Chapter I Characterization

Introduction

Location

The Blue River Watershed is a fifth field watershed of 59,000 acres located entirely within the Blue River Ranger District of the Willamette National Forest. Most of the area is administered by the Forest Service; 3% of the watershed is within private ownership. The watershed is located north of the town of Blue River and extends from a ridge above Simmonds Creek to the west up to the Gold Hill area and then runs along the ridge up to Tidbits Mountain to Bear Pass and then to Squaw Mountain. From there the boundary turns south and continues to Carpenter Mountain down the ridge to Lookout Ridge where it turns west and back to below the Blue River dam and Simmonds Creek. The Blue River Watershed is located within the McKenzie River Subbasin and represents approximately 7% of the subbasin's total acreage.

Management Direction

Management Direction for the watershed is provided by the Willamette National Forest Land and Resource Management Plan (WNF LRMP) as amended by the Northwest Forest Plan in 1994 (USDA,USDI, 1994). The Northwest Forest Plan added several land allocations, including the Adaptive Management Area (AMA) which is the major land allocation guiding management in this watershed. There are underlying management emphases from the 1990 WNF Land Allocations that will be considered in the AMA decision making processes (Table 1: Management Allocations).

The overall objective for Adaptive Management Areas is to learn how to manage on an ecosystem basis in terms of both technical and social challenges, and in a manner consistent with applicable laws. Localized, idisyncratic approaches are expected that will achieve the conservation objectives of the standards and guidelines. The Adaptive Management Area was designed to emphasize technical and social learning. The first emphasis listed for the Central Cascades Adaptive Management Area is "Intensive research on ecosystem and landscape processes and its application to forest management in experiments and demonstrations at the stand and watershed level".

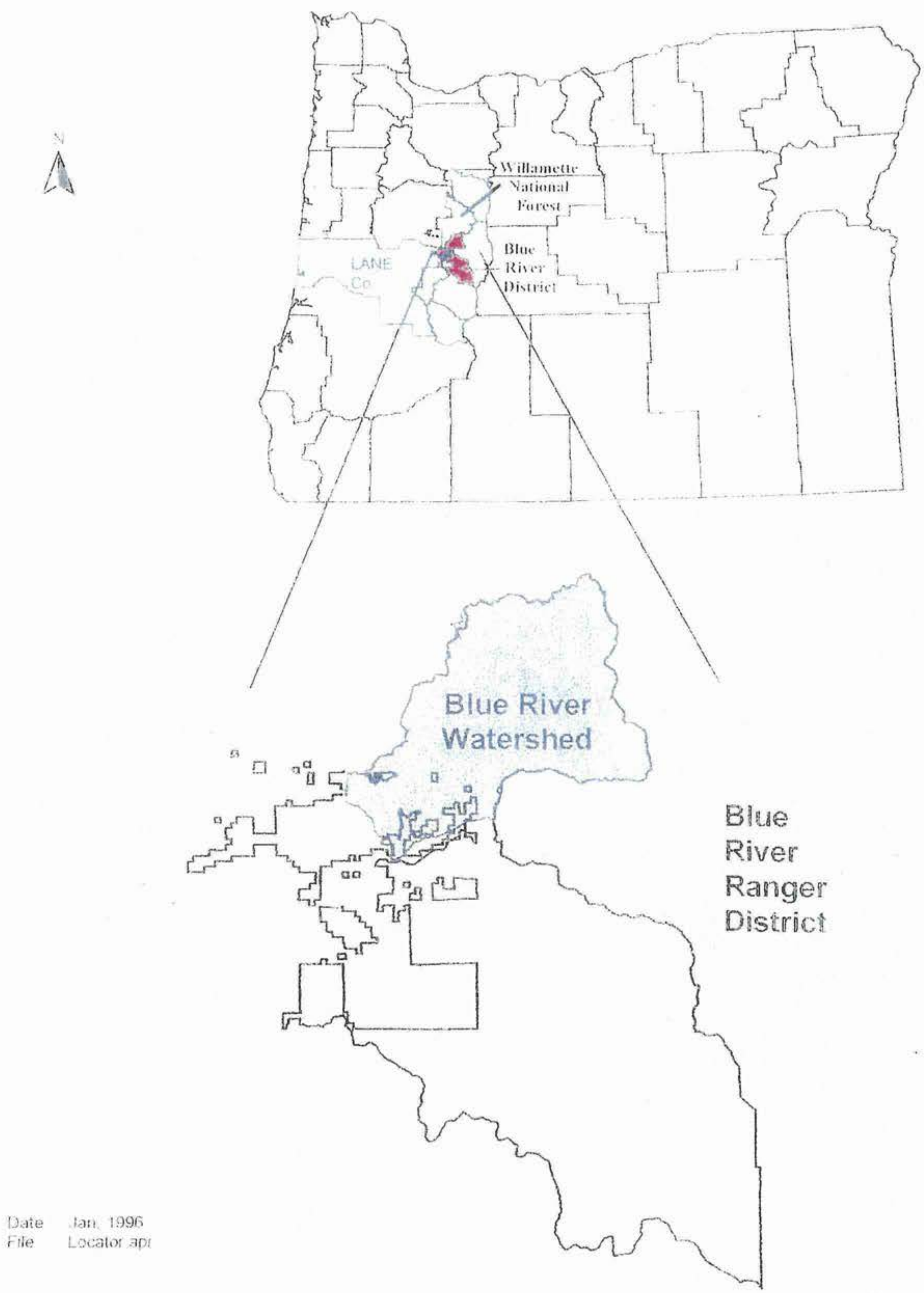
Flexibility in management and in application of Standards and Guidelines within Adaptive Management Areas provides room for innovative and experimental approaches for management activities. Management activities in the AMAs are to be conducted to acheive the objectives described in the standards and guidelines. The standards and guidelines of current plans, in this case the WNF LRMP need to be considered during planning and implementation of activities within the AMA and they may be modified based on site specific analysis.

An Adaptive Area management plan is currently being written.

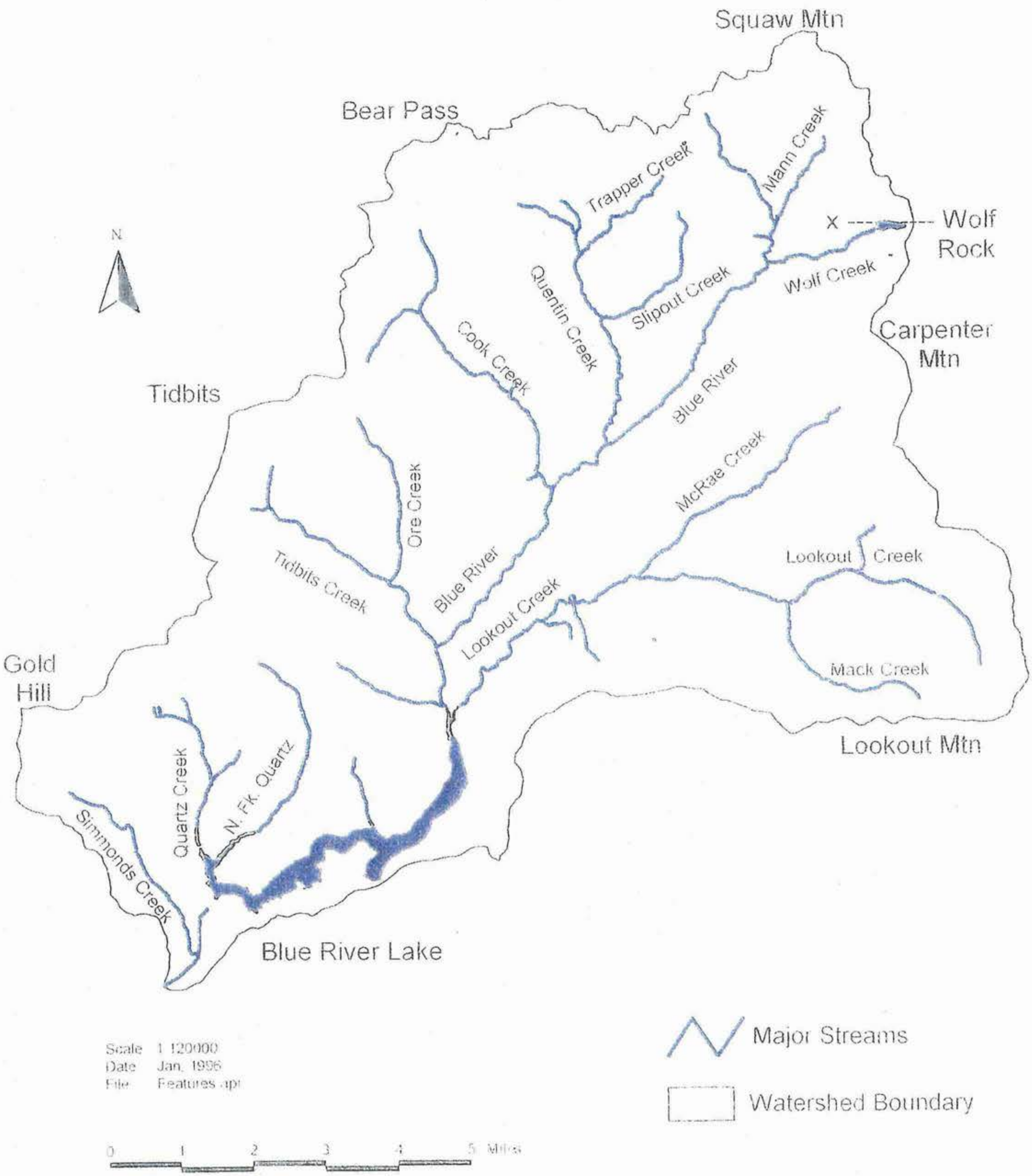
Table 1: Management Allocations

Amended Forest Plan Land Allocations	Acres
Adaptive Management Area	50,761
Late Succesional Reserve	1,748
LSR 100 acres	3,238
Underlying Land Allocations from the 1990 Willamette National Forest Plan	
Scenic	6006
General Forest	32,284
Research (HJ Andrews Experimental Forest)	15,727
Special Interest Area	1,125
Special Wildlife Habitat Area	715

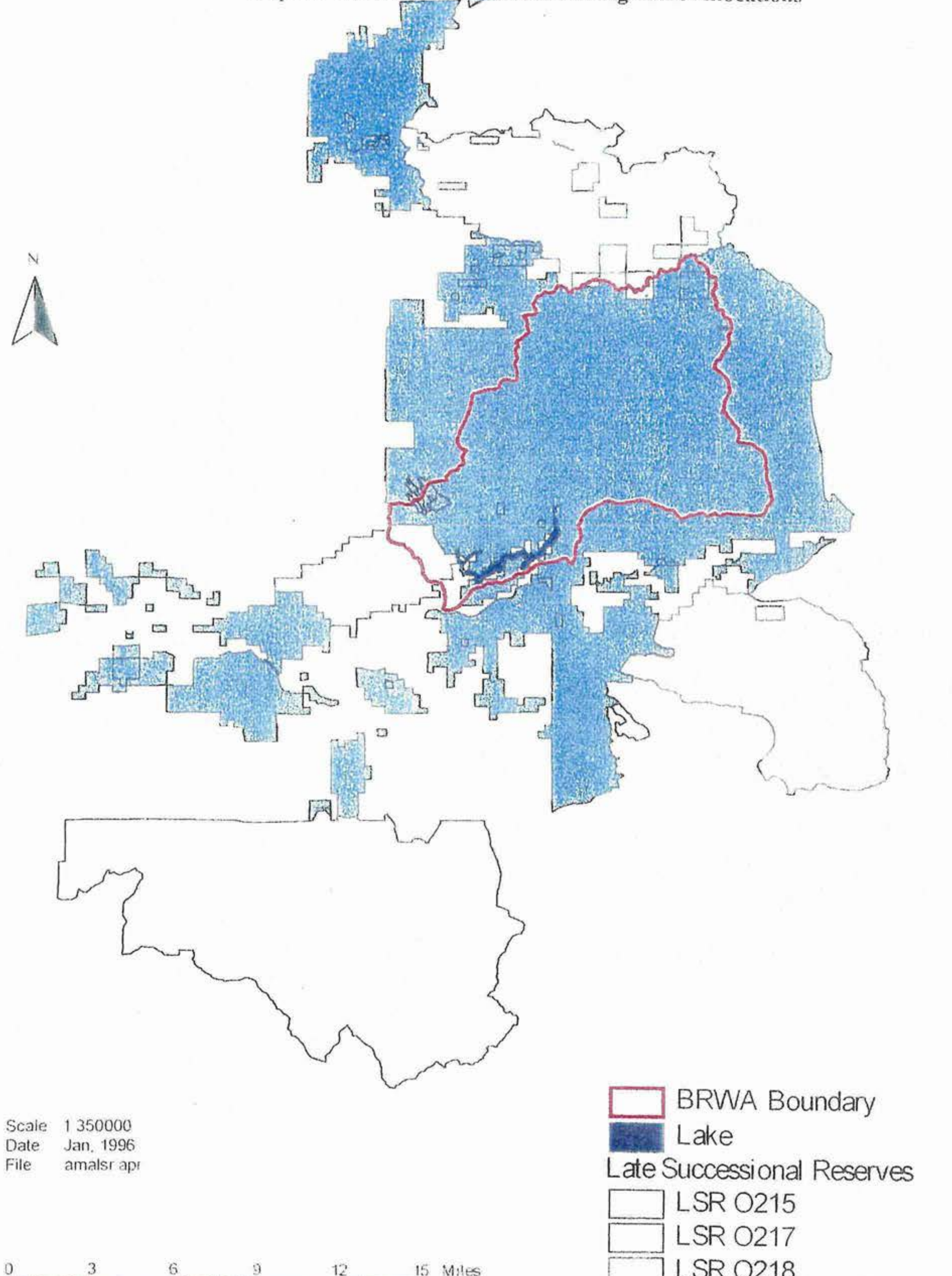
Map 1: General Locator



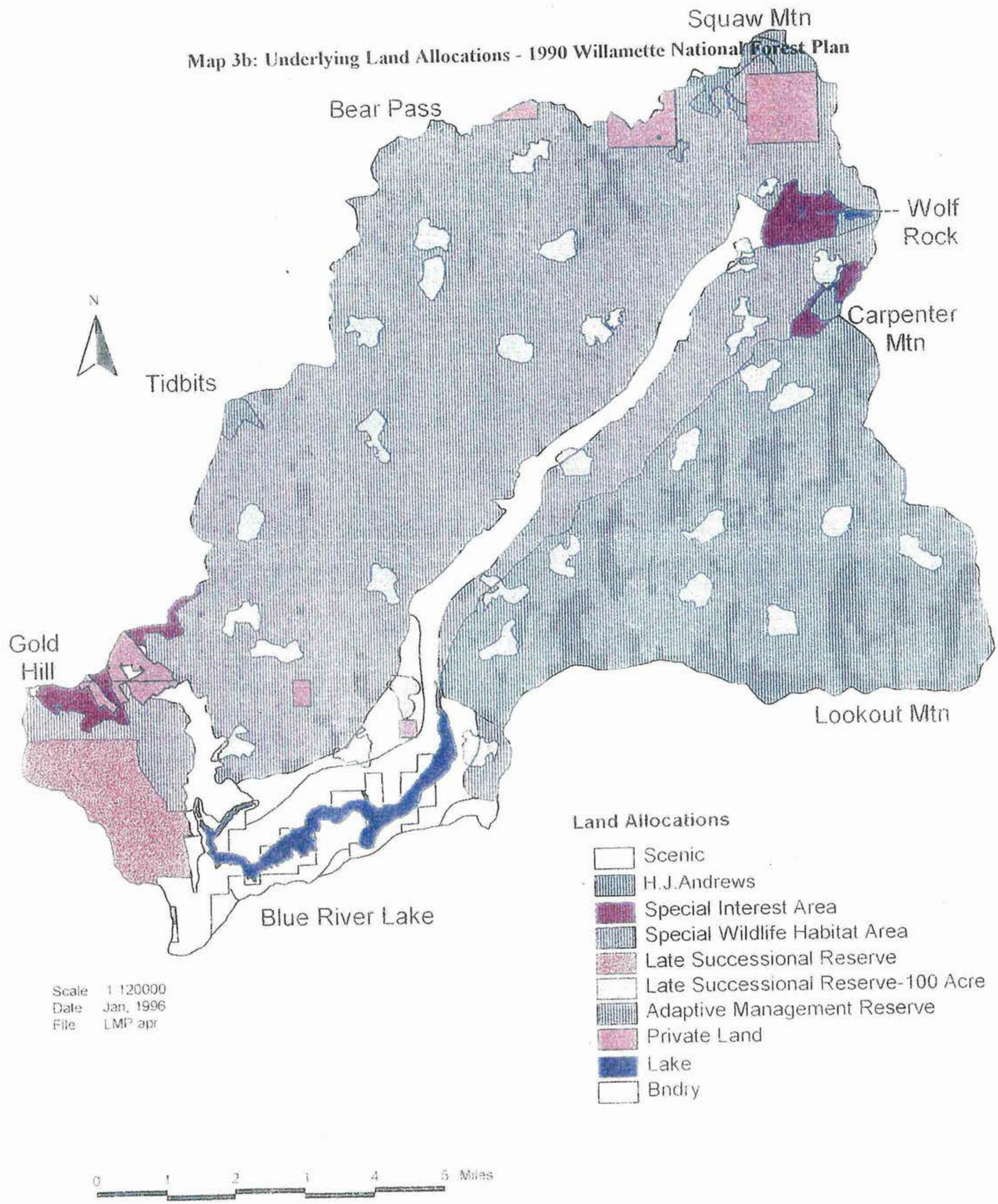
Map 2: Major Features



Map 3a: Northwest Forest Plan Management Allocations



Map 3b: Underlying Land Allocations - 1990 Willamette National Forest Plan



Physical

Geology

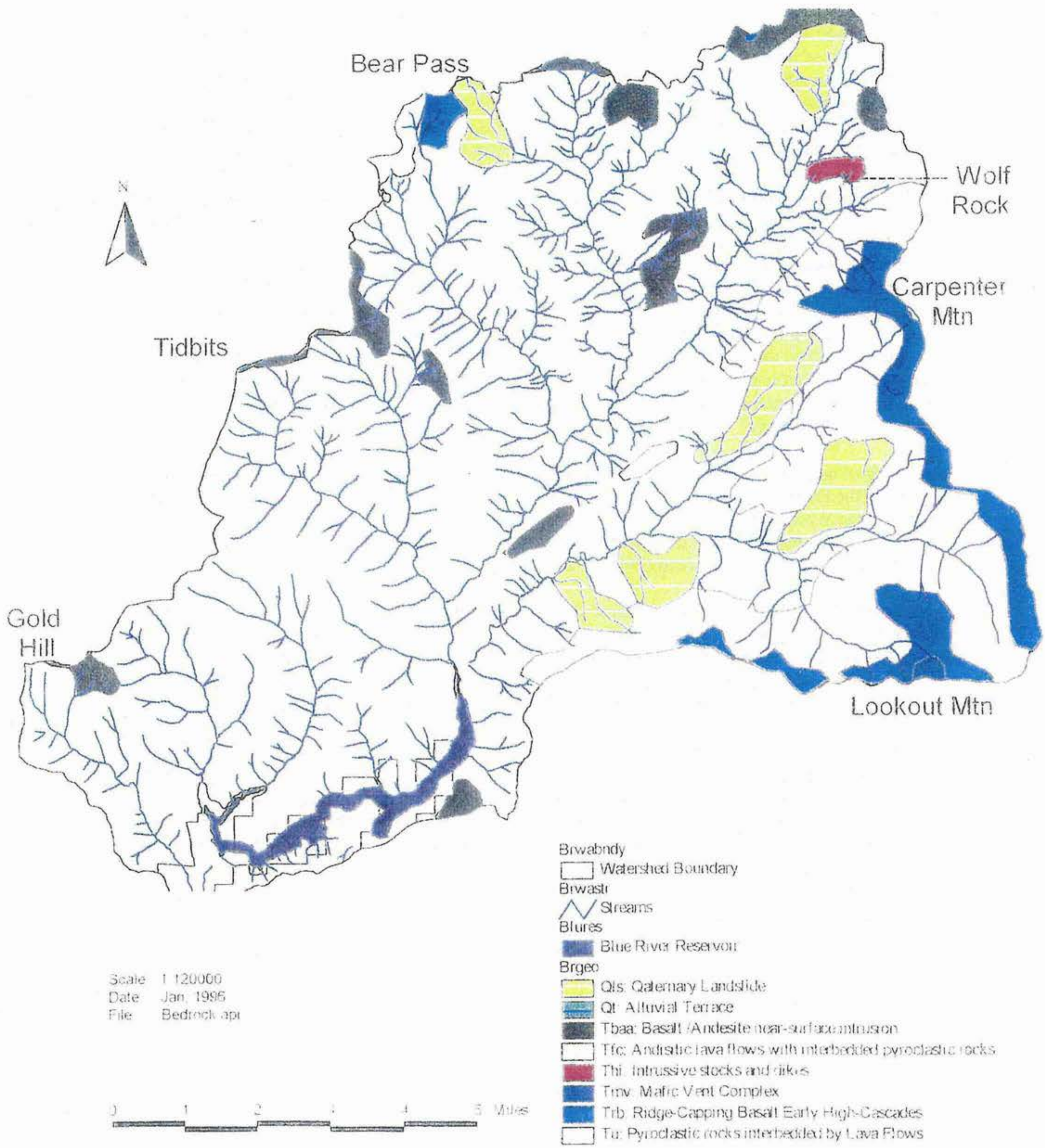
The Blue River Watershed reflects a landscape formed by volcanic eruptions, uplift of the land surface as a result of oceanic and continental plate collisions, glacial scour and fluvial erosion, and massive down-slope movements of material due to these processes. The watershed is located in an area of volcanic terrain on the west side of the Cascade Range. This is an area where two distinct physiographic provinces overlap; the Western Cascades (9-40 million years old) and the younger Early High Cascade volcanic flows (9-4 million years old) which are ridge-capping basalts in the highest elevations of the Western Cascades. The Blue River watershed is located on the eastern edge of the Western Cascades and is connected to the mainstem of the McKenzie River at the confluence of Blue and McKenzie Rivers. The watershed is confined in the south by glacial-remnant, east-west trending ridge-capping basalts of Lookout Ridge and in the east by north-south trending ridges of Frissell, Carpenter, and Squaw Mountain lavas. The northern and western boundaries are composed of ridges that were developed in older Western Cascade rocks of undifferentiated tuff interbedded by minor basalt and andesite lava flows. Approximately 13 million years ago, these older rocks at the head of Quartz and Simmonds Creeks were intruded by several small plutons of granodiorite and quartz diorite. This was accompanied by ore-bearing hydrothermal fluids deposited in northwest-trending shear zones in the Gold Hill area. This is the area which was mined for gold, silver, copper and lead between 1887 and 1913 (Power, 84). Another volcanic intrusion that is prominent on the landscape is Wolf Rock which has been interpreted to be a micro-norite (fine grained gabbro) plug of late Pliocene age, 2-4 million years old (Avramenko, 81) see "Map 4: Bedrock Geology".

