolt Burn, occurred in 1902 and covered an estimated 238,900 acres of state, private, and federal lands extending from the foothills of the Cascades. Fires repeatedly burned over the portions of the same area, including the Rock Creek Fire of 1927 (48,000

acres), and the Dole Fire of 1929 (227,500 acres). Some areas have burned over five times, with the last major fires occurring in 1952. Besides destroying most if not all of the vegetation within the burned areas, these fires were especially hot. Portions of the higher peaks and ridges burned so hot that shrub/forb seral stages still predominate.

Sediment loading, high stream temperatures, insufficient canopy cover, large peak flows, and soil productivity were probably at their worst soon after the large fires. The major flood events occurring in 1931 and 1934 were probably associated with rain-on-snow precipitation events that coincided with major fires. Natural processes are slowly healing the landscape, and many of the associated problems have decreased in severity. However, snag habitat, number of pieces of large woody debris per mile of stream, and the vegetation structure, composition, and age-class distribution remain well outside of historic conditions today, and are projected to remain outside historic conditions well into the future.

The climate of the subbasin is typical of western Washington. The maritime air moderates the seasonal extremes, producing mild, wet winters and cool summers. Average annual rainfall in the subbasin varies with elevation, but ranges from 45 inches near Woodland, at the mouth of the river, to 140 inches at the peak of Mount St. Helens.

The topography of the subbasin is a result of geological uplifting, volcanic activity and river flooding. Mount Adams is the highest peak in the subbasin at 12,307 feet. Mount St. Helens is an active volcano, last erupting in May 1980.

The basin has a complex geologic history, having undergone Tertiary volcanism, several glaciations, and interglacial erosion and deposition. Bedrock surrounding the reservoirs is predominately comprised of younger Eocene to older Oligocene volcanic lava flows Oligocene volcaniclastic rocks, and Quaternary volcaniclastic deposits. The volcanic rocks have undergone regional compressional deformation; rock strata are folded by a major southeast plunging anticline and a southeast plunging syncline.

Merwin Dam regulates streamflow on the lower section of the North Fork. Average annual flow, measured below Merwin (1924-1986), is 4,849 cubic feet per second (cfs). Average annual flow on the East Fork, measured at the confluence with the North Fork, is 1,000 cfs. Average annual flow for the entire watershed, measured at the river's mouth, is 6,125 cfs.

The average annual stream discharge for the North Fork Lewis is 4,900 cubic feet per second. Glacial runoff contributes to the flow in the Lewis River, but rainfall provides the most significant contribution. Management of the flow in the Lewis is largely controlled through the Merwin Project licensing agreement with the operator of the dam, PacifiCorp. Since 1985, PacifiCorp and the Washington Departments of Fisheries (WDF) and of Wildlife (WDW) have studied the relationship between spring flows and chinook rearing habitat on the North Fork and evaluated the need to modify spring flow provisions in Article 49 of the licensing agreement. In 1995, Article 49 was amended to provide for increased minimum flows of 2700 cfs in April, May, and June. The need for additional modifications of flow regimes and ramping rates to protect other ESA listed or proposed for listing species (steelhead, chum salmon, coho salmon, and cutthroat trout) will be assessed as part of the ongoing relicensing studies.

Soils in the subbasin derive from recent alluvial deposits, overlaying an older alluvial fan known as the Troutdale Formation, which consists of clays, sands and deposits of gravel. Underlying materials of the upper watershed include volcanic and basaltic formations of the Cascade Range.

A large portion of the North Fork Lewis River basin is managed as commercial forest and, as such, is undeveloped except for logging roads. However, recreational use and residential development demand has increased significantly. Road densities in the basin range from 4.96 miles/square mile in the lower North Fork below Merwin Dam (Lewis County GIS 1999) to as low as 2.01 miles/square mile in the upper portions of the watershed on Forest Service lands. Population densities are generally low within the basin. There is scattered residential development with only a few small communities (Cougar, Chelatchie, and Amboy) in the upper basin. The largest urban population center, the City of Woodland, lies near the mouth of the river.