Two periods of major faulting took place in the area 8-10 million, and 4-5 million years ago as a result of extension of the Earth's crust. These major northwest-trending fault systems developed near the present boundary of the Western and High Cascades. These fault systems control the north-south direction of flow of many of the upper reaches of Cascade rivers including the McKenzie, South Fork of the McKenzie, Smith, and North Santiam (Priest et. al., 83).

Approximately 3-5 million years ago, regional uplift began taking place at the rate of approximately 20 centimeters per 1,000 years, which produced an increase in elevation of approximately 500 meters. This increase in elevation was associated with an increase in stream gradient, some of which were more than twice their norm (Sherrod, 86). The increased stream gradients produced deeply dissected valleys, increased relief, and drainage patterns which are now present in the Western and Early High Cascades.

The Western and Early High Cascades were subsequently eroded by at least three periods of alpine glacial advance down-valley as far as Blue River (Long & Leverton, 84, Scott, 77, Van Dusen, 62). Glacial floods and lower mean sea levels produced further valley scouring, however, subsequent outwash, still water, and landslide deposits to depths of over 100 feet refilled the valleys to the base stream level that matches the existing sea level. Valley fills have been drilled to 146 feet in the Blue River area and up to 175 feet in the McKenzie Bridge area (Williamson, 61).

Map 4: Bedrock Geology



This sudden increase in relief also pushed the Early High Cascade lava flows to the highest elevations in the watershed. The subsequent erosion and stream incision left them stranded in the positions seen today as "ridge capping" basalts that can be seen in the upper reaches of Cook, Mann, Wolf, Mcrae, Mack and Lookout Creeks. The contact between these younger, more resistant basalt flows and the older, more altered underlying Western Cascade volcanics is characteristic of other layered rock sequences such as sandstone and shale beds where differential erosion takes place. As the older rocks are exposed in the valley sidewalls, they chemically and physically degrade faster than the overlying rocks. This can result in valley sideslope collapse and subsequent overloading of lower elevation alluvial and colluvial slopes which can trigger earthflows. This landscape is more typical of the Eastern-half of the watershed, especially Lookout Creek and Blue River.

The Western half of the watershed is situated further from the volcanic center of the High Cascades and thus lacks the ridge capping basalts and associated large-scale differential weathering processes that typify the Eastern half. This area was also located further west of the High Cascade platform ice masses during the Pleistocene, which reduced, to some extent, the amount of glacial scour and subsequent mass wasting that has taken place in comparison to the eastern half of the watershed. This is especially true of Simmonds, Quartz, and Tidbits Creeks.

There are over 60 road related areas of cut and fill slope failures documented within the watershed (Dyrness (67), Swanson and Swanston (77), Marion, (81) and over 100 localized failures within clearcut units and forested areas. Sidecast ravel from roads, road surface erosion from plugged culverts are other processes that contribute to the sediment budget. Rockfall as a result of mechanical weathering of rock outcrops and rock cutslopes are a continual problem for road ditch maintenance as well as being a source for debris avalanche potential in higher elevations of Lookout Creek. Other erosional mechanisms include localized snow avalanches, periodic floods of varying frequency and magnitude, surface erosion and historical mining activities.

Hydrology and Stream Channels

Blue River Watershed represents 7% of the McKenzie River Subbasin. The McKenzie River, with a basin area of approximately 873,000 acres, is a major tributary to the Willamette River. The water of the McKenzie River is one of the most cherished resources of the subbasin. In addition to providing habitat for fish and other aquatic species, the McKenzie River provides drinking water for over 200,000 people.

Five major dams lie within the McKenzie River Subbasin; three on the mainstem, and two on tributaries. One of the tributary dams is Blue River Dam, on Blue River. There are eight additional major dams in the Willamette Basin for a total of thirteen. These dams were constructed for flood control purposes in the Willamette Valley. During the season of major floods which extends from November through early February, a maximum of flood control storage space is provided. Starting in February as the storm activity begins to decrease in intensity and frequency, the space reserved for flood control storage can be gradually filled. Flood control regulation is based primarily on downstream channel capacities and reservoir storage space available (U.S. Army Corps. of Engineers, 1989). Many of the dams also supply hydroelectric power which is sold to the Bonneville Power Administration and is incorporated into the Pacific Northwest power grid. Blue River Dam does not currently have the facilities for power generation, although initial plans and discussions about the possibility of establishing power generation at Blue River Dam occurred in 1994 and 1995. The project has been postponed by EWEB at this time.

Wet, cool winters and dry, warm summers typify the Pacific Maritime climate here. Seasonal snowpacks usually develop above 3500 ft. elevation, with the lower elevations dominated by rain, or rain-on-snow from November through May. Elevations range from 5,349 ft. at Carpenter Mountain, to 1,040 ft. at the confluence with the McKenzie River.

Blue River is a 6th order tributary to the McKenzie River that flows south-southwest from its headwaters in the Western Cascades Province. The headwater streams of Blue River are Mann Creek and Wolf Creek which originate in the earthflow terrain of glacially carved valleys with relatively low gradients and moderately incised channels. Below the confluence of Mann Creek and Wolf Creek, Blue River quickly becomes incised as the gradient increases and downcuts through pyroclastic rocks. Between the Wolf Creek/Mann Creek Junction and Quentin Creek, Blue River flows through an old glacial terrace which is subject to mass wasting in the form of streamside slides. Further downstream, interbedded lava flows provide stable bedrock substrate and banks, at some points forming bedrock gorges. The river then enters Blue River Reservoir, a 975 acre, 6.4 mile long reservoir (at full pool) formed when Blue River Dam began operation in 1968. Flows below the dam are regulated by the Army Corps of Engineers, affecting the final 1.5 miles of streamflow prior to entering the McKenzie River. The dam has altered the river's hydrologic regime, channel and floodplain morphology, riparian vegetation, transport of sediment and wood, and natural temperature fluctuations.

The shallow soils and very steep terrain in the west-southwest portion of the watershed cause streamflows to be relatively "flashy", with stormflows occurring rapidly. Tributary streams to Blue River located in this steep terrain with flashy flows include Quartz Creek, N. Fork Quartz Creek, Mona Creek, Tidbits Creek, and Ore Creek To the north, Cook Creek and Quentin Creek are somewhat less "flashy" due to inclusions of earthflow terrain that are characterized by deeper soils that are able to absorb and meter out water on a more regular interval. To the north and east, the subwatersheds of Mann Creek, Wolf Creek, and Lookout Creek are dominated by earthflow terrain resulting in streamflows that rise and fall less rapidly than those streams located in steep, shallow soils.

The streams within the Blue River Watershed are generally high gradient (>2%) with a step-pool morphology. Most are steeply incised with narrow valley widths. The exception is Lookout Creek where an earthflow toe has formed a constriction in the channel, causing deposition of bed material upstream of the constriction and a widening of the valley bottom within the soft, earthflow terrain. Stream channels within the watershed generally lack LWD (Large Woody Debris) as a result of past timber harvest in riparian areas, road construction in riparian areas, fire, debris flows, active removal of in-channel wood, and mining. Most of the stream channel substrates are dominated by bedrock and small to large boulders, lacking small cobble and gravels due to high gradient, "transport" type stream channels, lack of LWD, mining and debris flows. Road construction and harvest associated with mining in the headwaters of Quartz Creek have been the major contributing factors to poor channel conditions in Quartz Creek A small earthen dam located on privately owned ground collapsed in Mann Creek initiating a debris flow that sluiced Mann Creek to bedrock. North Fork Quartz Creek is sluiced to bedrock due to debris flows resulting from road failures. A USGS gauging station located on Blue River upstream of the reservoir and below the confluence with Tidbits Creek has recorded major flood events from1963 to 1995. They are displayed in Table 2.

Table 2: Major Flood Events Recorded from 1963 To 1995

DATE OF EVENT	RECURRENCE INTERVAL
December 1964	100 year event
January 1965	12 year event
January 1972	8 year event
December 1977	8 year event
Febuary 1986	4.5 year event
February 1996 *	

* The Febuary 1996 event occured during this analysis. Additional data gathering and assessments are currently underway.

Water Quality

The McKenzie River Subbasin Surface Water Classification for Blue River and its tributaries are identified for year-round use only for domestic, commercial use for customarily domestic purposes not to exceed 0.01 cForest Service, livestock and public instream uses. Blue River Dam was constructed and is managed by the U.S. Army Corps of Engineers to provide a variety of uses including flood control, irrigation, recreation, and flow enhancement for fish and water quality (Water Resources Dept., 1992). The minimum perennial streamflow sufficient to support aquatic life and minimize pollution is 30 cForest Service of natural flow as measured above the Blue River/McKenzie River confluence. In addition, up to 350 cForest Service may be released from storage to augment these natural flows (Water Resources Dept., 1994). During the month of September, a minimum of 50 cForest Service is released from Blue River Dam to maintain constant flow and to augment flow as requested by the Oregon Dept. of Fish and Wildlife. Augmented flows released from the reservoir during the months of low precipitation and streamflow maintains water quality through dilution of the Willamette River to meet DEQ standards (dissolved oxygen, temperature, dissolved solids) downstream from Corvallis to Portland. Beneficial uses of Blue River include fish, water quality (parameters include temperature and sediment), domestic water source for Springfield and Eugene, and recreation (uses include boating, fishing and swimming).

Biological

Vegetation

The watershed lies within the western hemlock and silver-fir vegetation zones. Dominant conifer species are Douglas-fir, western hemlock, western redcedar, Pacific silver fir, and noble fir. Common understory species include vine maple, rhododendron, sword fern, salal, Oregon grape, huckleberries, beargrass, and numerous species of grass and forbs.

The natural stands of trees in the drainage contain a mix of younger forest ranging in age from approximately 60-150 years and older forest of about 450 years of age. The southeast part of the drainage is dominated by older forest of approximately 400-500 years of age. These vegetation patterns were created primarily by fire.

Interspersed within these natural stands are patches of young stands resulting from harvest. Much of the formerly private land in Simmonds and Quartz Creeks as well as adjacent to what is now the reservoir were initially harvested in the 1930s and had numerous re-entries in the 1940s and 1950s. The majority of the land administered by the Forest Service began to be logged in the 1950s. The formerly private land is the land that is in close proximity to the town of Blue River

Soil productivity as demonstrated by vegetation growth varies considerably within the drainage. The south western and western portions of the watershed are dominated by rocky terrain with thin rocky soils. The eastern half of the drainage is dominated by highly productive deep soils.

Non forested areas are distributed across the watershed. Plant community types include rock outcrops; talus and talus/shrub; grass and forb meadows; sitka alder; herbaceous/shrub and hardwood riparian communities. Wolf Lake located in the northern section of the watershed has an abundance of water lilies and other aquatic vegetation. High elevation huckleberry patches are local favorite for fall picking. None of the non-forested plant communities are unique to the province, but are characteristic of the Western Cascade range.

Potential habitat for sensitive and other rare plant species exists in the watershed. Documented sighting reports exist for some of the vascular plant species, fungi, lichens, and bryophytes listed in the Northwest Forest Plan. Ongoing research in the H.J. Andrews Experimental Forest has been a major contributor of information in understanding many of these species and habitat requirements in a forest ecosystem.

Noxious weeds and other invasive non-native plants occur throughout the watershed mainly adjacent to the road system.

Species and Habitats

Aquatic Species

There are 13 fish species and 10 aquatic amphibian species that are known to inhabit Blue River Watershed (Appendix Fish). The high diversity of these species' habitat requirements indicate the diversity of habitat types that can be found within the watershed. Aquatic habitat within Blue River Watershed includes a reservoir, river, streams, and ponds. In comparison with the entire McKenzie River Sub-basin, which supports 23 species of fish, Blue River has less species diversity.

Blue River Dam is an upstream migration barrier for fish, isolating fish populations upstream. Adult spring chinook return to the base of Blue River Dam on their spawning runs and some of these fish may successfully spawn in the river below. Oregon Department of Fish and Wildlife (ODFW) release 200,000 chinook juveniles per year in the reservoir to rear throughout the summer. These fish augment and diversify the fisheries in the reservoir and supplement the commercial ocean and recreational river (particularly the inner city fisheries in Portland) fisheries. They are evacuated from the reservoir during the fall reservoir drawdown. Prior to the construction of the dam, Blue River and its tributaries may have supported a small population of about 200 spawning adult chinook. In comparison, the South Fork of the McKenzie River used to support a run of 4-10,000 adult chinook, prior to the construction of Cougar Dam.

Cutthroat trout occur both upstream and downstream of the dam and can be considered the most common wild salmonid in the system. They can be found in all tributaries of Blue River where fish are present. Isolated populations in these streams are common due to natural upstream migration barriers. Cutthroat trout can be found nearly to the headwaters of most major tributaries of Blue River. Rainbow trout can be found in the reservoir, river, and the lower part of its tributaries. Both wild and hatchery rainbow trout exist in the watershed. 18,000 hatchery rainbow trout are stocked in Blue River Reservoir and 8,000 in Blue River, annually. Cutthroat and rainbow trout are common throughout most of the McKenzie Sub-basin.

Larval tailed frogs have been found during stream surveys in well aerated streams, and are used as ecological health indicators. Cascade frogs, an Oregon State listed sensitive species, occur in ponds and indicate the health of that habitat type. Rough-skinned newts are very abundant around Blue River Reservoir; they are not as common around other reservoirs on the Willamette National Forest. Presence of other amphibians and reptiles in the Blue River watershed is expected to compare to other watersheds on the Willamette National Forest.

Aquatic ecosystems have been impacted through road building, logging and salvage of instream wood.. The streams have also been impacted by floods. Recent efforts have been made to begin to restore the quantities of wood in the streams through aquatic restoration projects. Restoration projects have occurred in Blue River and Mann Creek. An impassable culvert has been removed from Mack Creek to restore upstream migration for cutthroat trout. Currently the district is working in cooperation with Oregon State University (OSU) to study aquatic vertebrate community response to the addition of various amounts of wood (complexity) to the stream channel. This project is occurring on North Fork Quartz, Tidbits and Lookout Creeks. What we learn there can be applied to future efforts to restore aquatic ecosystems through wood additions. Evaluating the responses to the Febuary 1996 event will provide useful information.

In an effort to decrease soil erosion and enhance the aquatic food chain and cover within the reservoir, portions of the drawdown zone have been planted with vegetation that can withstand being flooded for most of the summer. Structural elements such as brush bundles and erosion cloth have also been used.

Terrestrial Species

Many of the 327 species of birds, mammals, reptiles, and amphibians expected to occur on the Willamette National Forest are also expected to occur within this watershed. The distribution of species and their aggregation into communities varies with the distribution of plant communities, vegetation , and climatic conditions. Several species on the Regional Forester's sensitive species list occur in the Blue River watershed. Bald eagles have been sited numerous times but a nest has never been found. There are several potential peregrine eyrie cliff sites throughout the watershed , and there is one unverified historical peregrine falcon sighting and a more recent possible sighting.

There have been several sightings of harlequin ducks within the watershed. These ducks are also listed as Sensitive on the Regional Forester's sensitive species list Optimum harlequin duck habitat exists in several creeks including Lookout and Tidbits and Blue River. Optmum habitat is characterized by shrubby riparian vegetation along rivers and streams with fairly low gradients, and adequate loafing sites consisting of large boulders and logs. In recent years nesting has been verified within the watershed.

The Townsend's big-eared bat, a sensitive species, has been documented in the watershed. A unique cooperative study of bats at the HJ Andrews Experimental Forest has been conducted for the last three years. Several different species of bats have been identified, which may include some of those identified in the Northwest Forest Plan. Shafts created during mining activities may be used by bats for roosting.

Some of the original spotted owl radiotelemetry research was conducted in the Blue River watershed in the 1970s (Forsman). In 1987, a spotted owl density study was initiated through the Oregon Cooperative Wildlife Research Unit at Oregon State University. As a result of this research, information about owl sites in the watershed is excellent. The entire area is surveyed annually. Numerous spotted owl pairs exist within the watershed, many of which have been banded, allowing identification of individual owls through time and space. Excellent old-growth habitat exists on the HJ Andrews Experimental Forest in the Mack Creek area. Other fairly large blocks of old-growth are located in the Quentin Creek, Cook Creek, Ore Creek, North Fork Quartz Creek, and North Carpenter areas. These areas provide excellent habitat for northern spotted owls, pileated woodpecker nest groves, pine marten, and other old-growth dependent species.

The distribution of other wildlife species in the watershed is not expected to differ greatly from the species distribution in other watersheds on the Willamette of similar elevations. Beavers are known to occur in the watershed and help maintain aquatic pool habitat in some areas. Wolf Lake is a more dramatic example of this, where beavers are responsible for the creation of the lake which is used by waterfowl and aquatic amphibians.

Social

Human Uses

Native American Use of the Blue River Watershed:

The earliest artifact found in the watershed, a "Clovis" fluted projectile point, suggests that in early postglacial times nomadic hunter gatherers were working in the Blue River Area. Other than this single, isolated artifact, we have no knowledge of lifeways in that Paleoindian Period (ca. 11,500-10,000 BP).

Much more abundant are artifacts from the subsequent Archaic Period, spanning roughly 10,000 years. Numerous locations have been documented in the drainage, indicating that native people were occupied with broad spectrum hunting and gathering, exploiting available food sources on a seasonal basis. Perhaps the main staples were deer, grouse, various berries, seeds and fish. Environmental change may have brought cultural changes, but how this would be manifested can really only be reflected in the archeological record, with changes in artifact types perhaps reflecting either different cultural or ethnic groups or a shift in adaptive strategies.

The Late Prehistoric Period of roughly the last 200 years before Euroamerican settlement (ie, AD 1650-1850) saw use of the area by a band of resident Molalla-speaking people, although it is likely that Calapooya and Warm Springs bands visited the area as well. Early ranger memoirs indicate that Calapooya and Warm Springs families and bands continued to gather huckleberries and hunt game, and began grazing stock in the watershed in the mid and late 19th Century. Vision quests and other religious activities took place as well, although documentation is sparse. Descendants of the Late Prehistoric and Historic native peoples are currently enrolled in the Siletz, Grande Ronde and Warm Springs reservations.

Those people regard the living and working sites of their ancestors as historically and culturally significant, especially those in the Gold Hill area. Vision quest sites are generally regarded as "sacred sites"; it is not known if vision quest sites are currently being used for such activities, given the highly personal, private nature of the activity.

Historic Uses

Homesteading, Grazing, and the U.S. Forest Service

Before the discovery of gold in the Blue River area in the 1860's, European use of the watershed was limited to hunting and fishing parties as well as travel over the Cascade mountains. Earliest records show that Mr. Sewell Smith and John Davis had homestead claims in Blue River in the 1860's or 70's (no date given). In 1895, the Sparks family purchased two adjoining homesteads consisting of 320 acres which included the present site of the community of Blue River and the McKenzie High School. In 1900 when mining was booming the Sparks family built a sawmill, hotel, and a livery stable, and by 1911, Mr. Sparks had the town site of Blue River City laid out and plotted.

In 1893 the Cascade Range Forest Reserve was established to set aside or protect the forested area along the Cascade Range. In 1907 the Cascade Range Forest Reserve was renamed to the Cascade Forest Reserve and in 1908 renamed to the Cascade National Forest with the McKenzie Ranger District being established. In 1955 the Blue River Ranger District was formed.

From the time the Cascade National Forest was established, lookouts were constructed to provide warnings of fires. Lookout Mountain was used in the early 1900's before permanent structures were built. Tidbit and Carpenter Mountains were built in 1915, Frissell Point in 1928, Buck Mountain in 1934 and Gold Hill in 1935. During WW II Gold Hill Lookout was used as an aircraft observers lookout. All of the lookouts have been removed except Carpenter Mountain, which was reactivated in 1995.

Guard Stations were built at Wolf Rock (Buckhaven) in 1912, Blue River in 1934, and Lookout Creek in 1935. During the 1930's a CCC forest camp was located at Bear Pass.

During the late 1800's to the mid 1900's sheep bands grazed in the Cascade meadows and in the upper areas of Blue River Drainage.

A Boy Scout Camp and a few homesteads were located along Blue River before 1963, when the Army Corps. of Engineers started the construction of the Blue River Dam.

Mining:

Gold was discovered in Blue River and in the Gold Hill area along the crest of the divide between the McKenzie, South Santiam, and Calapooia River drainage's around the 1860s. The Blue River Mining District (established in the 1870s) saw most of the mining activity concentrated in the headwaters of Quartz Creek drainage and the Lucky Boy mine, although other mines were located in the North Fork Quartz and Simmonds Creek and on the north side in the Calapooia drainage.