Despite extensive residential development, forestry and farming are still the predominate land-use even in the lower portions of the watershed. In general, the upper portions of the watershed contain mainly large private and public holdings actively managed for timber production. Approximately 56 percent of the upper East Fork Watershed is owned and managed by private timber companies, 23 percent by the Washington State Department of Natural Resources (DNR), and 23 percent by the U.S. Forest Service.

Just below Daybreak Park (RM 10) are a number of abandoned gravel mining pits. During November 1995, the East Fork avulsed (abruptly changed channels) through a gravel pit pond at RM 9 and abandoned about 1,700 ft of channel. In November of 1996, the river again avulsed through 6 closely spaced gravel pit ponds called the Ridgefield Pits from RM 8.3 to RM 7.6. The avulsion into these ponds has created highly dynamic and unstable conditions within the lower reaches of the East Fork. Wetlands and open-water also covers large areas of the floodplains within this lower stretch of the river. La Center, Washington is the only heavily urbanized area on the main stem of the East Fork.

There are three major hydrodams on the Lewis River. From downstream they are: Merwin Dam (RM20), Yale Dam (RM35) and Swift No.1 (RM 45). Each dam forms its own reservoir with lengths of 14.5, 10.5 and11.5 miles respectively. Additionally there is a smaller project Swift 2, which channels the flow from the tailrace of Swift 1, down a 3.2 mile canal and into a powerhouse.

Colvin Creek (RM 16.2) has a dam that at one time provided water to the hatchery. The water intake is no longer in use and the dam forms a complete passage barrier for all species.

Wind River Subbasin Description

The Wind River Subbasin, located in southwestern Washington, originates in McClellan Meadows in the western Cascades on the Gifford Pinchot National Forest (Wind River Ranger District) and enters Bonneville Reservoir at River Mile (RM) 154.5 near Carson, Washington (Figure 1).