Within the active years of 1897 to 1924 about 18 patented claims were issued averaging from 0.5 acres to 25 acres each and over 300 mining claims filed. Around the 1900s mining had developed into a booming industry in the Blue River area with many of the patent claims having well established camps consisting of saw mills, offices, equipment sheds, boarding houses, bunkhouses, kitchens, blacksmith shops, hotels, stamp mills, processing mills, and a post office. On each claim, tunnels (some with multi levels) were dug extending from 10 feet to a 1000 feet or more, and many trenches dug to expose gold bearing ore. In addition to gold, there was also silver, copper, lead, and zinc recovered from ore taken from the mines in the Blue River Mining District. Production for the Blue River Mining area between 1896 and 1924 was estimated at about 77,514 tons of crud ore, 7,727.89 oz of gold, 17,162 oz of silver, and 257 oz of copper (these figures vary depending on references).

The extensive activity in mining between 1898 and 1912 had a significant impact on the growth and development of the Blue River community. At one time more than 250 men were employed or working in various capacities in the area.

The mining activity died out in the 1920's due to the increased cost of extracting the gold from the ore. Some minor activity in the Lucky Boy mines continued into the 1960's. There are no major active operations today.

There is no information on mining activity elsewhere in the Blue River Watershed area, but many areas were prospected for gold along Blue River and other subdrainages.

Current Use of the Blue River Watershed

Most of the human use occurs in the area around Blue River Reservoir and the H.J. Andrews Experimental Forest. The H.J. Andrews Experimental Forest, established in 1948, is administered through the Forest Service and Oregon State University. It is a center dedicated to research of forest and stream ecosystems, with a commitment to communicate the results to land managers, students, and the general public. There is an administrative facility which includes housing, laboratories and offices. The facility is open all year with a full time staff, hosting tours and workshops. In conjunction with the Cascade Center for Ecosystem Management and the Blue River Ranger District, hundreds of tours are conducted each year in the Blue River Watershed for the purpose of demonstrating examples of new forest practices as well as sharing information on basic and applied research. The area within the HJ Andrews, especially the Old-Growth hiking trail and Carpenter Mt. Lookout are popular recreation destination points.

The Blue River Reservoir provides boating, swimming, fishing, and camping. The Reservoir typically is the first reservoir in a system of 13 to begin letting water out at the end of the summer. Boating, fishing, and camping occurs from April through September. There is dispersed camping and one developed campground (Mona) adjacent to the reservoir. Mona Campground has 23 spaces and averages 2800 campers each year. The number of campers is directly dependent on how long water is held in the reservoir. During the fall of 1995 Lookout Boat Ramp at the north end of the reservoir was reconstructed to extend the boating season. The entire camping area was improved and redesigned as well. There is a second boat ramp located next to Saddle Dam.

Carpenter Mountain Lookout was staffed during the 1995 fire season for the first time since the mid-sixties. Many people visited the Lookout and it is expected that visitor numbers will increase in the future. In addition to the trail to Carpenter Mountain there is a trail to Buck Mountain, as well as a trail to Tidbits Mountain.

Chapter II Issues/Key Questions

Introduction

Issue 1: AMA/Research

The Blue River Watershed is home to the HJ Andrews Experimental Forest, and the entire watershed is included within the Central Cascades Adaptive Management Area (CCAMA). Adaptive Management Areas were identified in the Northwest Forest Plan to encourage the development and testing of technical and social approaches to achieving desired ecological, economic, and other social objectives. The Central Cascades AMA was specifically identified due to its strong existing relationship between research and management. The vision of the CCAMA is to bring together research, communites and resource professionals to guide a future for natural resource management. Emphasis areas for the CCAMA include intensive research on ecosystem and landscape process as they apply to forest management, demonstrating projects at both the stand and landscape level , understanding implications of natural disturbance regimes, integrating forest and stream management objectives and acceleration of the development of late successional conditions. This watershed analysis will provide a base of understanding about the ongoing processes within the watershed that will facilitate the development of a landscape designed to meet ecological and economic needs. The Watershed Analysis and the landscape design will help lay a foundation for how activities will meet objectives of underlying management allocations.

Key Questions

1. What activities or projects are most likely to contribute to the goals of the AMA and involve researchers, managers and the community?

2. What areas in the watershed provide opportunities to address questions identified in the CCAMA Research and Learning Assessment?

3. What opportunities exist within the watershed for providing forest based employment and for producing a variety of forest products?.

4. What ongoing processes or conditions within the watershed are important to consider in landscape design?

Issue 2: Natural Disturbance

The land and vegetation within the watershed have been shaped over many millions of years by natural disturbance including volcanic action, glaciation, wind, fire, flood, insects and disease. Fire and a variety of erosional processes have played major roles in the formation of the stream channels and vegetation within the watershed.

Exclusion of natural fire from the ecosystem has altered natural processes and influenced the makeup of current vegetation. Fire history studies have been accomplished for several areas of the Blue River watershed. As in most areas of the Western Cascades , fire has been a significant force in development of distribution patterns of vegetation patterns across the landscape. Plant species composition, distribution and diversity are all affected by frequency and intensity of fire occurrence. Location and abundance of snags and large woody debris, amount of disturbance across riparian areas, size of meadows or other openings and their relation to the species associated with these factors are all influenced by the role of fire in the ecosystem. Fire causes have been both human and natural for the period that developed all of the current vegetation in the watershed.

Key Questions

1. What is the past pattern and intensity of fire disturbance in the watershed?

2. Fire pattern, fire behavior, and burn intensity are affected by fuel loading conditions and leave behind characteristic levels of large wood and snags. How do current conditions compare to fuel loading conditions before fire suppression?

3. What is the speculated role of human-caused fire in altering the vegetation, both now and in the past.

4. How did natural disturbance shape the vegetation in the watershed? What patterns were created both in the upslope and riparian?

5. Are there individual species or communities of plants that are decreasing or increasing due to fire suppression? Are there wildlife species associated with these communities that would also be increasing or decreasing?

6. What are the dominant erosional processes, not management related, and sediment delivery mechanisms operating within the uplands and riparian areas? What are the relative rates of delivery?

Issue 3: Mining

The Gold Hill area of the watershed contains the Blue River mining district. The mines were operated between 1890-1924. Although the effects of mining are localized they are unique in this area and will be discussed as a key issue.

Past mining activities may have affected a variety of processes including erosion, hydrology, water quality, human interactions, and vegetation patterns through direct mining activities such as dredging, piling of tailings and digging of shafts and through associated activities including road building, timber harvesting and transportation of equipment and chemicals. Water quality could have been affected by the introduction of chemicals and sediment. The original shafts may have changed hydrologic regimes by capturing subsurface flow. Instream dredging may have misparted fish habitat by decreasing substrate stability. Old roads are located across the slopes as well as in close proximity to the stream channels themselves and may have affected drainage patterns as well as stream channel characteristics.

Mining claims are still active in the area. New mining activities may have continued impacts on water quality and may also affect ongoing research studies by affecting the processes described above. There would be a concern in the future if mining activities were to occur closer to the Blue River reservoir or the confluence of Mann and Wolf Creeks.

Key Questions

1. What ecological processes have been affected by mining operations and to what extent?

2. What mitigation could be used for future mining activities?

Issue 4 Roads

The Blue River watershed has an extensive network of roads that were built in conjunction with timber sales. The density and location of these roads are having an effect on various processes in the watershed. Many of the roads are located on steep and unstable terrain causing mass failures in some locations and increased contribution of ravel to stream channels. There are areas of sidecast on the existing road systems that are also contributing to additional sediment input to streams.

Other roads have been built within riparian areas and are constricting stream channels, decreasing large wood potential and contributing sediment through runoff to the streams. Roads located in riparian areas and adjacent to stream channels, specifically in Tidbits and North Fork Quartz Creek, have affected the vegetation composition by encouraging alder rather than conifers in openings created by rights of way. The density of the road system also contributes to a change in timing of peak flows and contributes to larger peak flows. This occurs by the roads acting as small stream channels and in effect extending the drainage network. Roads can also interrupt the drainage pattern and affect wet areas by either creating new ones or eliminating existing wet areas and meadows. Culverts within the road system in the watershed are generally undersized and would not be able to accommodate the flow from a 100 year flood event. Some of the culverts are also acting as a barrier to movement of fish and other aquatic species.

Roads can also affect the continuity of habitat by creating a non passable barrier for some wildlife species. The system also has the potential to affect wildlife that are sensitive to human noise and disturbance. Roads act as conduits for the spread of non-native plant species.

Although roads have the potential for a variety of effects to ongoing physical and biological processes in the watershed they are at the same time a source of recreational and economic opportunities for people wishing to use the resources in the watershed. The road system also provides access for fire suppression activities.

The upkeep and maintenance of the road system is becoming an issue because the decrease in timber sales has resulted in a decreased amount of funding available to maintain the roads. Without maintenance there is the possibility that damage may occur to streams and riparian areas if the roads fail. One specific problem resulting from declining maintenance dollars is a backlog of deferred ditch and ditch relief culvert maintenance. At present a significant number of ditches and ditch relief culverts are functioning at a reduced capacity. They are partially filled in or blocked from sloughing cut slopes. Some ditch relief culverts are in need of replacement because they are damaged or near the end of their design life. If ditch and drainage maintenance is deferred much longer, drainage structures may become inoperable at some point in the future. The result may be an increased likelihood of road prism failures and increased erosion rates due to water flowing on road surfaces during storm events.

Key Questions

1. Where and to what extent has the density and condition of roads influenced natural and management induced disturbance including mass movement, landslides and surface erosion? Where and to what extent does the input of sediment influence channel conditions? What effects have these changes had upon fish populations?

2. Where and to what extent has the density and configuration of roads affected surface and subsurface hydrology through expansion of the drainage network?

3. Where and to what extent have roads affected drainage patterns that have created or eliminated wet areas or meadows?

4. Where are high risk or high priority stream crossings which do not have drainage structure designed to withstand 100 year events? Where are the culverts that would prevent fish passage?

5. Where and to what extent have roads affected riparian function by encroaching on stream channels causing constriction of stream channel, conversion of conifer stands to hardwood and decreasing large wood potential and increasing sediment to streams?

6. Where and to what extent have roads affected wildlife populations ?

7. Where and how is road use contributing to the spread of non-native plants?

8. Where are the high priority areas that need maintenance based on access needs, potential resource damage and reconstruction costs?

Issue 5: Past Harvest Activities

Harvesting trees is the primary activity that has influenced vegetation patterns since 1940. Seral stage distribution may be outside historic ranges that have occurred in this area in pre management time. Prior to timber harvest the primary process that created vegetation composition and structure was fire.

Timber harvest has resulted in a patch work type pattern across the landscape. There are usually few to no older larger trees left within these harvested areas and the trees within these areas are even-aged. The edges of these units tend to be very distinct and abrupt against adjacent forest. This pattern has resulted in a fragmented landscape which contains many fewer acres of interior forest. For the most part harvesting was concentrated in late successional forests. This has resulted in changes to species composition and habitat complexity. Some animal populations have declined due in part to shrinking amounts of habitat which they require and the inability of the species to successfully disperse across the altered landscape.

Recent management has been limited due to management allocation designations. There may be many young stands that are overstocked.

Past harvest has had the potential to affect hydrologic and erosion processes in the watershed as well. Many of the effects are similar to those associated with roads including the potential for peak flows due to increases in water quantity, changes in timing or rate of soil movement, and decreases in water quality through increases in temperature and/or sediment. Harvest could also have affected stream channel conditions by removal of large in-stream wood and harvest of potential source areas adjacent to the streams.

Key Questions

I. How does the current landscape pattern compare with historic patterns and seral stage distribution? How has timber harvest contributed to the landscape?
   - A. What is the seral stage distribution ? How does it compare to the past?
   - B. Where and what kind of non-forested habitat is present within the watershed? Are there some that have limited distribution across the watershed/Forest/Region? What threatens these areas?
   - C. What vegetative species of concern as identified in the Presidents Plan exist within the watershed? What species may occur based on their range and habitat requirements?
   - D. What TE&S species are known to occur or could potentially occur within this watershed? What is the condition of their populations and habitat?

II. What is the distribution of habitat for animal species resulting from harvest patterns and how does that compare with pre-harvest conditions?
   A. Interior habitat
   B. Edge habitat
   C. Early, mid and late seral habitat
   D. Riparian habitat
   E. Snag and log habitat

III. How has the landscape pattern created from harvest affected overall habitat for specific species of concern?
   A. What is the historic and current landscape for marten and pileated woodpecker habitat suitability?
   B. What is the current amount of suitable northern spotted owl habitat surrounding all known activity centers? What is the health of the large LSRs surrounding this watershed? How will this habitat change over the next few decades?
   C. What is the current big game habitat quality in the watershed?
   D. What wildlife species of concern as described in the President's Plan may potentially occur in the watershed based on range and habitat requirements? What species are known to occur?
   E. What TE&S species are known to occur or potentially occur within this watershed? What is the condition of their populations and habitat?

IV. What are the most important sediment delivery mechanisms generated by harvest activities? How do the rates of delivery compare with natural processes? Where are the high risk areas?

V. Where and to what extent has timber harvest amount and distribution affected water yield and water quality? Where and to what extent have these changes affected stream channel function and habitat?

VI. Where and to what extent has the removal of in-stream large wood and harvest of source wood areas changed the routing of sediment and in-stream habitat?

VII. What opportunities exist in the watershed for aquatic and terrestrial ecosystem restoration projects?

Issue 6: People Related

The Blue River watershed has been used as a place of hunting, gathering, living and recreation for people over many years. The area around Gold Hill and along the major ridge systems surrounding the area have been used by various Native American Tribes as hunting and travel routes. Most current recreation use is centered along the reservoir and the lower end of Blue River. The only place in the watershed that is developed occurs along the river below the dam. There are parcels of private land along the reservoir and along the north and west ridge systems. These areas are forested.

A major recreational activity is fishing. Blue River and the reservoir have been stocked with hatchery rainbow trout since 1970 by ODFW to enhance the recreational fishing experience In recent years they have stocked annually with 8,000 and 18,000 hatchery rainbow trout, respectively. Blue River has a wild population of rainbow trout. The hatchery fish compete with wild fish for habitat and food. Some hatchery fish may interbreed with wild fish.

Although not nearly as popular as fishing there is a minor amount of kayakers using Blue River during spring flows. The stretch of river between Quentin Creek and the reservoir is identified in the Willamette Kayak and Canoe Club Soggy Sneakers Guide as a Class 4 and 5 river run. To date, aquatic restoration efforts have balanced and accommodated the needs of the aquatic ecosystem and kayakers. This has included working with a member of the club in the design of a restoration project.

When the reservoir is drawn down, all terrain vehicles (ATV) use the drawdown zone. These vehicles may disturb vegetation and increase erosion and this practice appears to be in conflict with the effort to revegetate the drawdown zone.

During good water years, there is a desire among users of the reservoir to hold water in the reservoir as long as possible through the summer. However, if the reservoir remains too full late into the summer, the vegetation established in the drawdown zone will not have enough time to grow before winter.

Key Questions

1. How has the stocking of hatchery rainbow trout affected the wild rainbow population in the watershed?

2. Can a balance be maintained between in-river wood and kayaker opportunities?

3. What effect does ATV use in the reservoir drawdown zone have upon the establishment of vegetation and how can impacts to vegetation be avoided?

4. How can preservation of heritage sites be enhanced?

5. How does maintaining full pool later in the summer of good water years affect established draw down zone vegetation? How does the timing and amount of drawdown of the reservoir affect recreation users?

Chapter III Reference/Current Conditions

Physical

The physical section of this document will first present an overview of the entire watershed in terms of transportaion system, erosion processes and aquatic processes. The physical conditions of the Watershed will then be discussed by individual Landform Blocks. The stratification used to determine these delineations is discussed in an introduction to the individual Landform Block dicussions.

Transportation

The Blue River Watershed contains a total of 235 miles of forest development roads (Map 5: Roads). There are approximately 4 miles of privately owned roads in the northeast and southwest corners of the watershed.

Forest Service road 15 provides the mainline access into the watershed. This arterial route is 11 miles long and is maintained for passenger car use. Five collector routes, totaling 47 miles, branch off the 15 road. These routes provide access to the 173 miles of local routes which access remote project sites throughout the watershed. Twenty five miles of the local routes are currently under consideration for level 1 maintenance or decommissioning.

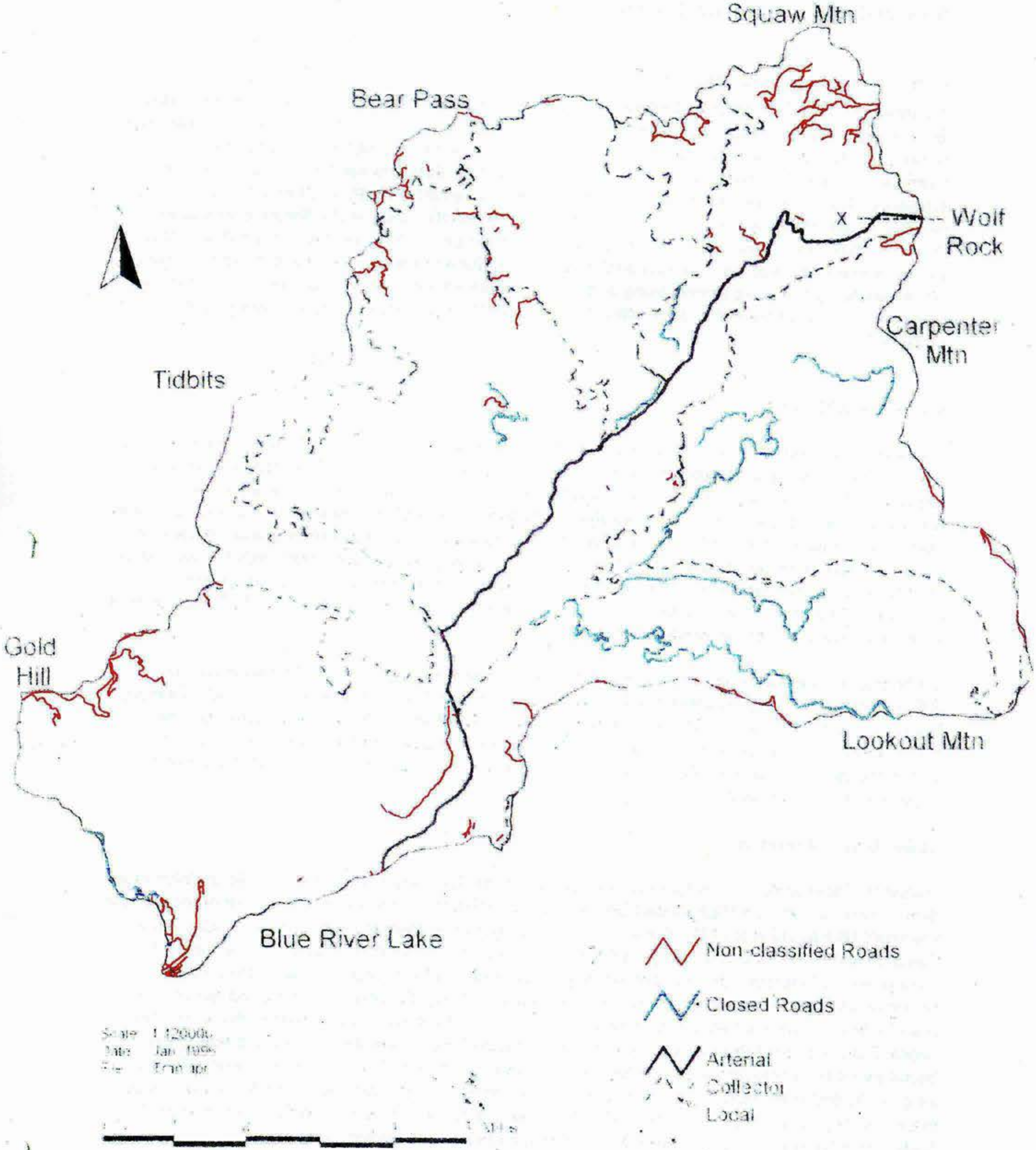
The average daily traffic on the asphalt double lane paved portion of the 15 road, just north of highway 126, was 380 vehicles per day for the months of August and September in 1995. Traffic counts for the same months in 1982 and 1983 were 266 and 442 vehicles per day. In 1982 and 1983 it was estimated that 43% of traffic was related to logging, 44% recreation, and 13% related to Forest Service administrative use. With essentially no logging activity in this area since 1992 the current count is related to recreation, administrative, and traffic to the HJA.

The collector routes are currently driveable by passenger cars but are technically only maintained for high clearance vehicles. These routes have been maintained to a standard higher than intended in the road management objectives to support the high traffic flows associated with timber harvest activities of the past 20 years. As a result there is a precedence set for passenger car use that will not be sustained in the future as the road condition is managed to a lower standard due to declining maintenance budgets. Many of the short local routes are currently driveable by high clearance vehicles.

At present, aside from areas of localized slope instability, the collector road network appears to be in a well maintained low impact condition. However, declining maintenance dollars are resulting in a backlog of deferred non-traffic generated road maintenance such as ditch cleaning, slough removal, and culvert cleaning. At present a significant number of ditches and ditch relief culverts are functioning at a reduced capacity. If ditch and drainage structures become inoperable at some point in the future an increased likelihood of road prism failures and increased erosion rates could result due to water flowing on road surfaces during storm events. Deferring this relatively low cost maintenance may potentially lead to high cost reconstruction in the future and increased sediment delivery to adjacent resources.

The private roads in the Gold Hill mining area and section 16 in the northwest corner of the watershed are intermingled with Forest Service roads.