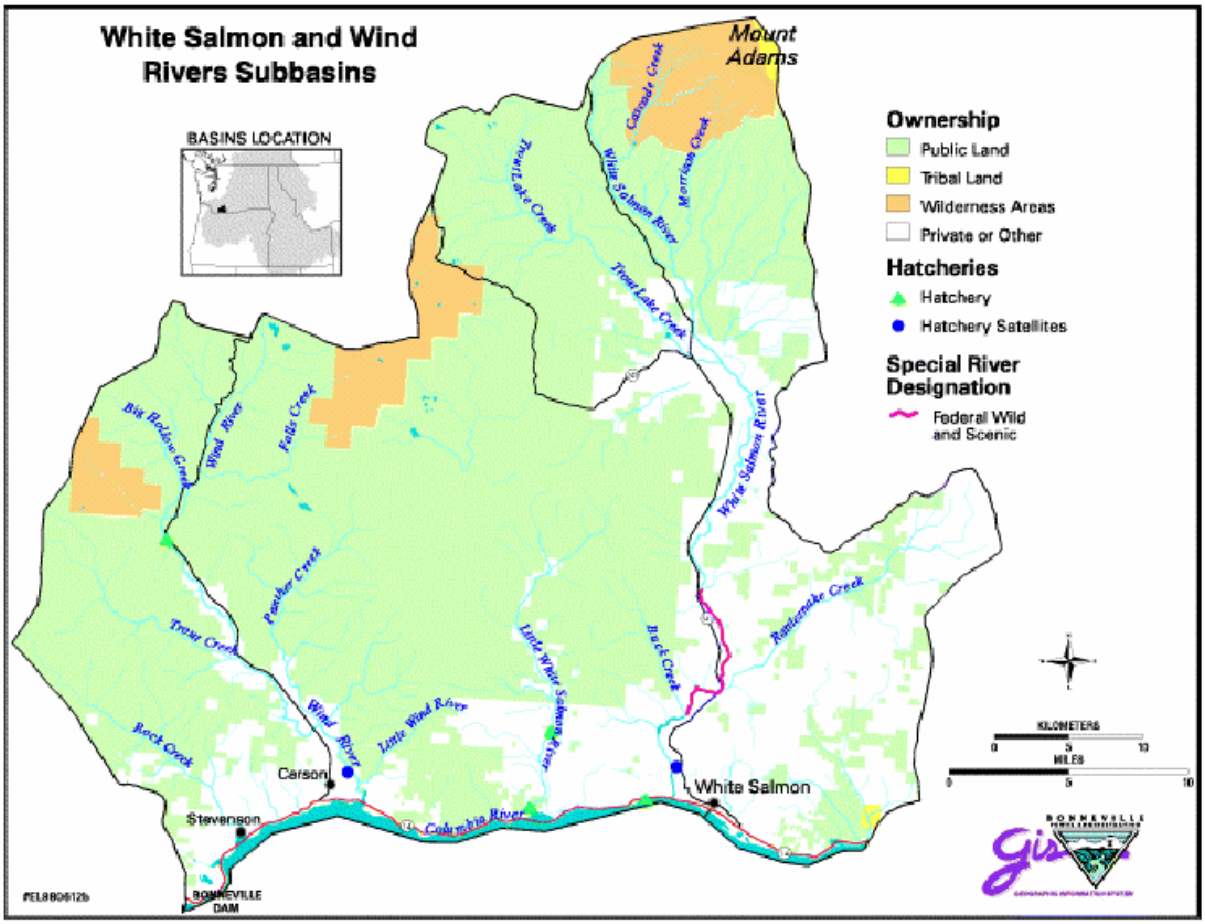

Figure 5 - Location of the Wind, Little White and White Rivers in the Columbia River Subbasin Gorge Province

Wind River, a fifth order stream, drains approximately 225 mi² of Skamania County over a distance of approximately 31 miles. Principle tributaries to Wind River include Little Wind River, Bear, Panther, Trout, Trapper, Dry, Nineteenmile, Falls and Paradise creeks. The largest tributary, Panther Creek, enters at RM 4.3 and drains 18% of the Wind River subbasin (26,466 acres). Trout Creek, which drains 15% of the subbasin (21,732 acres), enters at RM 10.8.

Climatic patterns of the Wind River subbasin are controlled by marine-influenced air masses from the Pacific Ocean. The mean annual average precipitation in this watershed is 110 inches per year at Stabler, Washington (elevation 800 feet). Approximate 80% of the precipitation is

delivered in the form of rainfall or snow between October and April. The average ambient air temperature is 66 F during the summer and 40 F in the winter.

The basin is oriented northwest to southeast with elevations ranging from 80 - 3,900 feet. Topography varies within the watershed; it is steep in the northwest and lower southeast, gentle in the northeast - McClellan Meadows area, and it is benchy in Trout Creek Flats and middle portions of the Wind River Valley. The mainstem of the Wind River drops 3,820 feet in 30.5 miles for an average gradient of 2.3%. Shipherd Falls, located at RM 2.0, is a series of four falls ranging from 8 to 12 feet that were a barrier to all anadromous salmonids except steelhead until the construction of a fish ladder in 1956. Stream flows in the watershed range from summer low flows to peak flows in the winter. Some streams only flow during high flow events and are dry the remainder of the year (ephemeral streams). Others such as the mainstem of the Wind River increase from an average daily flow of less than 250 cubic feet per second (cfs) during August and September to over 2,000 cfs in December and January. The largest stream flows typically occur in response to rain-on-snow events, when heavy rains combine with high air temperatures and high winds to cause widespread snowmelt. Low flows are maintained by late season snowmelt and areas of water retention or recharge.

The Wind River Watershed has been shaped through 25 million years of volcanic activity and glacial action. Most of the watershed was formed 12 and 25 million years ago with some younger flows out of Indian Heaven and Trout Creek Hill being dated between 350,000 to three million. The flows out of Trout Creek Hill are the youngest at about 300,000. The majority of the watershed is in the older volcaniclastic material. These areas are more susceptible to erosion and mass failure due to the weathering of the material to silts and clays. Glacial activity has had an effect on the landscape especially in the upper regions of the watershed by Indian Heaven, where volcanic flows have scoured and smoothed the land. Outwash and alluvial material from this time period have been eroding down through the Wind River Valley. Since the construction of Bonneville Dam, this material has been accumulating at the mouth of the Wind River. Other material that has been moving into the streams in the lower parts of the valley are flood deposits left from the Bretz Floods from ancient Lake Missoula. Sediment input has also resulted from large landslides in the watershed. Most subbasin soils originate from weathered bedrock. Alluvial soil is found along the river and some soils north of Paradise Creek were buried under a thin layer of ash and pumice from Mt. St. Helens. Major woodland soils are deep and well drained but become shallow as elevation increases. Soils above 4,000 feet are subject to cold temperatures, while those along the Columbia River are subject to high winds.

Presently, vegetation is approximately 90% Douglas fir, western hemlock and grand fir. Prior to European settlement, the forest of the Wind River Basin contained either latesuccessionalold growth or early-successional young growth. Late-successional stands contain trees over 21 inches in diameter with multiple canopy layers. Mid-successional stand also contain trees with diameters over 21 inches but with a single canopy layer consisting of nine to 21 inch trees. Early-successional stands consist of trees from 0 to 9 inches. Table 1 displays the number of acres in each successional class and how the proportions changed over time to the present day.

The Wind River Subbasin is part of the Yakama Indian Nation lands ceded to the United States in the Treaty of June 9, 1855. Within this area the tribe reserves the right to hunt and fish at all usual and accustomed places in common with citizens of the territory. The upper portion of the basin is situated within the legislated boundary of the Gifford Pinchot National Forest (GPNF) and federal ownership accounts for 127,682 acres (89%) of the watershed. Non-federal ownership includes Washington Department of Natural Resources (WDNR) at 3,757 acres (2%), private timber interests at 8,122 acres (6%), and other private ownership at 3,943 acres (3%). Most of the first six miles of mainstem river and its drainage are outside the GPNF, but a large portion of this area lies within the Columbia River Gorge National Scenic Area (CRGNSA). The remaining 25 mainstem miles consist primarily of U.S. Forest Service (USFS) ownership. The President's Forest Plan (ROD) categorizes the Wind River Basin as a Tier 1, Key Watershed that provides habitat for anadromous salmonids. The Wind River drainage has traditionally been managed for timber production; however, under the Northwest Forest Plan, much of the drainage has been designated as late successional reserves, wilderness areas (wilderness areas pre-dated the Forest Plan), riparian reserves, or reserved through other means. In addition to the GPNF and DNR, there is a limited amount of commercial timberland ownership in the lower valley. Those holdings within the CRGNSA are regulated by their land use regulations as administered by Skamania County. Those outside the CRGNSA are regulated by the Washington State Forest Practices Regulations.

Urban development has been concentrated in Carson, Washington which is located at RM 2 and Stabler, Washington at RM 7. There are individual dwellings throughout the first 12 miles of the river, with the majority located in the lower reaches. In addition, a number of vacation cabins are located near Government Mineral Springs along Trapper Creek. These cabins are privately owned on land leased from the USFS. Large-scale industrial activities are limited by lack of available land outside the National Forest and Scenic Area. The two major industrial operations in the watershed are a plywood mill on the east side of the river near the mouth and a lumberyard north of Carson. Both are owned and operated by the WKO Company. A gold mine is operated near the Upper Wind River approximately one mile south (downstream) of the mouth of Paradise Creek. In addition, the USFS recently conveyed approximately 190 acres and infrastructure of former nursery land to Skamania County. The river's proximity to the Portland/Vancouver area makes it a popular recreation destination for cross country skiing, tubing, sledding, fishing, mineral prospecting, swimming, golfing, camping, hiking, picnicking, waterfall viewing, hunting, and berry picking. In addition, the Wind River Valley is a significant transportation corridor for travelers, including significant summer tourism traffic. Forest Road 30, which follows the river through much of its length, offers access to the upper Lewis River basin and to the Mount St. Helens National Volcanic Monument.