Map 5: Roads


Squaw Mtn
Bear Pass
Wolf Rock
Carpenter Mtn
Tidbits
Gold Hill
Lookout Mtn
Blue River Lake
Non-classified Roads
Closed Roads
Arterial
Collector
Local

Geology-Erosion Processes Overview

Reference Conditions Overview

An understanding of the watershed reference conditions relies on an interpretation of the history, origin, and processes of natural disturbance regimes that have resulted in the present topography and geomorphic landforms. Over the landscape, estimations of pre-human occupation conditions can range from quantitative probability models to qualitative descriptions of the dominant mechanisms of erosion and deposition. Both methods were used in this study where appropriate. Landform Blocks 1, 2 and 3 were modeled as statistically quantitative "Watershed Indices" due to the nature of the dominant landslide processes (debris flows and avalanches) being suitable for the Level I Stability Analysis Method (LISA). The quantitiative method was supplemented by a more qualitative approach for Landform Block 4 due to the dominant mass wasting process being deep seated earthflows and rotational slumps. The following disturbance regimes have had a causal relationship with erosion processes and mass wasting in the watershed.

Valley Stress Relief

Valley sideslope collapse and resulting talus and deep colluvial toe slopes can be the result of valley stress relief and elastic rebound (Matheson and Thomson, 73). Valley stress relief and the resulting rebound is a function of the elastic modulus of the rock, deviator stress, and cyclic intervals. Stress application to valley sidewalls and floors can result from alpine glaciation or outwash sediment accumulation. In alpine glacial environments, these events are usually recompression cycles, as a function of glacial advance and retreat in response to global warming and cooling trends. This cyclic deviator stress tends to have a more adverse effect on rock slope stability than single valley-stage alluvial development by erosion and deposition. These conditions conducive to mass wasting are prevalent in Landform Blocks 3 and 4 as well as in the higher elevations of Landform Blocks 1 and 2.

Differential weathering occurs in rock masses that are layered with sequences of alternating rock of different strength, such as sandstone and shale sequences, basalt flows over glacial till , or ridge-capping basalts overlying pyroclastic rocks such as in Landform Blocks 3 and 4. In these situations, the lower-strength material weathers at a faster rate than the overlying material, resulting in an overhang. This force imbalance eventually results in failure of the overhang, which may precipitate mass failure of the slope (Arambarri and Long, 93).

Alpine Glacial Processes

During the Pleistocene (1.6 my bp to 12,000 yrs bp) at least three major changes of climate (perhaps more than a dozen) produced a High Cascade ice field that completely covered all but the highest of the Cascade volcanoes (Birchfield et.al., 81). The ice sheet eventually moved down the valleys on both sides of the Cascades and in the Mckenzie valley, as far as the community of Blue River (Scott, 77, VanDusen, 62). Avramenko ((81) mapped the extent of valley glaciers from Squaw Mountain down the Blue River Drainage, and from Carpenter Mountain down the Lookout Creek drainage. Swanson and James (75) describe how the ancient Blue River drainage flowed into the McKenzie basin through what is now the Saddle Dam area, until this drainage was blocked by the McKenzie mainstem glacier and subsequent lateral moraine. These advances were followed by retreats of the ice. These cycles may have taken as long as 100,000 years each. Many theories have been advanced as to a general reason for major changes in the Earth's climate, but the one most often held now is a periodicity in the Earth's orbit that takes it further from the sun on about a 100,000 year cycle (Shackelton and Opdyke, 73).

Glacial Advance

During times of extreme ice accumulation on the continent, and in the higher elevations of the Cascades, several processes interact to produce accelerated geomorphic change. As ice accumulates, the world ocean levels are lowered due to a lack of return moisture (that becomes entrapped in the ice) to the hydrologic cycle. Sea levels are estimated to have been at least 200 feet lower during the Pleistocene than today (Flint, 71). This means that in addition to the ice scour that took place in the valleys during glacial advance, the stream gradients were drastically increased which in turn caused stream velocities and erosive capabilities to increase.

As a glacier advances down a valley, compressional stress is applied to the valley sidewalls which causes a temporary elastic strain, or deformation, to accumulate within the rock masses. Glaciers accumulate material from the valley bottom and sidewalls as they advance. These deposits are transported down valley in front of the glacier as terminal moraine. The material transported along the bottom of the glacier is called lodgment till and is often found in a very compacted and dense state. The material transported and deposited along the sides is called lateral moraine, and the upper glacial debris left as the ice melts in place is called ablation till (Flint, 71). These deposits all have a common aspect in that they are composed of unsorted material of varying sizes and lithologies.

Geomorphic features in the higher elevations produced by glacial scour and morainal blockage of streams include most of the high elevation basins. Other features produced include cirques (depressions left by ice), cols (saddles between ridges formed coalescing glaciers) and tarns (peaked spires).

Glacial Retreat

Valley side slope instability is a result of glacial processes. The stress applied to the valley sideslopes during glacial advance may be removed by glacial recession rather quickly (geologically speaking, thousands of years). When this occurs, the temporary elastic strain that accumulated in the valley sidewall rock mass during 100,00-200,000 years of ice loading, elastically "rebounds" as the load is released. This causes rupture in the rock mass, and valley side slope collapse which results in large landslide deposits and talus slopes (Ferguson et.al., 81, Long, 94a,). Earthquakes and seismic loads associated with volcanic eruptions are also a source of major landslide and debris avalanche initiation (Keefer, 93, Long 94b).

During glacial retreat, deposition occurs along valley sidewalls from material that has fallen on top of the ice mass at the lateral margins which then may become stranded on the valley side slopes after ice melt occurs. This material may remain in a marginal state of slope equilibrium as latent landslides, and may be susceptible to failure with very little geometric modification such as road construction or stream scour.

Ice dams may have formed at valley constrictions behind terminal moraines. Proglacial lakes then form, and still water sediments of clay and silt accumulate in seasonal varves, or thin layers. These deposits can be very important to geologists who can interpret the time, sequence, and climate during this period in Earth history. Ice dams are susceptible to breaching and cause massive down valley flooding, scour and deposition, and may cause major rivers to change course.

Fire

Wildfire, especially in high intensity burns where tree mortality is greater than 70%, has four direct impacts on slope stability: root strength is removed from the soil as root systems are burned underground; macropores are opened in stump holes leaving large cavities for water infiltration; evapotranspiration ceases; and tree surcharge, which adds a stability component to the slope is removed. In addition to mass movement, overland erosion is also accelerated. In 1981, 50% of all post-fire slope failures on the Boise N.F. occurred as debris avalanches in soil less than 3 feet deep on slopes greater than 73% (Gray and Megahan, 81). Unlike high intensity wildfire, prescribed burns are normally low intensity in which the stumps and roots do not burn out. Swanson (79) cites that the "almost 70 percent of long-term sediment yield ...occurs in the first year after fire..." Historically, the shortest return interval (96 years) and probably the highest intensity fires in areas of steep slopes and low shear strength soils have burned in Landform Blocks 1, 2 and 3.

Precipitation

Local storm events that depart from normal precipitation can be a triggering mechanism for slope failures, especially if the antecedent rainfall has been above average, and the soil is already near saturation such as the 1964, 100-year event and the 1986, 7-year event.

Earthquakes

Earthquakes have probably triggered many of the ancient landslides in the watershed, especially slopes that contain loose glacial deposits, and are a daily occurrence in the Pacific Northwest. The majority are below 3.0 magnitude, but due to our proximity to the Cascadia Subduction Zone off the Pacific Coast, magnitudes of 8 to 9 have been recorded in the geologic record (Heaton and Hartzell, 87).

On the Oakridge Ranger District, a 2 million cubic yard earthquake induced landslide that displaced the North Fork of the Middle Fork of the Willamette River has been dated at 4,700 years before present (Long, unpublished report). Anecdotal reports include blockage of the Columbia River for several days after a major earthquake struck western Washington in 1872 and triggered a landslide dam (Oregon Geology, 94), and the great Bonneville landslide which blocked the Columbia 700 years ago (Palmer,77). The 5.6 magnitude Scotts Mills earthquake in March of 1993, and the Klamath Falls 6.0 earthquake in September of 1993 are just two examples of recent seismic events that are becoming more frequent. Darienzo and Peterson (95) have dated at least six occurrences of great earthquakes along the Pacific Northwest coast with and average magnitude of 8.0, and an average recurrence interval of 400 years with some as low as 200 years.

The proximity of the watershed to the probable focal point of a subduction earthquake is over 50 miles. This distance provides a certain amount of attenuation for primary and secondary shock waves. An expected peak velocity of 6-19 cm/s and a duration of shaking of less than 9 seconds reduces the risk of damage considerably (Weldon, 94), however does not eliminate the risk. The Corps of Engineers determined that the Tumalo Fault was capable of producing of magnitude 7.2 earthquake in the area, a local fault system in the Three Sisters area a 6.0, and a magnitude 5.1 for the North Santiam Fault Zone, which runs along the McKenzie and Smith Rivers south to Belknap Springs.

Methods of analysis for establishing statistical Watershed Erosion Indices

Using the Cumulative Area per unit Time Method (Marion,81) and the Level I Stability Analysis Program (Hammond, et.al., 88) to estimate historical soil transfer rates induced by wildfire, the results were compared to results of Marion's 1981 study. Marion found that the majority of slope failures occurred in S.R.I. soil type 21 on slopes between 30 and 40 degrees.

A Geographic Information System (G.I.S.) frequency query of the number of failures intersecting S.R.I. polygons showed that SRI units 201, 203, 212, and 21 (all SRI type 21 complexes) accounted for over 50% of the landslides (Figure 1: Landslides by SRI Unit). A slope map of the watershed was prepared from a digital elevation model which shows slopes bracketed <30%, 30-50%, 50-70%, and >70% (Map 6: Percent Slope Ranges). An intersection query was then run to obtain the number of polygons and their area in which SRI 21 complexes intersected slopes >70%.

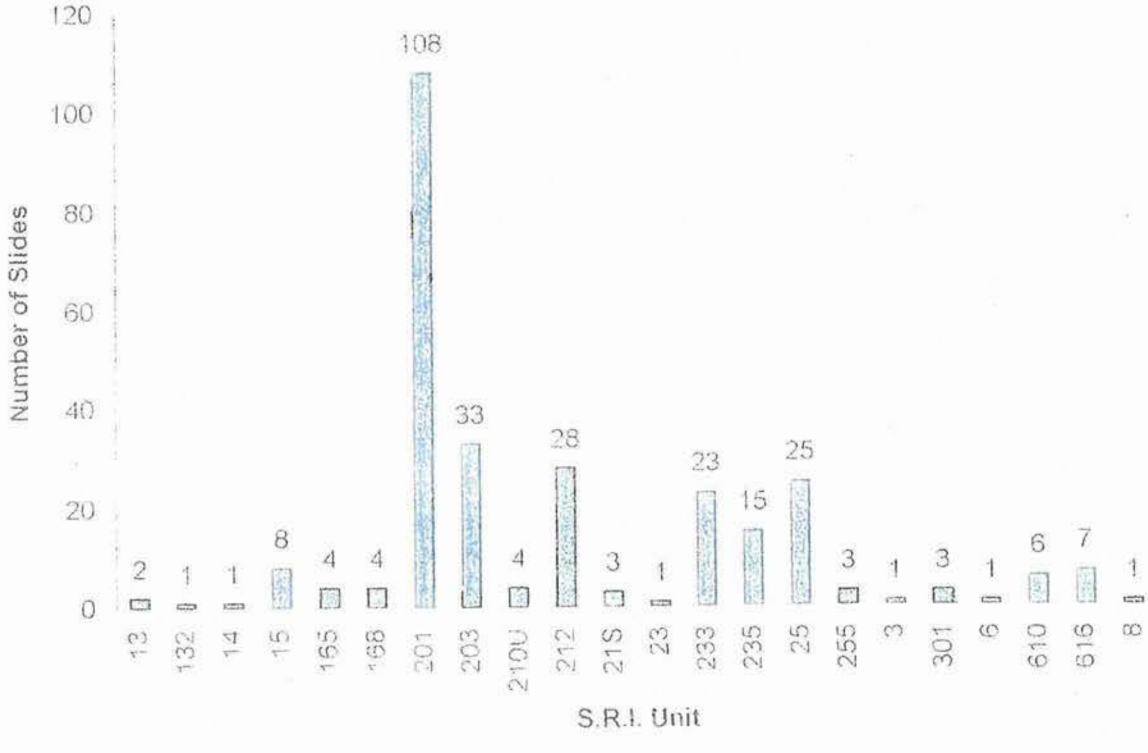
Probability Analysis

A probability analysis was made for these polygons using the Level I Stability Analysis program, LISA (91), developed by the Intermountain Research Station to statistically analyze the probability of failure within these polygons under historical fire return interval conditions coincidental with normal and extreme precipitation events.

The 1973 S.R.I. database for soil engineering properties was used for assigning ranges for physical variables such as soil depth, soil classification and shear strength. Slope angles were varied as intersections occurred between the S.R.I. layer, and a slope layer which was created by bracketing slope angles into polygons < 30%, 30-50, 50-70, and >70%. These ranges of values were then entered into LISA which develops cumulative and probability distribution functions for each variable used in the infinite slope equation to calculate a factor of safety. The equation is iterated 1,000 times using a Monte Carlo simulation subroutine to randomly select variables with the ranges and distribution functions defined to solve the equation. A factor of safety frequency histogram is produced along with a Probability of Failure. This can be interpreted as a percent of area within a polygon susceptible to failure, or the relative frequency of events.

Validation studies have been completed in areas of western and eastern Washinton and southwest Oregon by Ristau (88), McHugh (91), and Wooten (88). The results from the LISA analysis were then used to back-calculate soil transfer rate values for Landform Blocks 1 and 3 for what could be used as a reference condition prior to fire suppression or human occupation. NOTE: Landform Block 1 was used as a test to determine if the calculated values for soil transfer rate for reference conditions would be in the same order of magnitude as those calculated for field measured conditions by Marion (81). The results were encouraging, therefore Landform Block 3 was analyzed in the same manner to make a direct comparison. The results are shown in Figure 2: Soil Transfer Rate and the analysis is located in the Appendix.

Figure 1: Landslides by SRI Unit



Map 6: Percent Slope Ranges

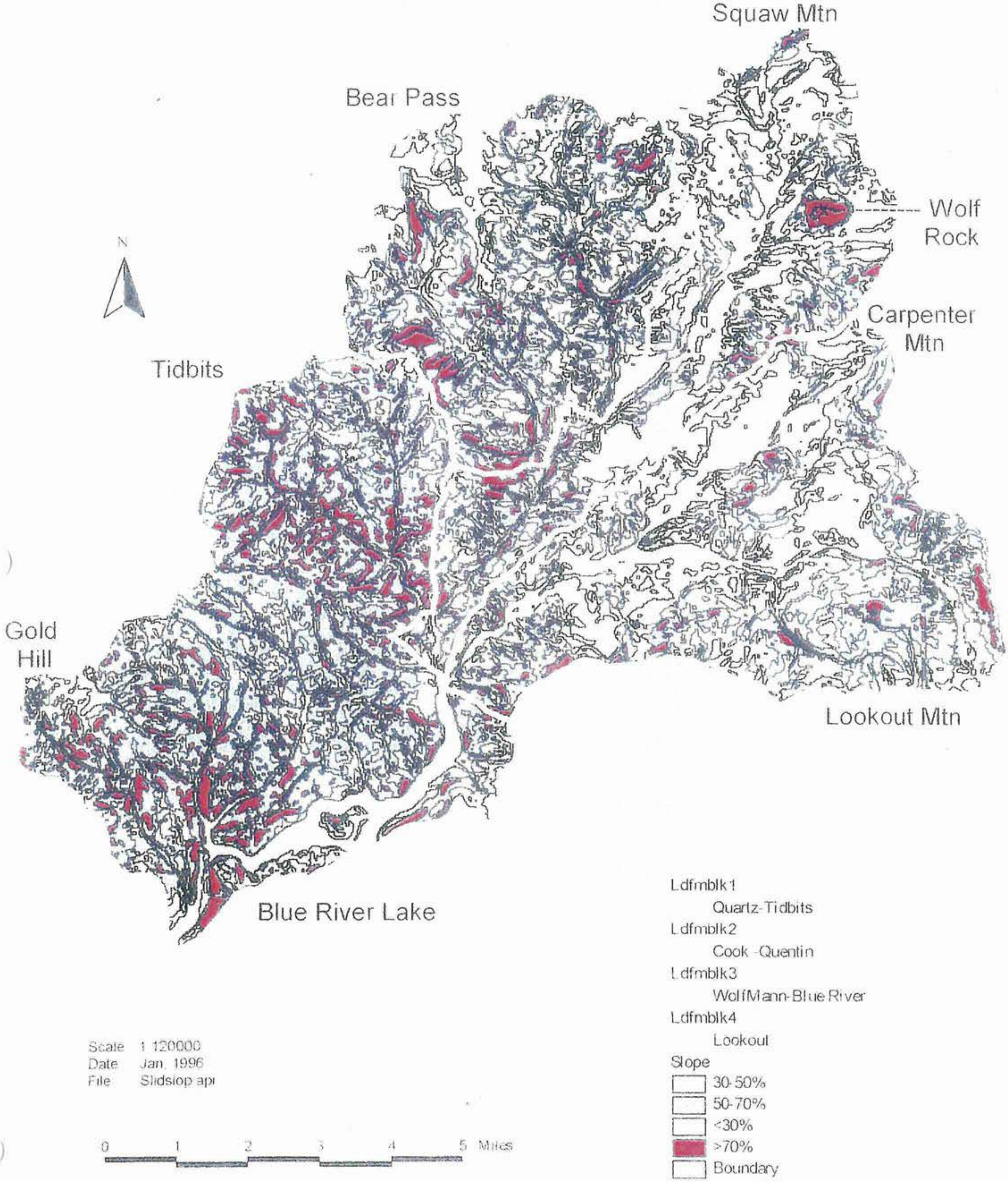
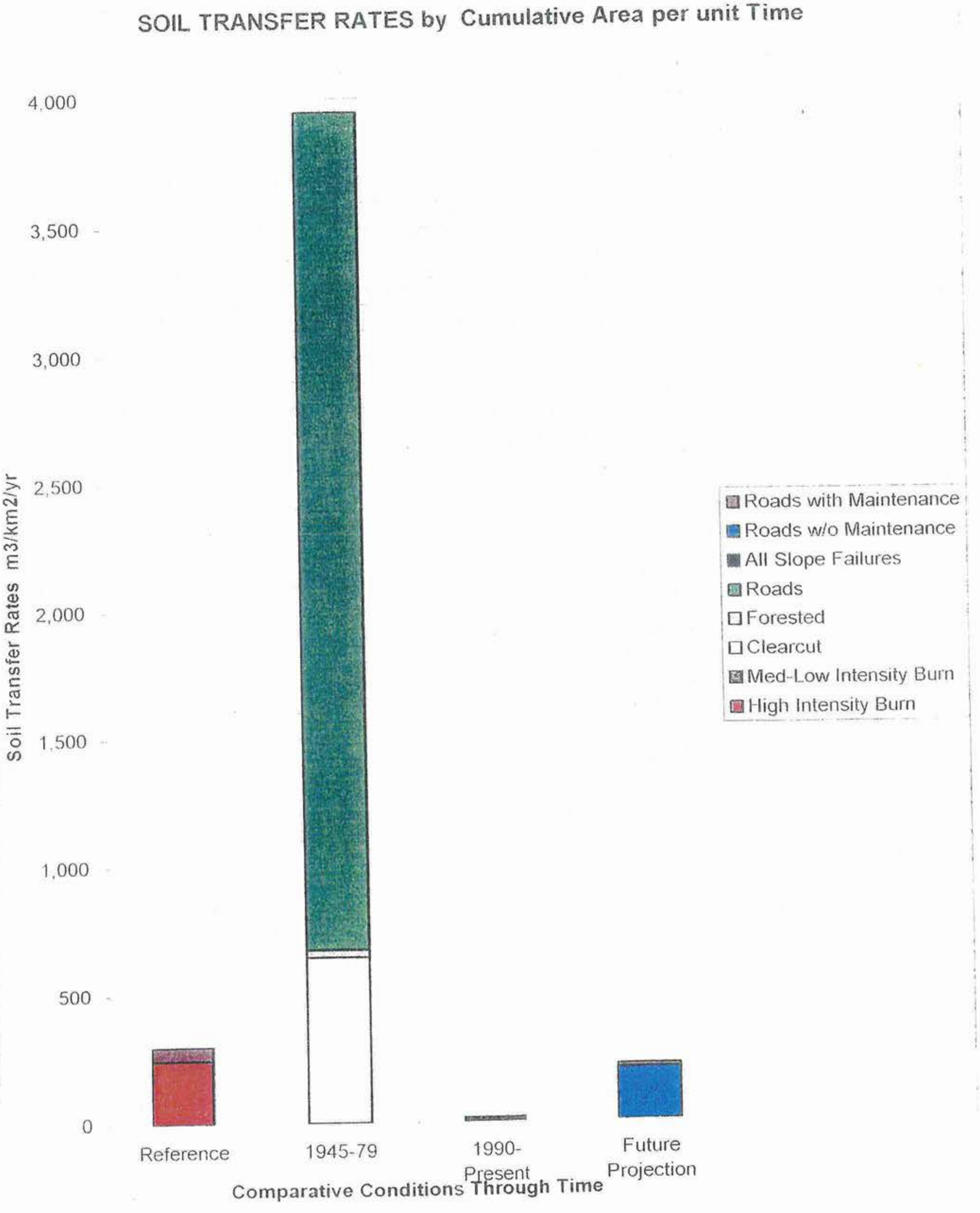


Figure 2: Soil Transfer Rate



Current Conditions Overview

Slope Stability and Recent Disturbance History

Mass wasting, or slope instability is initiated when the sum of the driving forces on a slope (gravity, earthquake loads, construction loads, valley stress relief, pore water pressures, changes in geometry) exceed the resisting forces (soil and rock shear strength, root cohesion, tree surcharge). Natural events such as fire, precipitation and earthquakes, and human caused disturbances such as road construction and tree harvesting can cause rapid changes in slope equilibrium (Koler, 94).