Fish assemblages in the Wind River are divided into the area above and below Shipherd Falls. Species found downstream from the falls include spring and fall chinook, coho salmon, winter and summer steelhead, coastal cutthroat trout, largescale and bridgelip suckers, pacific and brook lamprey, threespine stickleback, sculpins, white sturgeon, redside shiners, peamouth, and northern pikeminnow. Historically, pink and chum salmon likely used this area but are believed to be extirpated. Species found upstream of the falls included steelhead trout, shorthead sculpin, mountain whitefish, brook trout (non-endemic) and spring chinook salmon (non-endemic). No anadromous fish except unmarked steelhead are allowed above Hemlock Dam on Trout Creek (Figure 1). Shorthead sculpin is found in most areas except upstream of

the canyon area of Trout Creek (Figure 1), which has numerous small falls that are potential barriers to this sculpin's upstream distribution. Mountain whitefish, brook trout, and spring chinook occur in limited areas of the watershed, and wider occurrence is limited by habitat requirements and preferences. Fish surveys and smolt trap catches indicate limited natural reproduction of spring chinook. Sockeye salmon, coho salmon, lamprey (one or more species), and brown trout have recently been observed above Shipherd Falls.

Little White Salmon River Subbasin Description

The Little White Salmon River originates in the Gifford Pinchot National Forest west of Monte Cristo Peak in south-central Washington and enters Drano Lake near Cook, Washington. Drano Lake, a backwater created by impoundment of the Columbia River, enters Bonneville Reservoir at River Mile (RM) 162.

The Little White Salmon River drains approximately 135 square miles of Skamania and Klickitat counties over a distance of approximately 19 miles. Principle tributaries to the Little White Salmon River include Lost (north and south), Beetle, Lusk, Homes, Berry, Cabbage, Moss, and Rock creeks.

Climatic patterns of the Little White Salmon subbasin are controlled by marine-influenced air masses from the Pacific Ocean and continental air masses from eastern Washington. Winters are usually wet and mild, while summers are warm and dry. Approximate 75% of the precipitation is delivered in the form of rainfall or snow between October and March. The mean annual precipitation is approximately 65 inches.

The basin is oriented northwest to southeast with elevations ranging from 80 feet to 5,300 feet. Topography varies within the watershed from gentle slopes formed by lava flows and volcanic cones to steep rugged landforms. Based on geomorphology the watershed can be split into one area containing tertiary deposits of tuff and pyroclastic flow (Monte Cristo Range) and another containing younger quaternary basalt/andesite flows originating from the Indian Heaven Area. The mainstem of the Little White Salmon River drops 3,520 feet in 19 miles for an average gradient of 3.5%. Anadromous fish passage is blocked by a series of waterfalls located 2 miles upstream from the rivers confluence with the Bonneville Reservoir.

Stream flows in the watershed range from summer low flows to peak flows in the winter. Some streams only flow during high flow events and are dry the remainder of the year (ephemeral streams). Others such as the mainstem increase from an average daily flow of less than 60 cubic feet per second (cfs) during August and September to peak flows, which exceed 2,000 cfs during the winter. The largest stream flows typically occur in response to rain-on-snow events, when heavy rains combine with high air temperatures and high winds to cause widespread snowmelt. Low flows are maintained by late season snowmelt and areas of water retention or recharge.

The geology of the Little White Salmon Watershed is dominated by past volcanic activity. Subbasin soils are the result of volcanism and glaciation. The older tertiary deposits form most of the mainstem and these deposits have a tendency to decompose into silts and clays.

Soils are deep in alluvial deposits and shallow on side slopes. Landslides occur where the erosion potential of surface soil is high and soil fertility is low. Large past active deep seated slides have flowed from Augsburger Mountain toward the Little White Salmon River. The younger quaternary deposits have shallower soils and are more stable. An example of this is the Big Lava Bed flow covering 16,000 aces of the watershed.