In general, the highest number of incidents of mass wasting have occurred in Landform Blocks 3 and 4 (Table 3: Site Specific Landslide Occurences). This is due to the nature of the landforms being located in areas which are more susceptible to weathering and decomposition. Due to the stress loads applied to the valley walls during glacial advance. The majority of mass movements have occurred in elevation bands of less than 2,000 feet, and 2,000-2,800 feet, which may represent glacial process influences, deep glacial soils, and ancient landslide deposits interacting with timber harvest and road construction that were at a peak during 1964 and 1985 storm events (Table 4: Total Landslide Occurance by Elevation and Figure 4: Landslides by Elevation).

Table 3: Site Specific Landslide Occurrences

Number of Site Specific Landslide Occurrences							
Landform Block	1	2	3	4	Total	% Occurances	% Total Watershed Failure Acres
	Quartz-Tidbits	Cook-Quentin	WolfMann-Blue River	Lookout			
Unmanaged	19	2	32	60	113	36	2
Roads	28	10	16	33	87	28	1
Harvest	12	3	41	59	115	36	2
Total	59	15	89	152	*315		

Table 4: Total Landslide Occurance by Elevation

Total Landslide Occurance by Elevation					
Landform Block	1	2	3	4	Total
Elevation	Quartz-Tidbits	Cook-Quentin	WolfMann-Blue River	Lookout	
<2,000	12	7	47	58	124
2,000-2,800	19	1	26	64	111
2,800-3,200	11	2	11	16	40
3,200-3,600	6	3	2	6	18
>3,600	11	2	3	8	23

Road Construction

The watershed contains approximately 235 miles of roads. A review of the geotechnical engineering project files, interviews with district personnel, field surveys and several data bases concluded that the watershed contains approximately 87 road related failures with historical significance. 70% of these failures occurred in Landform Blocks 1and 4 (Table 3: Site Specific Landslide Occurrences). Rock aggregate for road surfacing has generally been of high quality in the watershed, which has kept road surface sediment contributions to a minimum, however, in the Tidbits and Cook-Quentin Creek drainages continual ravel from road cutslopes require yearly ditch cleaning.

Clearcut Harvest

The practice of clearcutting for timber harvest in itself is not entirely detrimental to slope stability. Root strength tends to remain in place for up to 5 years, and the soil biomass remains in place. However, clearcutting does remove the tree surcharge from the slope, and the major portion of the evapotranspiration system is removed until re-growth can occur. If a major storm event occurs, a net decrease in slope stability can lead to failure.

Unlike intense wildfire where root cohesion loss is 100%, after clear cutting, the root cohesion loss for Douglas Fir is approximately 50% by the end of the 1st year and 75% after 5 years (Gray and Megahan, 81). Ziemer (81) also noted that "Removal of slope vegetation tends to decrease root cohesion, increase piezometric levels and decrease slope surcharge...and about 50% of the original root reinforcement is lost within 2 years after clearcutting and 90% is gone within 9 years." He also pointed out that "It may take about 15 years until the new forest provides 50% of the root reinforcement supplied by the original forest before cutting and 26 years until the soil in the harvested area returns to the strength of that in the uncut forest." The majority of post-harvest failure (87%) has occurred in the Wolf-Mann and Lookout Creek drainages in Landform Blocks 3 and 4.

Map 7: Landslide Distribution

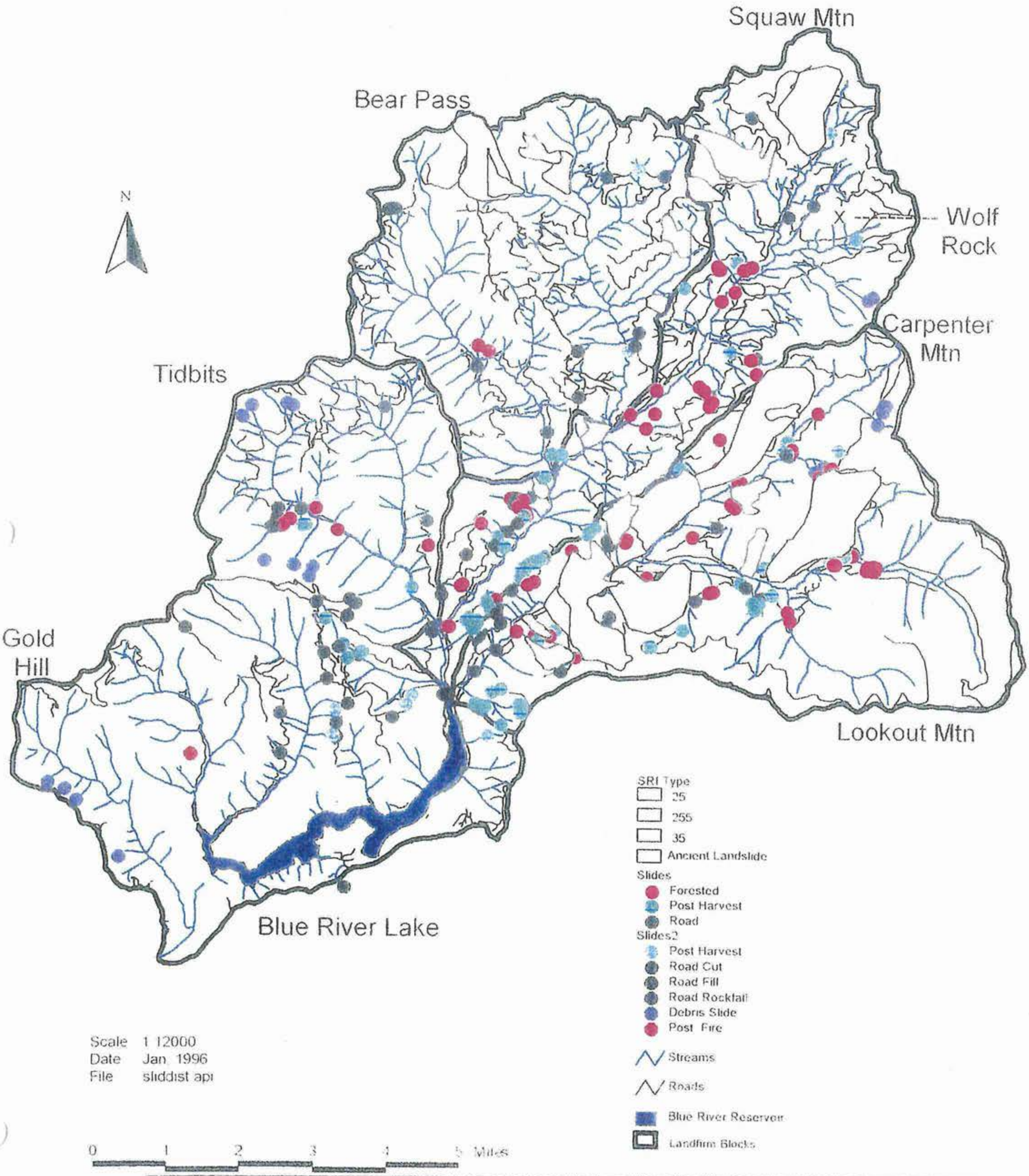
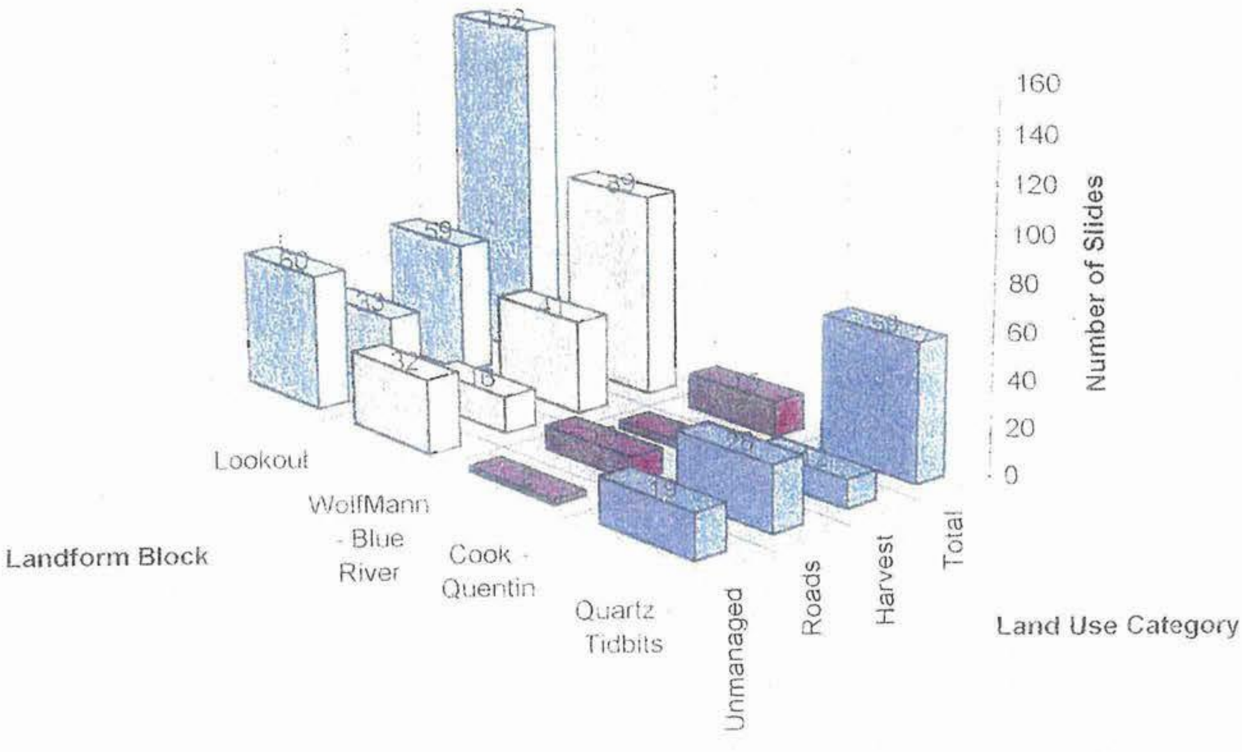


Figure 3: Landslides by Land Use Category



Aquatic

Watershed Overview

Stream Flows

Reference Conditions

Collection of streamflow data within Blue River began in 1935 in the current location of Blue River Reservoir. This station recorded a 25 year event in 1945, 10-year event in 1953, and a 7-year event in 1956. The 1964 flood is calculated as having a return interval of over 200 years based on the nearly 30 years of record at this station. The gaging station was discontinued on December 31, 1964 when plans were made to construct Blue River dam. A new gaging station was constructed downstream of the proposed dam and a second in Blue River below Tidbits Creek Data collection at these two stations began in 1963 below Tidbits, and 1966 below the dam. Both stations continue to operate to this day. During periods of high intensity burns which covered large areas, streamflows would likely have increased, particularly during the spring, summer and fall months due to lack of transpiration. Drainages that experienced such burns and would have translated into increased water yield and peak flows would have been Simmonds, Quartz, Cook, and Mann.

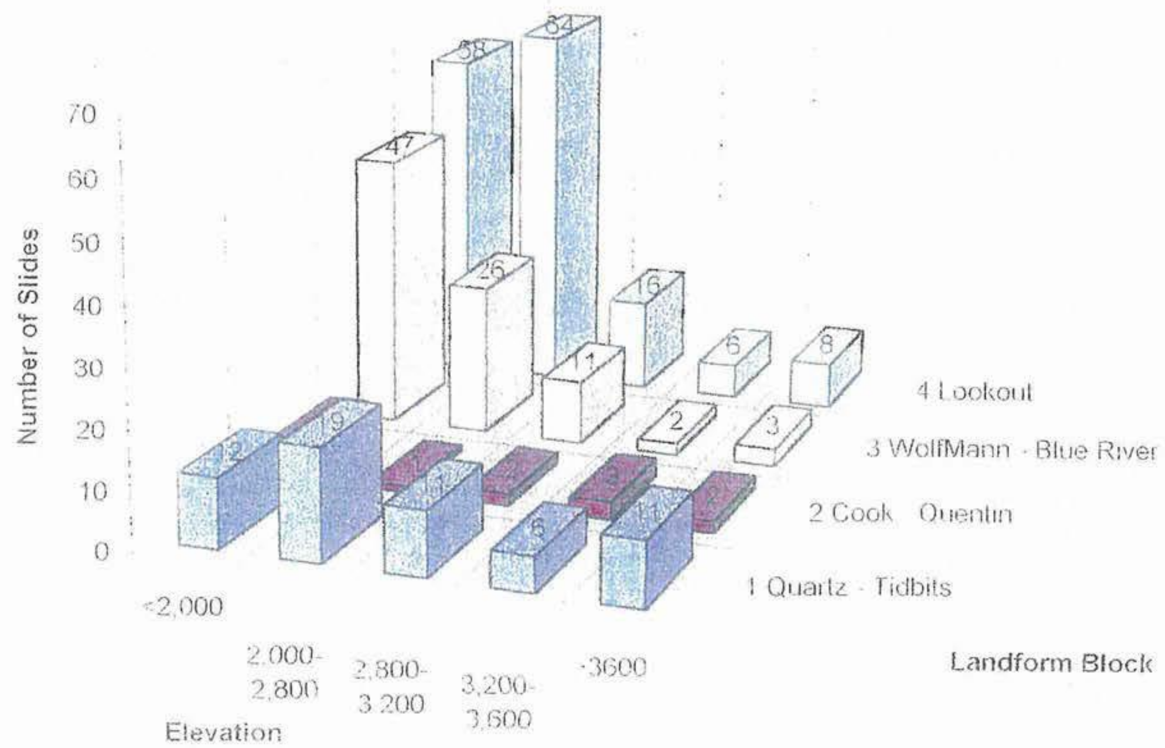
Most stream channels within this watershed are steeply incised, high gradient systems with narrow valley bottoms that confine the stream and are generally considered "transport" systems. The exception is Lookout Creek, which has a long stretch within the mid-section of it's stream length that has a relatively wide valley bottom and is a "response" reach. There are also numerous sediment "source" areas, many of which were not mapped. Map 8 displays "source", "transport" and "response" stream reaches based on valley segment types. Stream reaches are characterized as transport, response, or source based on valley segment type. Valley segment types that are transport systems are generally >5% gradient and have little room for depostion of bedload. High streamflows would mobilize channel substrate and transport the sediment through the system until lower gradients and wider floodplains would provide depositional areas. The following valley segment types are "transport" segments:

V-Shaped Moderate Gradient-V1
V-Shaped High Gradient-V2
Moderate Gradient Headwater-H1

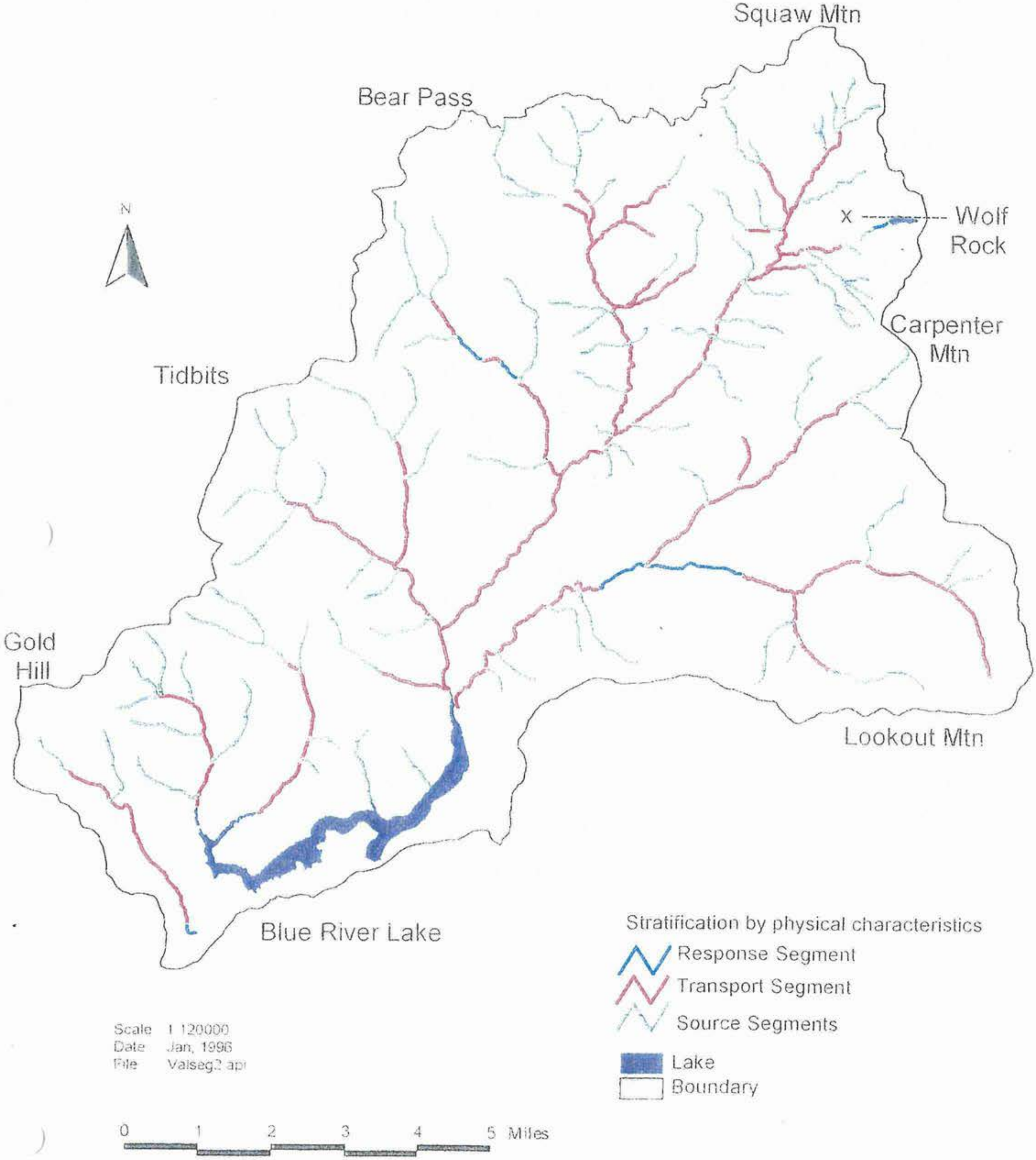
There are few "response" segments within the watershed, although there are locally many small reaches within "transport" segments that provide areas of deposition. "Response reaches are generally <5% gradient and have unconstrained stream channels within relatively wide valley bottoms. During periods of high flow, sediment transported from upstream reaches will have opportunity to deposit within the bankfull channel and on the adjacent floodplain, causing many changes in the channel configuration.. The following Valley Segments Types are considered "response" segements:

Alluviated Mt. Valley-V4
Paulustrine/Springfed/Meandering-F6
Moderate Slope Bound Vallye-M2
Incised U-Shaped Moderate Gradient-U2

Figure 4: Landslides by Elevation



Map 8: Stream Channel Stratification



The only stream with a clear "response" reach is Lookout Creek where it is coded as an Alluviated Mountain Valley. Cook Creek also has some short reaches that show clear signs of floodplain deposition. Although the lower sections of Cook and Quentin Creeks are assigned V-Shaped-Moderate Gradient valley segment types (transport reaches), they border on a "response" classification of Alluviated Mountain Valley.

Valley segment types that are considered sediment "source" areas include:
High Gradient Headwater - H2
Very High Gradient Headwater - H3

Current Conditions

Peakflows

Streamflows within Blue River have been modified from historic flows due to fire suppression, roading, and timber harvest. Peak streamflows may occur as a result of rain events or rain-on-snow events. They potentially cause transport of large channel substrate, channel widening, and bank erosion. A study which included Blue River and Lookout Creeks indicate that peak flows have increased as a result of harvest and roading (Jones and Grant, 1995). This was demonstrated where roads and harvest units ranged from 10 to 25% of the basin area. An increase in peak flows in the Jones/Grant Study was found to occur in both small drainage and larger subwatershed with the effect being greater for small storms as compared to larger storms. All blocks exceed 20% harvest with Quartz/Reservoir/Tidbits and Mann/Blue River/Wolf exceeding 30%. (Figure 5: Percent Harvested by Landform Block)

Focusing on a smaller scale, several drainages with >30% of their area harvested, including Reservoir Face, Simmonds, Scout, North Fk. Quartz, Mona, Blue River Face, Wolf, and Mann. (Figure 6: Percent Harvested by Drainage) These figures do not even include the area in roads which are identified as causing changes in flow routing (Jones and Grant, 1995). Roadside ditches intercept subsurface flow and directly route this water to stream channels. A recent study suggests that approximately 60% of the road network in Blue River and Lookout Creek is connected to the streams, potentially increasing the stream drainage density by 40% (Wempel et al, submitted).

The Landform Block Mann/Blue River/Wolf exceeds 3.5 miles/sq. mi., with Cook/Quentin and Lookout just below 3.0 miles/sq. Mi. (Figure 7: Road Density by Landform Block and Figure 8: Road Density by Drainage)

Mann smaller drainage is the main factor for a high road density within Mann/Blue River/Wolf, however, Blue River Face contributes as well. Within the Lookout Block, Lookout and McRae drainages exceed 3.0 mi./sq. mi., but Mack drainage pulls the average road density down for the block. Although Quartz/Reservoir/Tidbits has been extensively harvested, harvesting was accomplished using tractors without formal road building, reflected in a low road density.

To determine the relative contribution of Blue River Watershed to a potential rain-on-snow event, three factors were considered: snow accumulation; snow-melt rate, and water yield from soils. The combination of all three factors are displayed in Map 10: Potential Constribution to Rain-on-Snow. Drainages that had a high percentage of harvest units or mid-slope roads located within potentially high contributing areas to rain-on-snow, are considered to contribute to increased peak flows. Blue River Face and Quentin drainages had both harvest units and mid-slope roads located within high contributing areas, likely resulting in increased peak flows. Tidbits drainage also had a large area of harvest units located with high contributing areas. Cook and Mann drainages had harvest units located within high contributing areas to a lesser degree than Blue River Face and Quentin, but probably still cause increased streamflows. Roads may increase peak flows independent from harvest units, and may be causing increased flows in Mann, Lookout, and McRae drainages.

Of course, placement of the dam on Blue River has dramatically modified streamflows below the dam. As documented in The South Fork McKenzie River Watershed Analysis (1994), dams constructed for the purpose of flood flow regulation reduce instantaneous and average peak flows, eliminating floodflows which are critical to the rejuvenation of the system.

Map 9: Sixth Field Subwatersheds and Smaller Drainages

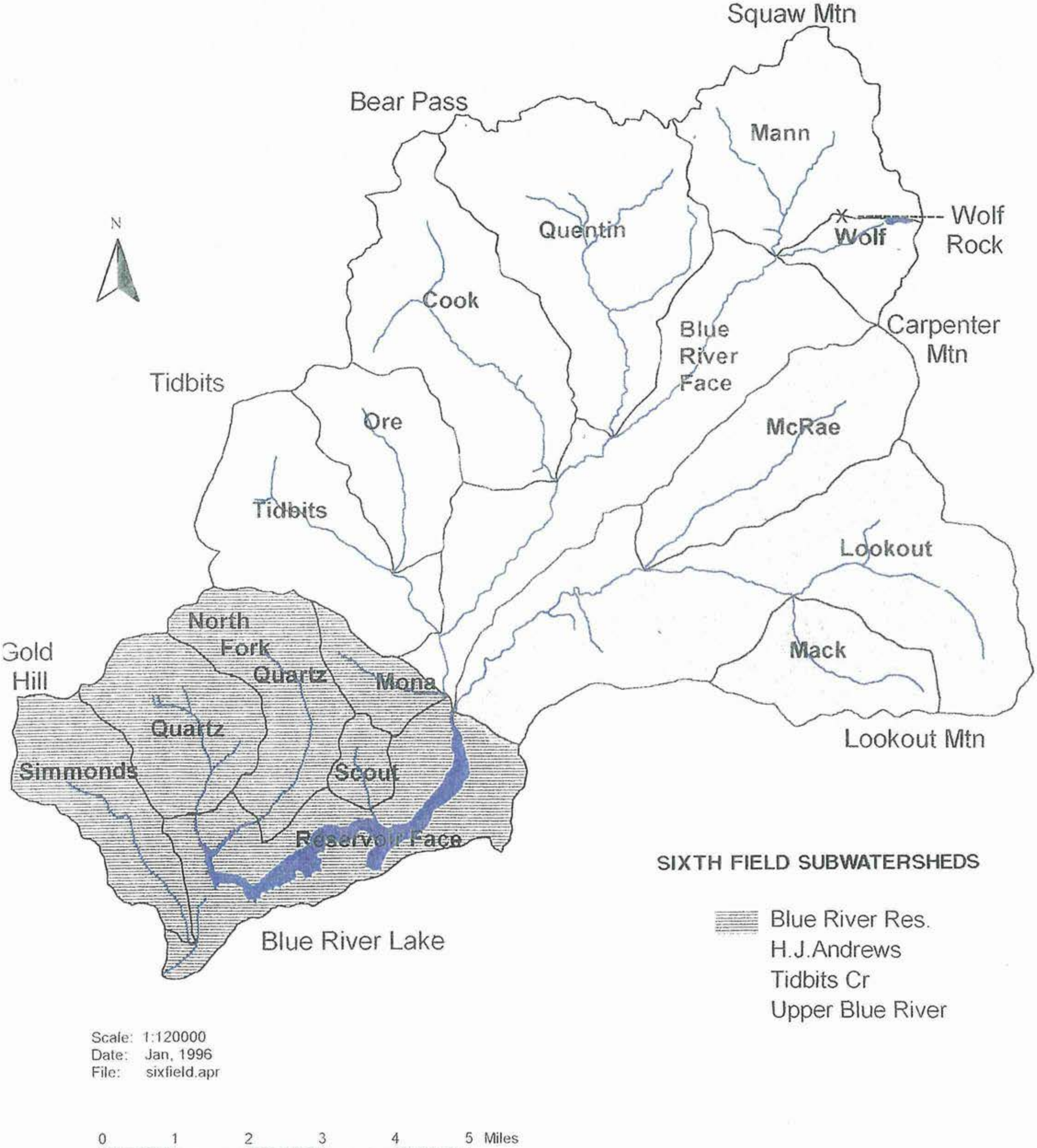


Figure 5: Percent Harvested by Landform Block

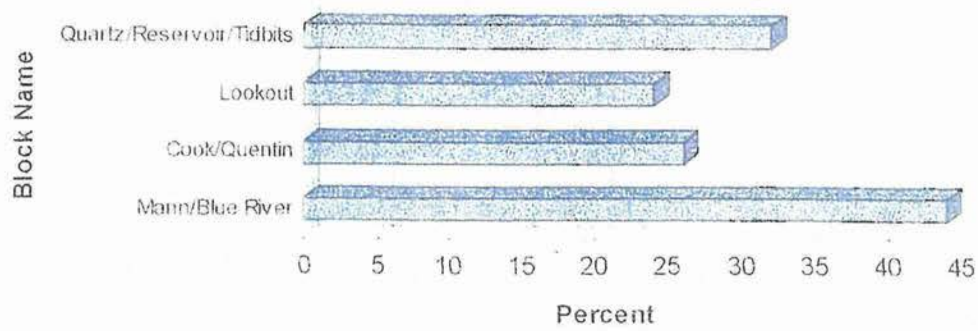


Figure 6: Percent Harvested by Drainage

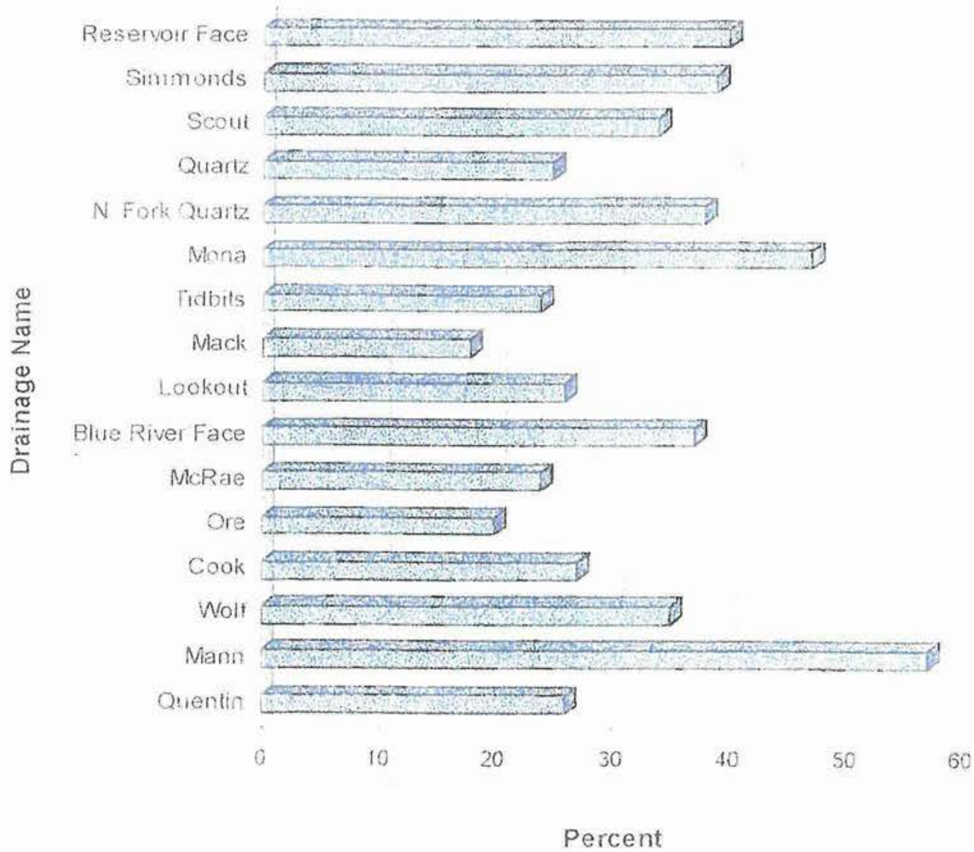


Figure 7: Road Density by Landform block

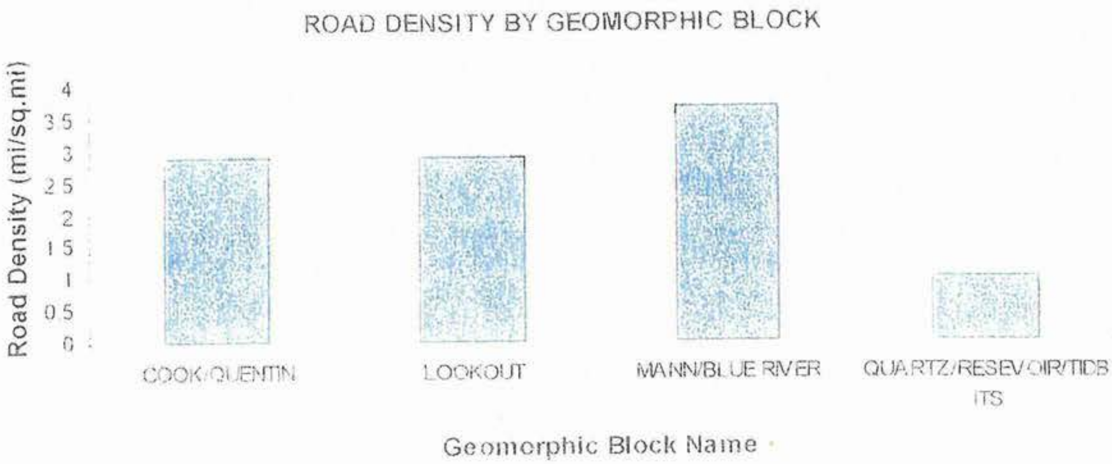
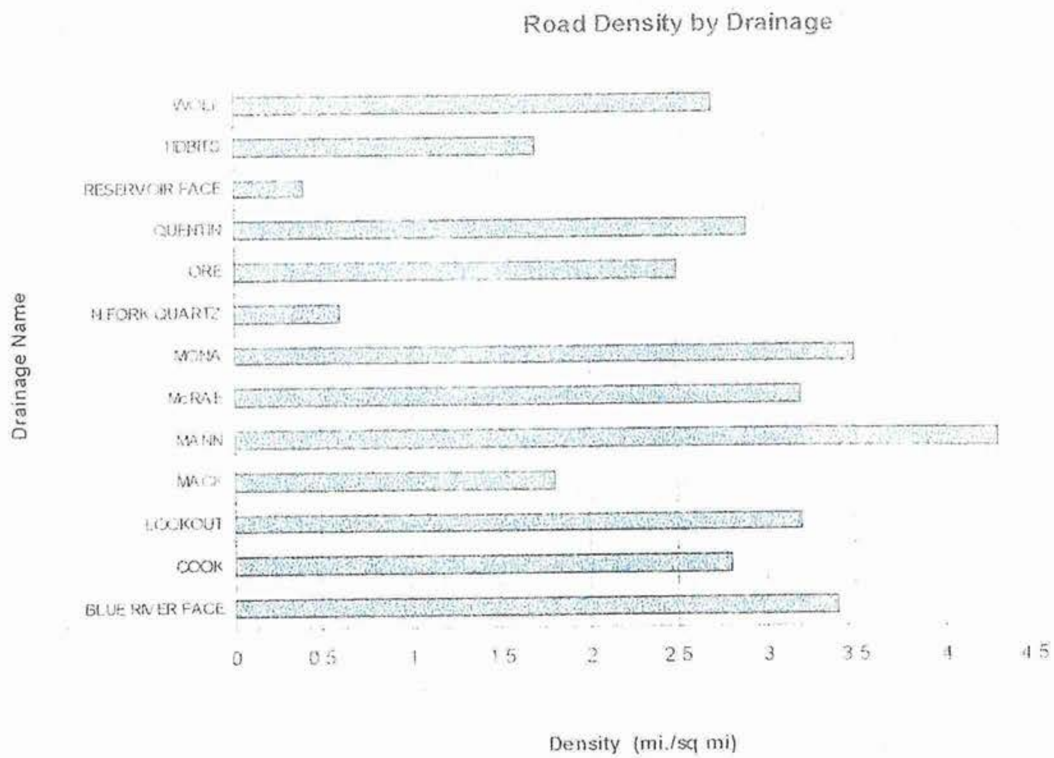
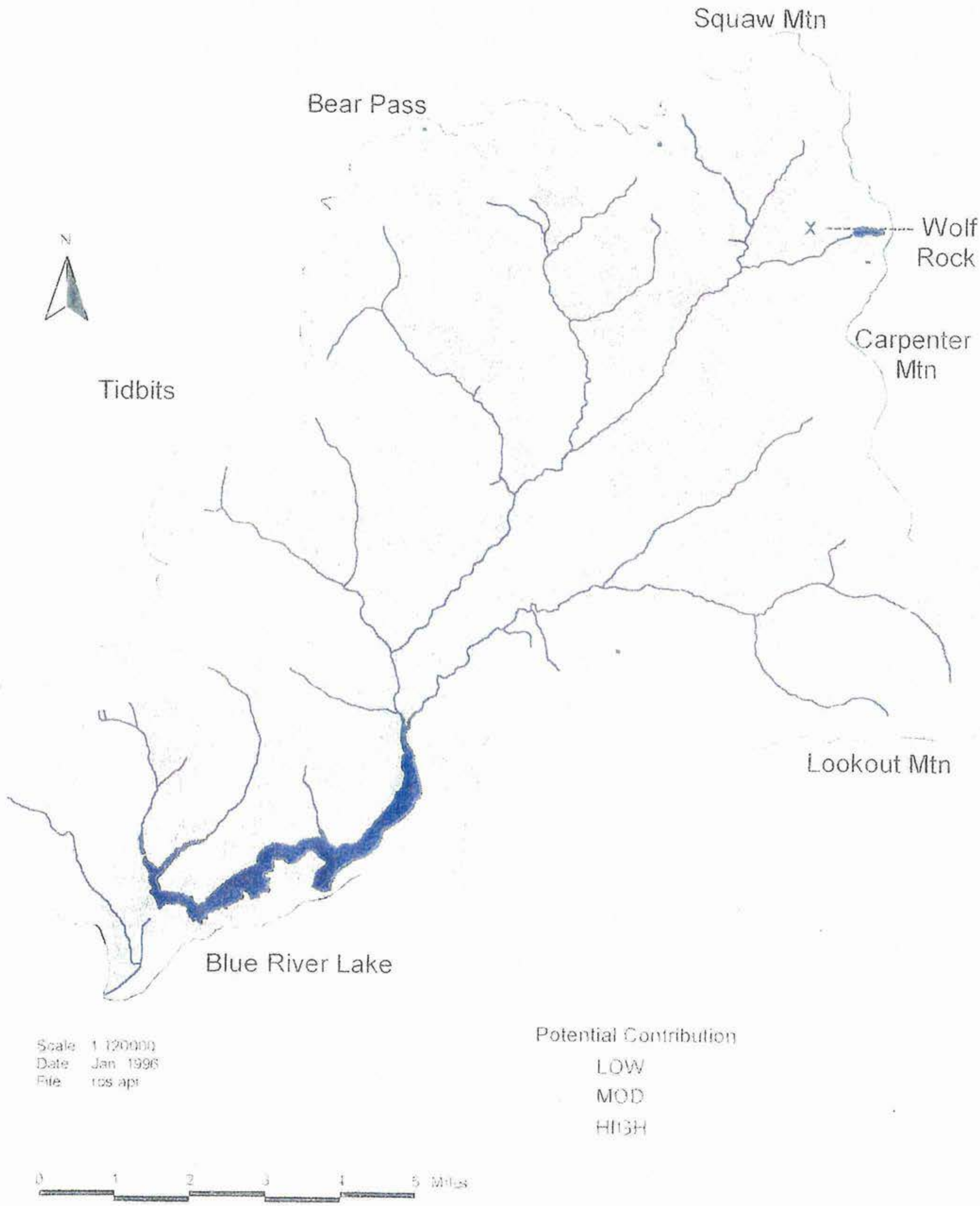


Figure 8: Road Density by Drainage



Map 10: Potential Constribution to Rain-on-Snow



ARP

A relative measure of the hydrologic recovery of watershed used by the Willamette National Forest is the Aggregate Recover Percentage (ARP). This is the percent of the watershed considered to have large enough trees to intercept and hold snow within their canopies. Within the WNF LMP the subwatersheds in the Blue River Watershed have midpoint ARP values ranging from 65-80 (Table 5: ARP Values). Midpoint ARP values were not recommended for the H.J. Andrews subwatershed due to their status as an experimental forest. Midpoint ARP values are a benchmark, or indicator, of potential increases in peak flows. The recommended ARP values may vary depending n site specific stream channel conditions.

Table 5: ARP Values

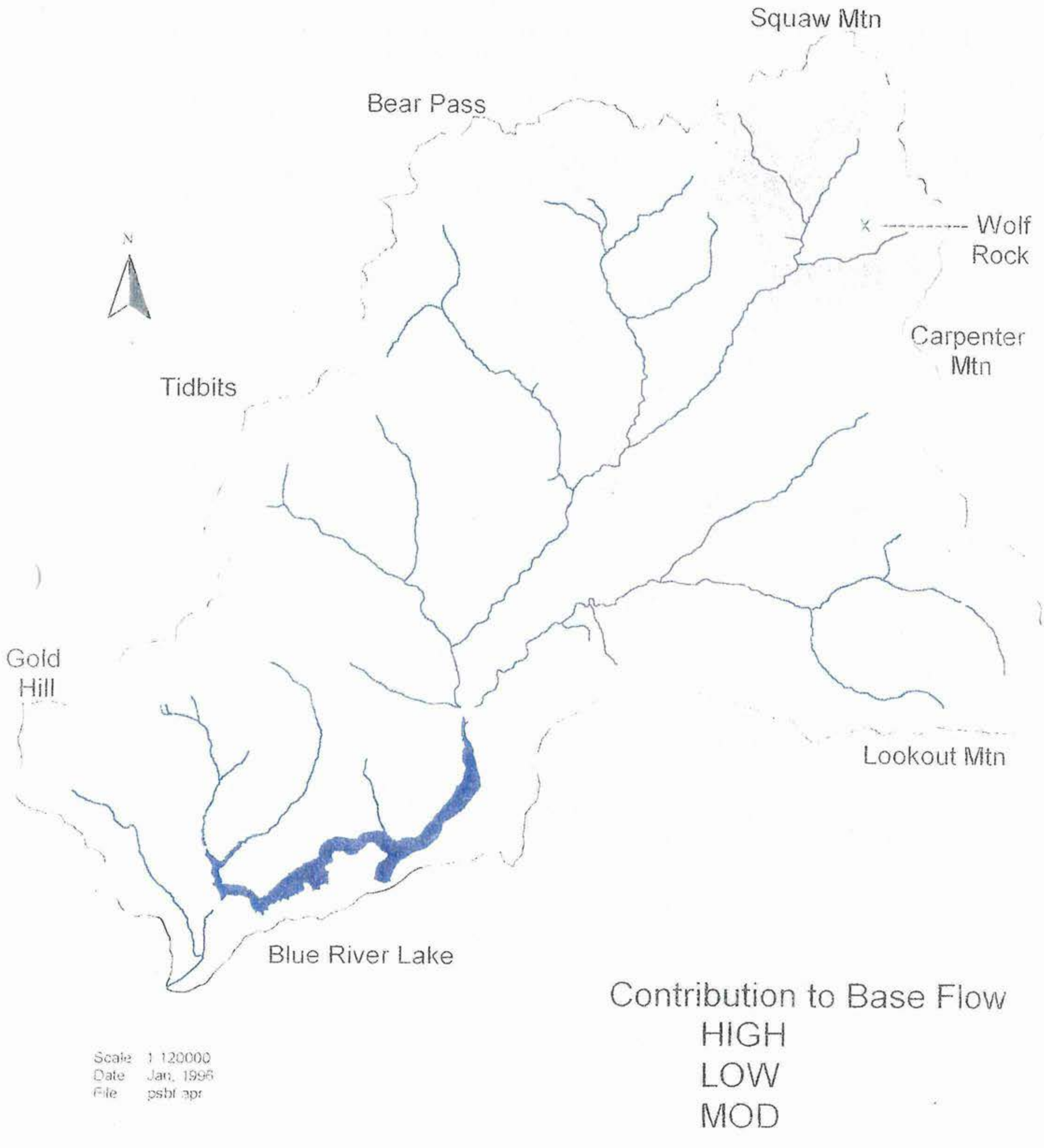
Subwatershed Number	Subwatershed Name	Drainage Name	Current ARP Value	Midpoint Arp Value
10-1	Blue River Reservoir		88	
		Simmonds	94	70
		Quartz	90	75
		North Fk. Quartz	89	75
		Scout	84	75
		Mona	81	75
		Reservoir Face	78	65
10-2	H.J. Andrews		97	
		Lookout	98	N/A
		Mack	97	N/A
		McRae	95	N/A
10-3	Upper Blue River		88	
		Cook	93	70
		Quentin	87	70
		Blue River Face	87	75-80
		Mann	83	65
		Wolf	81	75
10-4	Tidbits		95	
		Tidbits	94	75
		Ore	97	75

Baseflows

Potential for a reduction in streamflow within Blue River Watershed during summer months was not considered an issue. The quantity of surface flow is generally adequate for aquatic life, with subsurface flow occurring very rarely. In fact, many studies in the past have indicated that stream flows increase during the summer months following timber harvest as a result of reduced evapotranspiration and greater soil moisture levels (Harr, et al., 1979; Klock and Lopushinsky, 1980; Cheng, 1989, Bartos, 1989, and Keppeler and Ziemer, 1990). Increases in summer streamflows were also documented in this watershed in the H.J. Andrews Experimental Forest (Rothacher, 1971).