Subbasin vegetation is generally comprised of mostly Douglas fir, western hemlock and grand fir. Unique habitats containing Oregon white oak and golden chinquapin are present within the watershed. There are 16,870 acres of early successional (seedling and sapling size up to 5 inches DBH); 24,840 acres of mid-successional (5-12 inches DBH), and 15,180 acres of late successional(stands greater than 880 years old and 21 inches DBH); and 14,160 acres of stands meeting the Region Six definition of old growth.

The Little White Salmon River subbasin is part of the Yakama Indian Nation lands ceded to the United States in the Treaty of June 9, 1855. Within this area the tribe reserves the right to hunt and fish at all usual and accustomed places in common with citizens of the territory. The upper portion of the basin and its tributaries are located within the legislated boundary of the Gifford Pinchot National Forest (GPNF) and federal ownership accounts for 68,660 acres (79%) of the watershed. The Washington State Department of Natural Resources (DNR) owns land in the middle basin, and extensive private ownership in the lower subbasin. Private ownership in the basin also extends along a narrow path on both sides of the mainstem Little White Salmon River into the headwaters, primarily in the valley bottoms. Most of the first six miles of mainstem river and its drainage are outside the GPNF, but a large portion of this area lies within the Columbia River Gorge National Scenic Area (CRGNSA). The President's Forest Plan (ROD) categorizes the Little White Salmon River Basin as a Tier 2, Key Watershed that provides habitat for salmonids.

The Little White Salmon River drainage was traditionally managed for timber production; however, under the Northwest Forest Plan, much of the drainage has been designated as riparian reserves, or reserved through other means. In addition to the GPNF and DNR, there is a limited amount of commercial timberland ownership in the lower valley. The land holdings within the CRGNSA are regulated by the CRGNSA's land use regulations as administered by Skamania County in addition to the Washington Forest Practices Act. Those outside the CRGNSA are regulated by the Washington State Forest Practices Regulations. Urban development has been concentrated in Willard, Washington, which is located five miles from the mouth of the river. Large-scale industrial activities are limited by lack of available land outside the National Forest and Scenic Area.

The river's proximity to the Portland/Vancouver area make it a popular recreation destination for cross country skiing, tubing, sledding, fishing, mineral prospecting, swimming, golfing, camping, hiking, picnicking, waterfall viewing, hunting, and berry picking.

Fish assemblages in the Little White Salmon River are divided into the area above and below the RM 2 falls. Species found downstream from the falls include spring and fall chinook, coho salmon, winter and summer steelhead, largescale and bridgelip suckers, pacific and brook lamprey, threespine stickleback, sculpins, white sturgeon, redside shiners, peamouth, and northern pikeminnow. Historically, pink and chum salmon likely used this area but are

believed to be extirpated. Species found upstream of the falls included rainbow trout, sculpin, brook trout (non-endemic) and coho salmon (non-endemic). No anadromous fish except hatchery coho smolts, which are released from Willard National Fish Hatchery, are found above the falls at RM 2.

White Salmon River Subbasin Description

The White Salmon River originates in the Gifford Pinchot National Forest in south central Washington along the south slope of Mount Adams in Skamania and Yakima counties. It flows south for 45 miles before entering the Bonneville Reservoir in Underwood, Washington at River Mile (RM) 167.

The White Salmon River drains approximately 386 mi^2 (250,459 acres) of Skamania, Yakima, and Klickitat counties over a distance of 45 miles. Principal tributaries include Trout Lake, Buck, Mill, Dry, Gilmer, and Rattlesnake Creeks.

Climatic patterns of the White Salmon subbasin are controlled by marine-influenced air masses from the Pacific Ocean and continental air masses from eastern Washington. Winters are usually wet and mild, while summers are warm and dry. Approximate 75% of the precipitation is delivered in the form of rainfall or snow between October and March. The average precipitation along the eastern most portion of the watershed equals 40 inches a year, increasing to as much as 95 inches in the west and north.