The relative contribution of the Blue River watershed to summer base flow is displayed (Map 11: Potential Contribution to Summer Base Flows) and was determined using snow accumulation, seasonal snow-melt rate, and groundwater storage. Due to the relatively shallow soil depths which restricts groundwater storage, most of the watershed has limited ability to provide summer streamflow. Lookout drainage stands out as having a large area which contributes to summer base flow which is due to the high groundwater storage capacity within the earthflow terrain, and the north facing slopes with low snow-melt rate. Wolf and Blue River Face also have large areas with high contributing areas.

Map 11: Potential Contribution to Summer Base Flows



Riparian Areas

The Adaptive management Areas are intended to contribute substantially to the acheivement of objectives for the standards and guidelines outlined in the Northwest Forest Plan. This includes prosion for restoration and protection of riparian zones. The overall objective for AMAs is to learn how to manage on an ecosystem basis in terms of both technical and social challenges. Riparian protection in AMAs should be comparable to that prescribed for other federal land areas. However, flexibility is provided to acheive these conditions, if desired, in a manner different from that prescribed for other areas and to conduct bonafide reasearch projects within riparian zones. For the purposes of this watershed analysis and to display conditions within and adjacent to riparian areas, the width described for interim riparian reserves was used.

Reference Conditions

The historic vegetative condition of the riparian areas within the Blue River Watershed are largely unknown. However, based on the dominant erosional processes, the fire return interval, the historic vegetative pattern, and the frequency of large floods occurring within the watershed, one can make an educated guess at what the riparian areas might have once looked like. Some general characteristics will be described here for the watershed, with more specifics outlined within the Landform block analyses later in the document.

For Landform blocks 1, 2, and 3 (Quartz/Reservoir/Tidbits, Cook/Quentin, Mann/Blue River/Wolf), fire would have played a significant role in returning many of the lower order stream channels to early seral stages (first, second, and some third order -or- Class IV's and some III's). These stands would typically become established with conifer seedlings, with hardwoods along the banks depending on the moistness of the site. Repeated fire events may reburn the riparian area burned previously, or burn another Class IV or III streamside that escaped the previous burn. Bottom line is there would likely be some part of the landscape within the lower order channels of these three Landform Blocks that would have early or young seral stages due to short fire return intervals. The exception would be the Tidbits drainage that would be dominated by hardwoods within the riparian area of these lower order streams. This is due to the naturally high frequency of debris slides and debris flows which are triggered during periods of large storm events.

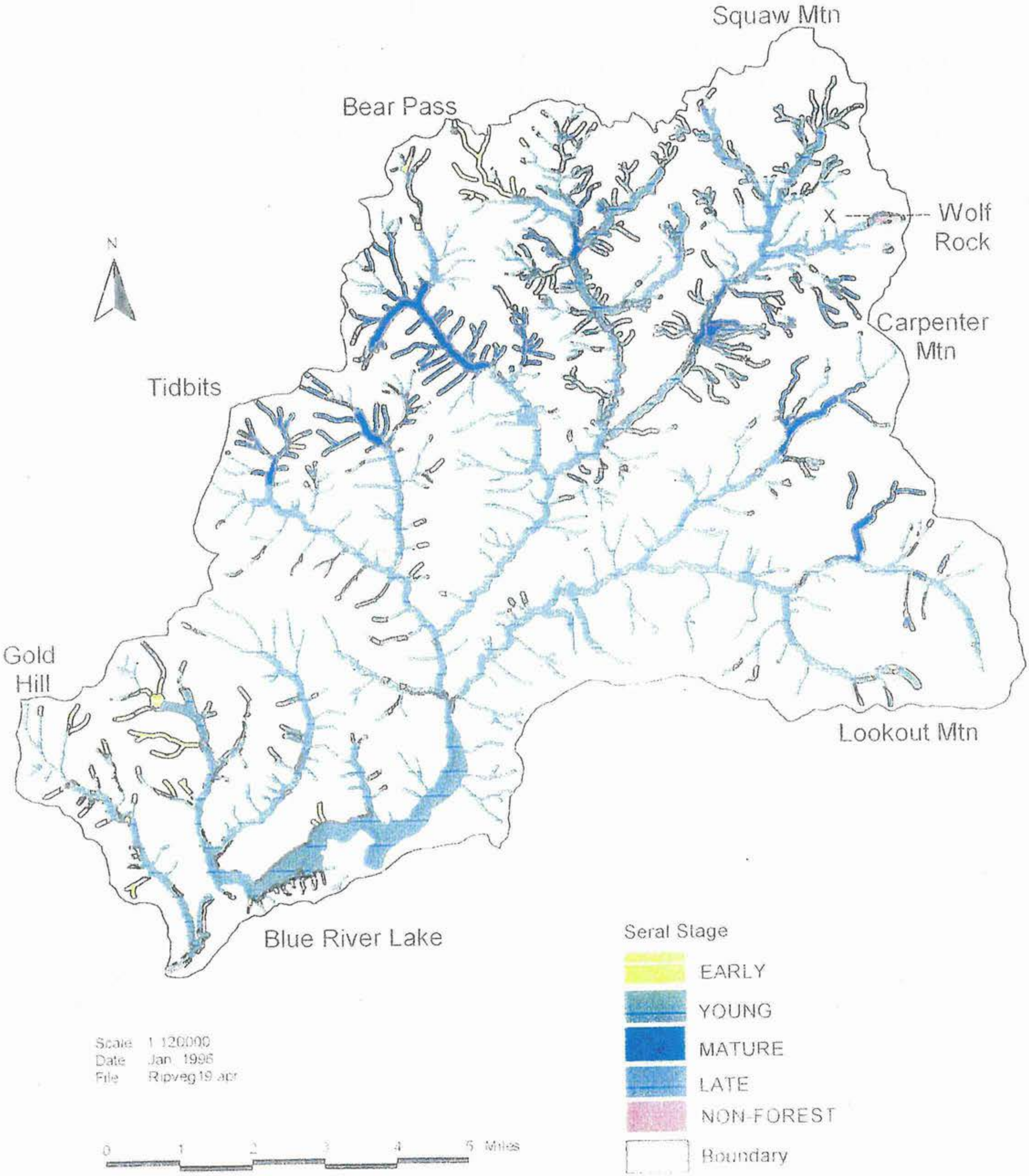
Most of the higher order stream channels within Landform blocks 1-3 would remain too wet to carry a stand replacement fire (Class I, II and some III's) with relatively short sections of some mainstem riparian vegetation consumed by fire as in Quartz Creek and Blue River. Small patches of riparian vegetation also burned along mainstem streams of Ore Creek and Quentin Creek Thus, these riparian areas would generally maintain mature stands of conifers with gaps created by large floods, wind, fire, disease, and insects. These gaps would likely become established with young shade tolerant conifers where the gap size remained small. Larger gaps would become established with hardwoods. Large floods or effects from upstream debris flows would create depositional features on the floodplains with relatively wide valley bottoms such as Lookout Creek, and Lower Cook and Quentin Creeks. These deposits would likely become established with hardwoods. However, due to the high gradients and narrow, V-shaped valleys of most of the remaining streams within the watershed, depositional features would only occur in small, localized areas, or near their mouths. Debris flows down these narrow V-shaped valleys would disturb only the narrow floodplain located there (Grant and Swanson, 1995).

Landform block 4 (Lookout) would also have some part of the lower order streams (Class IV/some III's) in early seral condition, though probably less than in the rest of the watershed. This is due to the long fire return interval and the low frequency of debris flows and debris slides. The exception is the vicinity of Lookout Mountain which is subject to debris slides. Some of the lower order streams may be dominated by hardwoods where associated with earthflows or landslides. Along the higher order streams (Class I, II and some III's), fire would be less likely to significantly influence middle or late seral stands.

Depositional features dominated by hardwoods as a result of flood events would more likely occur in this Landform Block due to the wide, unconstrained valley.

Based on the historic vegetation pattern, an attempt was made to characterize the seral stage distribution within riparian areas (Map 12). When the distribution is displayed on a geomorphic block basis it demonstrates how fire in the Cook/Quentin and Mann/Blue River/Wolf blocks determined the relatively high percentage of riparian vegetation in early or young seral stages (Figure 10). Note also how the longer fire return interval in Lookout block results in a significant portion of the riparian area seral stage condition in late and mature.

Map 12: Seral Stages within Riparian Areas - Year 1900



Current Conditions

Early and young seral stage conditions within ROD defined riparian areas range from 48% and 45% of the riparian areas in Landform Blocks 1 and 2, to 29% and 30% in Blocks 3 and 4 respectively (Figure 11: Seral Stage - Year 1995 - Acres Within Riparian Areas by Landform Block). Virtually all of the riparian areas in early or young seral stage is the result of harvest. The percent of riparian areas harvested range from 44% in both Landform Blocks 1 and 3 , to 26% in Block 2 and 28% in the Block 4 (Figure 9: Roads and Harvest Activities Within Riparian Areas by Landform Block and Map 14: Seral Stages Within Riparian Areas - 1995).

Roads located within the riparian areas are generally quite low, occupying 1-2% of the riparian areas in all Landform Blocks. The exception is Block 3 where 4% of the riparian area is roaded. This higher percentage of roaded area relative to the other blocks is due primarily to Forest Service road 15 which parallels Blue River for approximately 8-10 miles up the canyon, and a high road density within a section of private ground within the Mann drainage. More detailed discussion of current conditions of riparian areas will occur by Landform Block later in this document.

Figure 9: Roads and Harvest within Riparian Areas by Landform Block

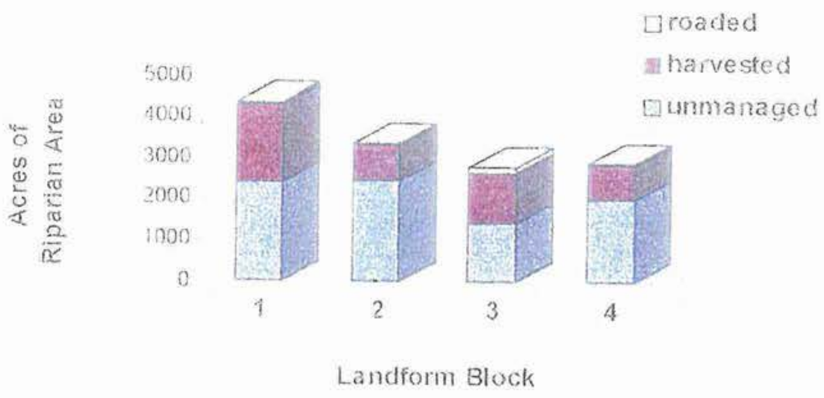


Figure 10: Seral Stage - Year 1900 - Acres Within Riparian by Landform Block

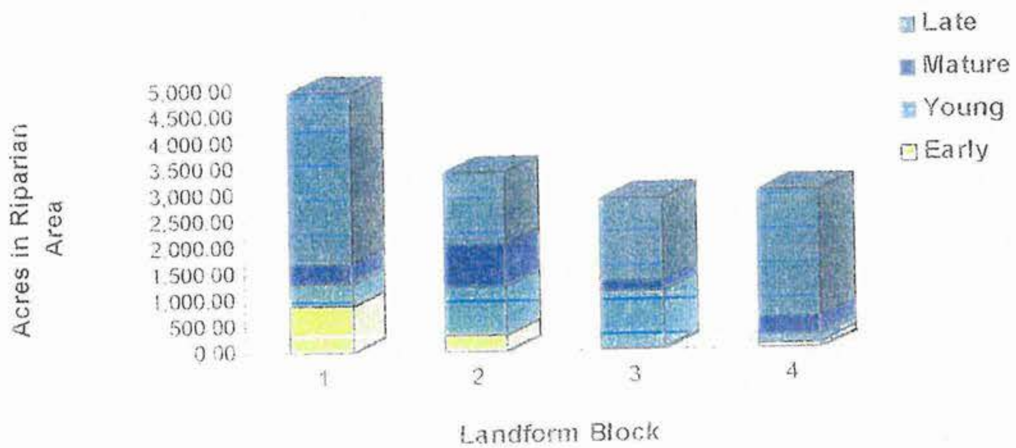
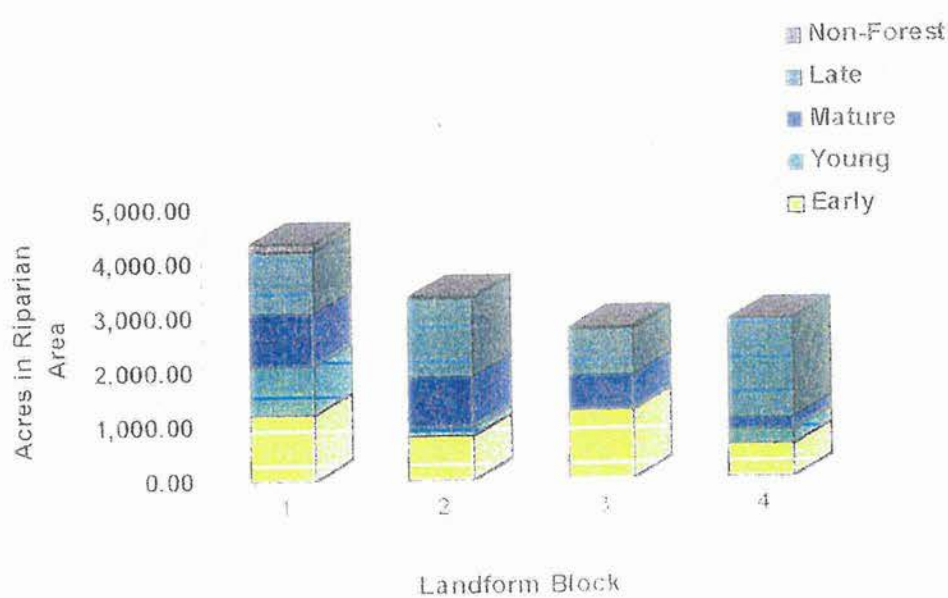
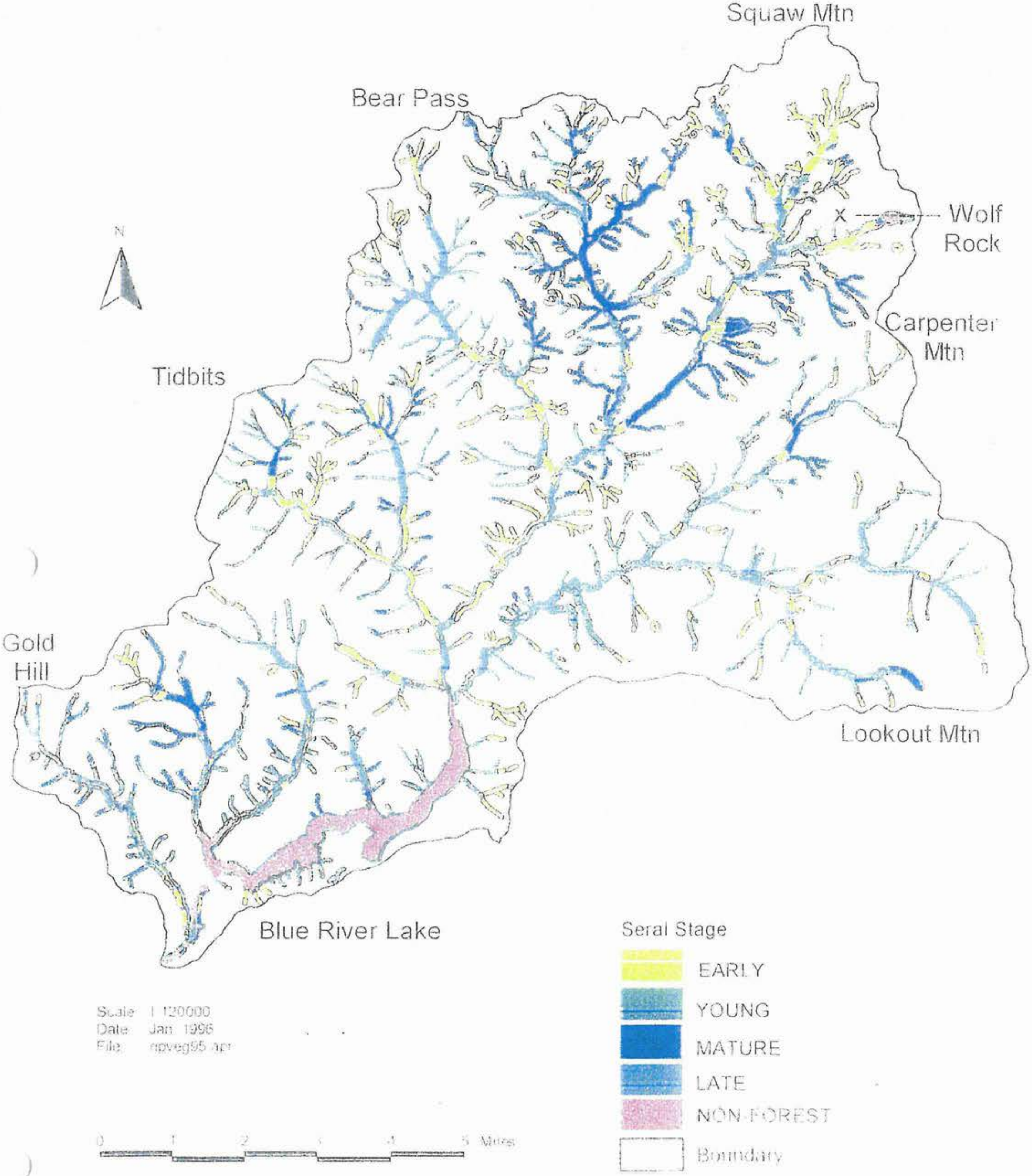


Figure 11: Seral Stage - Year 1995 - Acres Within Riparian by Landform Block



Map 13: Seral Stages within Riparian Areas - 1995



Data on Lookout Creek shows that the proposed water quality standards were met during the period from 1952-1955 and 1964 (Figures 13 and 14). From 1965-1981, summer stream temperatures exceed 17.8 deg C., with the exception of 1966 whose missing records during the end of July through the middle of August do not allow for accurate interpretaton (Figures 14, 15, 16, 17 and 18).

To determine whether climatic factors or management related practices are responsible for stream temperatures exceeding state standards following 1964, summer air temperatures and minimum flows for Lookout Creek were analyzed. Analysis of air temperatures exceeding the 90th percentile of the 7-day average daily maximum air temperature was not undertaken due to lack of time. Flows during July and August were analyzed with air temperatures that were collected at the HJ Andrews Experimental Forest. Air temperatues prior to 1958 were estimated from McKenzie Bridge and Belknap air temperatures (Figure 19: Lookout Creek Average Minimum Flows).

The period from 1952-1955 and 1964 had relatively high base flows and/or relatively low maximum air temperatures. This clearly explains why summer stream temperatures met state standards during the summers of 1952-1955 and 1964. For the period from 1965-1968, 1970, 1972, 1973, 1977, and 1981 summer base flows were terribly low, and maximum air temperatures were relatively high, likely causing summer stream temperatures to exeed state standards. Water quality standards were exceeded during other years when base flows were relatively high, but air temperatures were also high, such as during 1971, and 1969. Although air temperatures were moderate during the years of 1978, 1979, and 1980, base flows are relatively low. The closest comparison between the "meeting standards" period of 1952-1955, 1964, and the post 1964 "exceeding standards" period can be made with 1953 and 1976. Air temperatures during these two years are nearly identical, and base flows are slightly greater in 1976. State standards during 1976 are exceeded only slightly and only for approximately a one week period during the end of July. This data supports the argument that environmental factors, and not management related activities, are driving summer stream tempertures to exeed the proposed state standards.