The basin is oriented north to south with elevations ranging from 80 feet to 7,500 feet. Topography varies within the watershed from rugged mountains to rolling hills to river valleys. Consolidated sediments are overlain with basaltic lava flows; subsequent erosion, mud flows, and glaciation have resulted in precipitous cliffs, deeply incised canyons, and relatively flat valley floors. The mainstem of the White Salmon River drops 7,420 feet in 45 miles for an average gradient of 3.2%. Anadromous fish passage is currently blocked at RM 3 by Condit Dam. A falls at Husum is likely a partial barrier to some anadromous fish and the 20-foot falls at RM 16 is likely the upper extent of current anadromous potential; however, there is some historical evidence of anadromous fish reaching the Trout Lake Valley.

Stream flows in the watershed range from summer low flows to peak flows in the winter. Some streams only flow during high flow events and are dry the remainder of the year (ephemeral streams). Others, such as the mainstem, increase from an average daily flow of 644 cubic feet per second (cfs) in the fall to flows of 1,538 (cfs) during the spring. The flow pattern on the White Salmon River is relatively constant due to its glacial origin, large water recharge potential, and storage capacity. Recharged water is released mostly in the middle portion of the mainstem canyon between Trout Lake valley and Husum. The largest stream flows typically occur in response to rain-on-snow events, when heavy rains combine with high air temperatures and high winds to cause widespread snowmelt. Low flows are maintained on the mainstem by late season snowmelt and areas of water retention or recharge. Several tributaries (e.g., Rattlesnake Creek) currently experience very low base flows as a result of unknown recent causes (PWA 1997).

The geology of the White Salmon Watershed is dominated by past volcanic activity. Subbasin soils are the result of volcanism and glaciation. Soils in the valley are deep and coarse with moderate fertility. In the hilly areas the deep and well drained soils are derived from weathered volcanic ash and lava underlain with olivine basalt. In the lower portion of the basin, the soils are generally shallow and less porous.

The subbasin vegetation is a mixture of east and west Cascade forests. The trees are a mix of Douglas fir, western hemlock, western red cedar, grand fir, ponderosa pine, and Oregon white oak. In addition, Sukdorf's desert parsley, and blue-eyed grass are found here; both of these species are federal candidates for threatened or endangered species. Of the 250,459 acres that compose the watershed, 236, 963 (94.6 %) are forested, 3.6% are pasture, 0.6% are hay, 0.5% rural residential, and 0.7% are other uses.

The White Salmon River subbasin is part of the Yakama Indian Nation lands ceded to the United States in the Treaty of June 9, 1855. Within this area the tribe reserves the right to hunt and fish at all usual and accustomed places in common with citizens of the territory. The upper portion of the basin and its tributaries are located within the legislated boundary of the Gifford Pinchot National Forest (GPNF) and federal ownership accounts for 50% of the watershed. The DNR manages approximately 20% of the basin, corporate timber holding account for 20%, while the remaining 10% consists of small private timber lands, irrigated cropland, orchards, and residential area. Most of the first 12 miles of mainstem river and its drainage are outside the GPNF, but a large portion of this area lies within the Columbia River Gorge National Scenic Area (CRGNSA) and this section of river is designated a federal "wild and scenic river" (UCD 1994).

The White Salmon River drainage was traditionally managed for timber and agricultural production; however, under the Northwest Forest Plan, much of the drainage has been designated as riparian reserves, or reserved through other means. Additionally, all lands within the CRGNSA are regulated by the Columbia River Gorge Commission's land use regulations as administered by Skamania County and the Gorge Commission. Those outside the CRGNSA are regulated by the Washington State Forest Practices Regulations. Urban development has been concentrated in White Salmon Husum, BZ Corner, and Trout Lake, Washington. Large-scale industrial activities are limited by lack of available land outside the National Forest and Scenic Area.

The river's proximity to the Portland/Vancouver area makes it a popular recreation destination for whitewater boating, winter sports, fishing, golfing, wildflower viewing, camping, hiking, picnicking, sightseeing, hunting, and berry picking.

Fish assemblages in the Little White Salmon River are divided into the area above and below the Condit Dam. Species found downstream from the dam include spring and fall chinook, coho salmon, winter and summer steelhead, large-scale and bridgelip suckers, pacific and brook lamprey, threespine stickleback, sculpins, white sturgeon, redside shiners, peamouth, and northern pikeminnow rainbow trout, and bull trout. Historically, sea-run cutthroat trout, pink salmon, and chum salmon likely used this area, but are believed to be extirpated. Species found upstream of the dam include cutthroat trout, rainbow trout, sculpin, and brook trout (non-endemic).

Klickitat Subbasin Description

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 (Pahto) forms the western boundary of the basin. Basalt ridges and plateaus separate the Klickitat from other river basins on the north and east.

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.

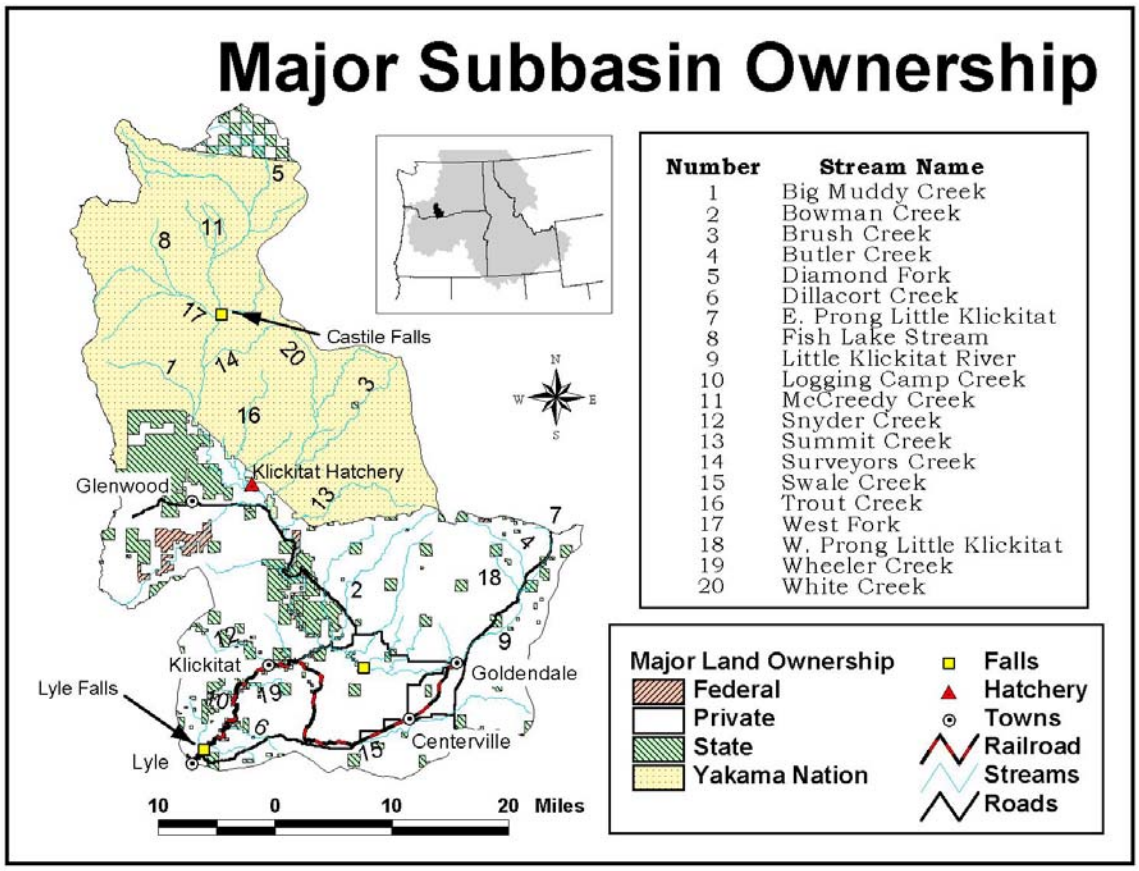

Figure 6 - Klickitat Subbasin Map

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.

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.