Figure 12: Frequency of Seven Day Moving Average

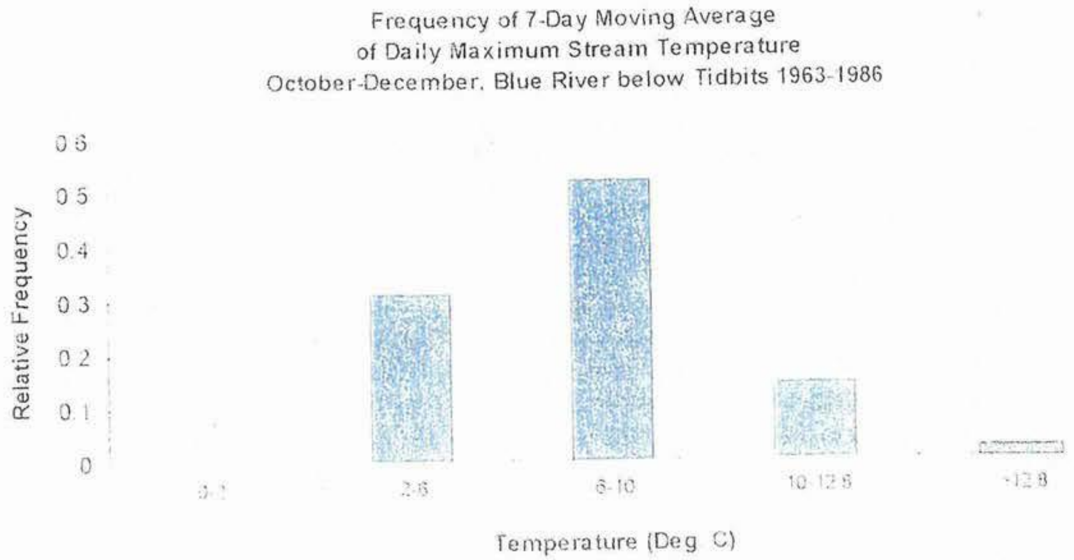


Figure 13: Lookout Creek Temperature 1952-1955

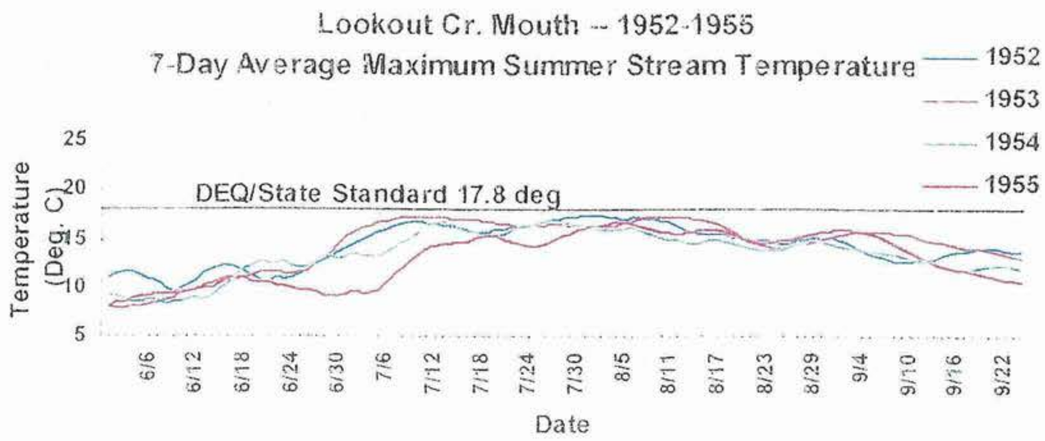


Figure 14: Lookout Creek Temperature 1964-1967

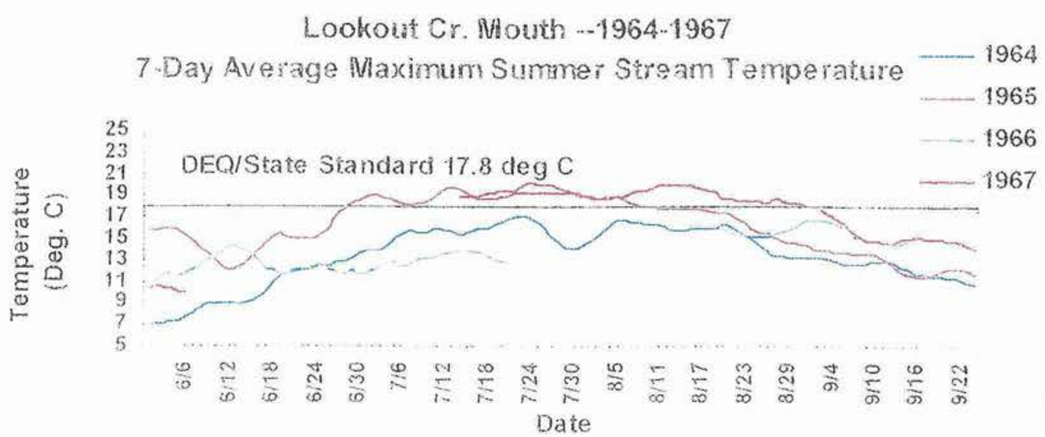


Figure 15: Lookout Creek Temperature 1968-1972

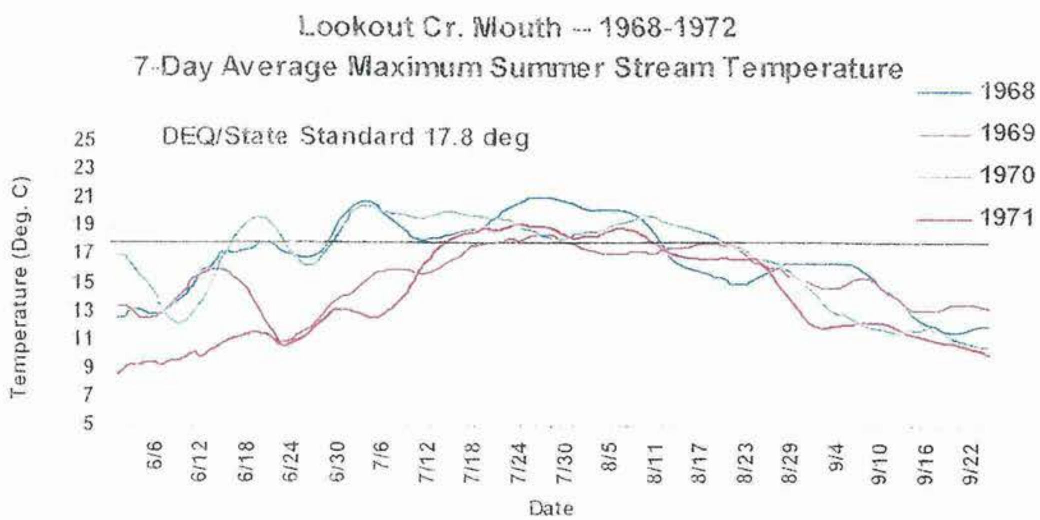


Figure 16: Lookout Creek Temperature 1972-1975

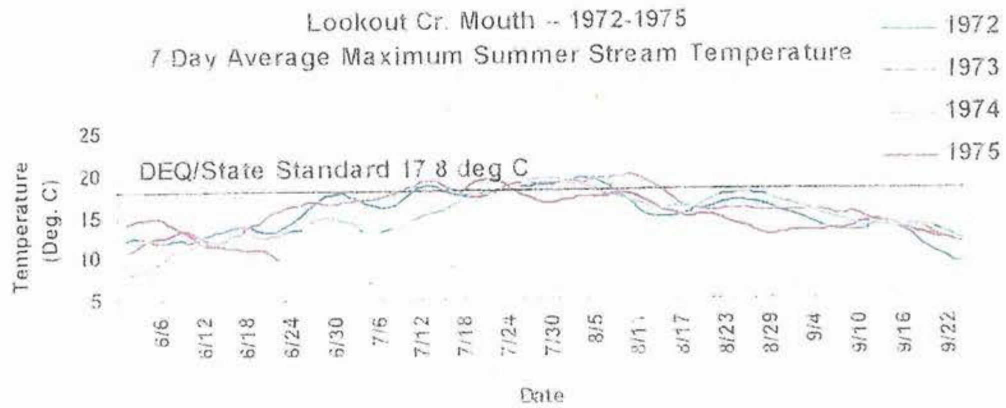


Figure 17: Lookout Creek Temperature 1976-1979

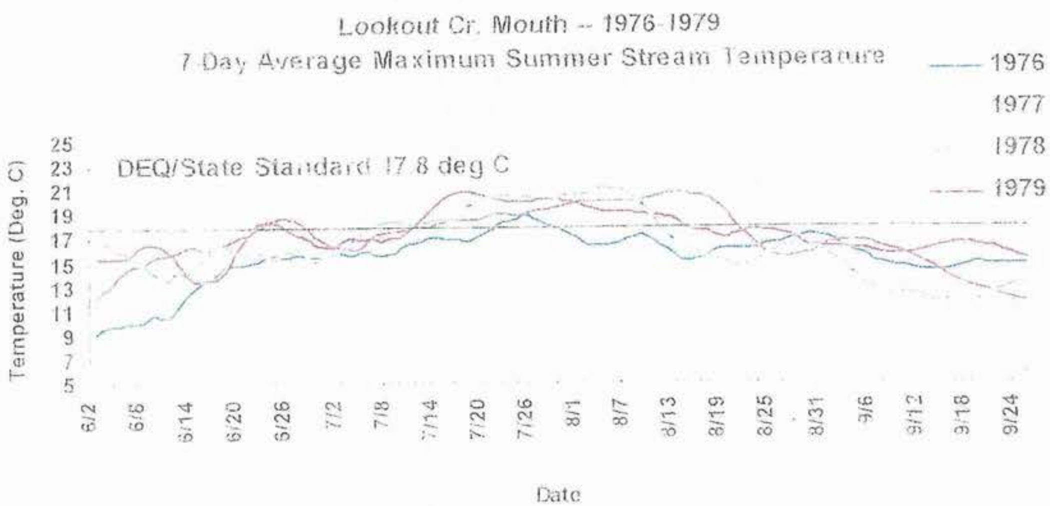


Figure 18: Lookout Creek Temperature 1980-1981

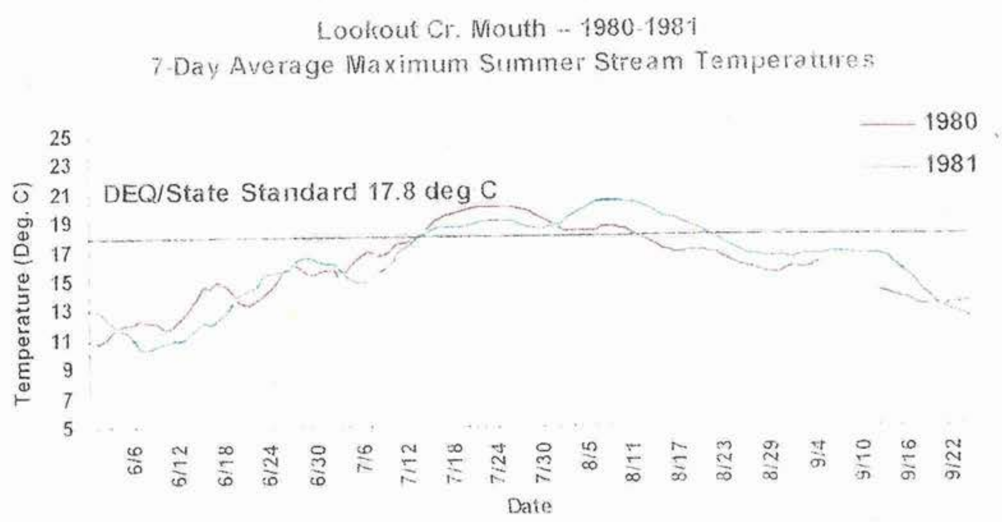
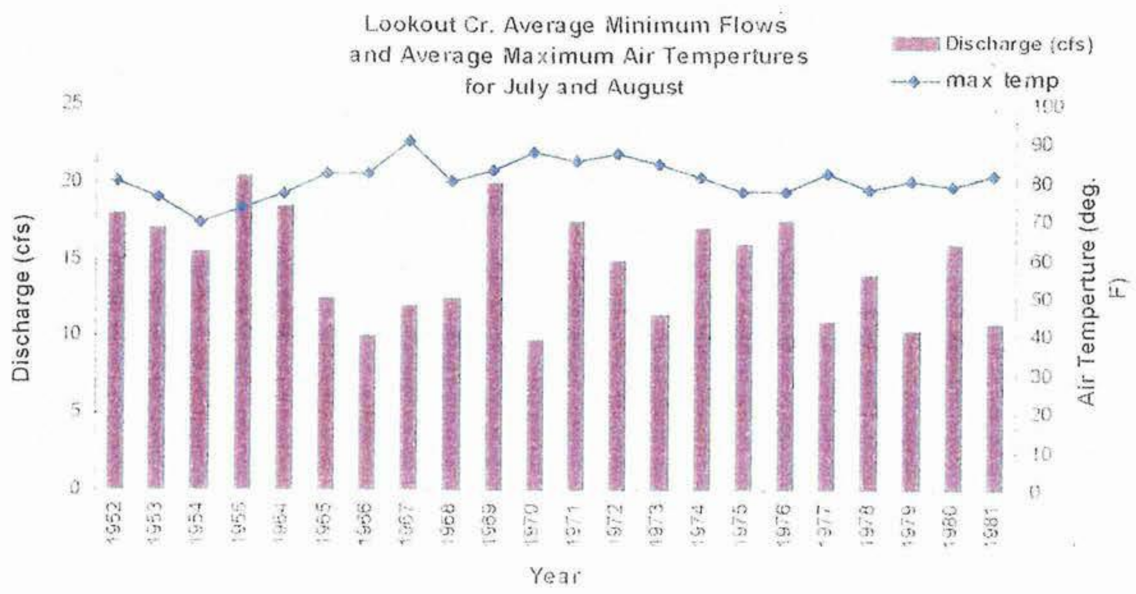


Figure 19: Lookout Creek Average Minimum Flows



Landform Blocks

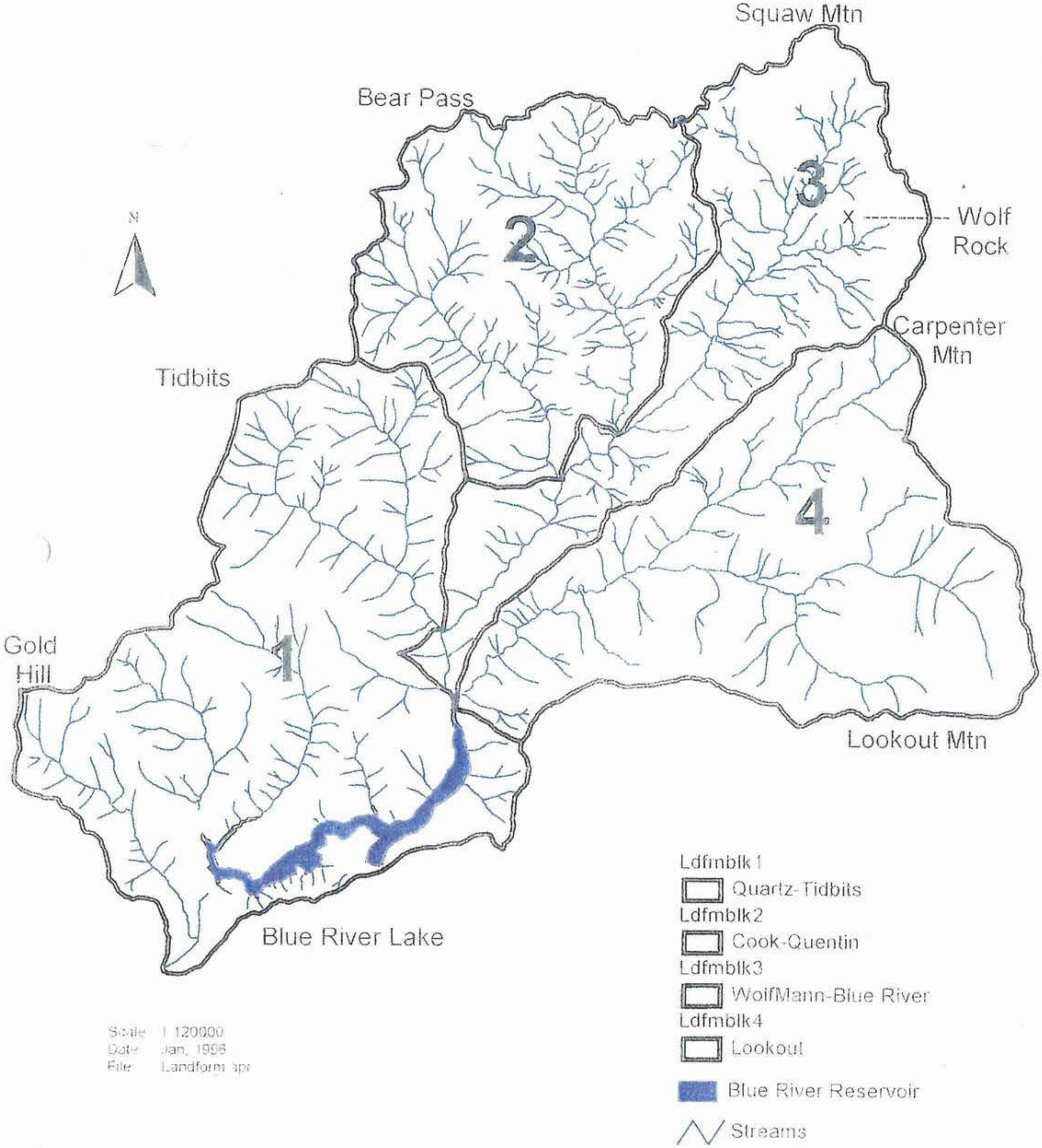
The watershed was divided into four Landform Blocks. Each of the four areas will be discussed individually describing the reference and current conditions of the physical environment. Each area will include a discussion of geologic formations in the upslope and riparian, stream conditions, aquatic habitat and riparian area conditions.

Stratification

Wilson's 1981 "Landforms of the McKenzie River Basin" was the basis of much of the interpretation of the geomorphology of the watershed. His study divided the area into ten "Land Systems" which delineated landforms based on origin and process and covered an area twice the size of the watershed.

For the purposes of this watershed analysis, the watershed was stratified into four Landform Blocks which are similar in development, process, and function, similar to Wilson's system, but reaching beyond the scope of hydrologic and geologic character of the watershed to include functional processes of vegetation patterns, fire behavior, valley segment types, and fish and wildlife habitats, as well as lithology, geologic structure, and erosional and depositional patterns (Map 5a: Landform Blocks). From this stratification, more detailed mapping of individual landforms may be made at a smaller scale to conform with the National Geology Data Standards for Ecological Unit Inventories that are now being developed and based largely on the work by Haskins and Chatoin (93) .

Map 5a: Landform Blocks



LANDFORM BLOCK 1

Simmonds, Quartz, Tidbits Creeks and Blue River Reservoir -Western Cascade Cirque-Ridge System

Erosional Processes

Reference Conditions

Geologic Formation

Landform Block 1 represents erosional topography. Tuck (1927) described the area as "...the canyons are all narrow and the canyon walls are steep. Drainage is well established, erosion is taking place vigorously producing very little deposition, because of the steep gradient of the streams." The northern and western boundaries are composed of ridges that were developed in older Western Cascade rocks of undifferentiated Tuff interbedded by minor basalt and andesite lava flows. Approximately 13 million years ago, these older rocks at the head of Quartz and Simmonds Creeks were intruded by several small plutons of granodiorite and quartz diorite which was accompanied by ore-bearing hydrothermal fluids. These fuluids were deposited in northwest-trending shear zones in the Gold Hill area. This is the area which was mined for gold, silver, copper and lead between 1887 and 1913 (Power, 1984).

Landform Block 1 is situated further from the volcanic center of the High Cascades and thus lacks the ridge capping basalts and associated large-scale differential weathering processes that typify the eastern half. This area was also located further west of the High Cascade platform ice masses during the Pleistocene, which reduced, to some extent, the amount of glacial scour and subsequent mass wasting that has taken place in comparison to the eastern half of the watershed. Tuck (1927) noted that "the streams terminate in cirque-like basins, which in some cases have been called cirques, and are believed to have been formed by glacial action." Storch (1978) likewise described "Small U-shaped troughs and cirque-like features above 4,400 feet indicate that small valley glaciers were active in the topographically higher portions of the district during recent geologic time. Since glaciation, streams have carved their steep V-shaped valleys..." This is especially true of Simmonds, Quartz, and Tidbits Creeks. The valleys are much more incised than those of the rest of the watershed exhibiting sideslopes in most cases greater than 70%.

The lower reaches of the Blue River valley were influenced most by glacial advances from Carpenter Mountain, and the main valley glacier in the McKenzie Valley to the south. The pre-glacial Blue River valley drained directly into the McKenzie through what is now the "saddle dam" area. Williamson, in his 1961 memorandum for the U.S. Army Corps of Engineer's Blue River Reservoir Auxiliary Dam interpreted the present morphology as a result of a sequence of geologic events:

"The best evidence of glacial origin of the gravel deposits in the saddle area is the numerous large boulders, some up to 15 tons, that lie on the upper surface of the ground in apparent alignment. Boulders up to 8 feet in thickness are also found at depth in the drill holes. The size of these boulders precludes transportation by normal river flow and the rock type is similar to Foley Ridge Andesite, from the upper McKenzie River valley.

The last advance of glacial ice from the higher elevations in the McKenzie River valley dammed ancient Blue River forming a lake. In this lake the tributaries of Blue River deposited lake sediments and delta deposits. The top of the glacial ice during the last advance was approximately 1400 feet in elevation and marginal streams flowing along the north side of the [McKenzie] on top of the glacier flowed [North] through the topographic break in the ridge and entered Blue River valley through the saddle. The tremendous loads of sediments carried by the melt water of the marginal stream deposited as a delta in the lake formed in the saddle area. This delta gradually built out toward Blue River and filled the saddle area with beds of outwash gravel which dip gently toward Blue River as can be seen in the road cuts.

These torrential deposits were laid down on top of the lake sediments which were protected from erosion by the depth of water. The volume of flow on the marginal stream into Blue River valley raised the water level in the lake until it overtopped a divide [between Blue River and Quartz Creek to the West] and the water entered ancient Quartz Creek drainage to the west.

Quartz Creek at that time was also impounded by glacial ice in the McKenzie River valley and was depositing alluvium in it's channel. The addition of this water to Quartz Creek had little effect until melting conditions progressed and the ice in the main valley retreated upstream to the mouth of ancient Quartz Creek. The resulting combined flow from the draining of the lakes, from the marginal stream through the saddle and from Blue River, caused rapid down-cutting of the divide and produced the permanent diversion of Blue River."

Riparian

The dominant erosional processes occurring within riparian areas of this block are debris slides, debris flows, and debris avalanches in these steeply incised, high gradient drainages. These mass wasting events are usually triggered by large storms and/or fire and are prevalent in the upper west side of the Quartz drainage, and the south side of Tidbits drainage. Initiation of the debris flows/slides/avalanches would be in the headwater tributaries and would scour the main channels within this block, transporting much of the sediment to downstream, lower gradient sections. Because deposition was limited within these narrow valley bottoms, the majority of riparian vegetation remained intact and was not set back to early seral condition. Riparian vegetation along the main channels that was consumed by fire would no longer provide stability and energy dissipation, thereby leaving the channel bank substrate susceptible to streamside slides. This likely transpired adjacent to the mid-sections of Quartz Creek, intermittently along the mid-section of North Fk. Quartz Creek, and along much of Scout Creek

Current Conditions

Upslope

Landform Block 1 is susceptible to debris avalanche and shallow planar failures due to the steep slope angles and presence of shallow granular soils. Debris failure transport is over a much longer segment of stream due to the high stream gradients and the fact that many of the 4th order streams confluence at an angle greater than 70 degrees. The area contains 17% of the total natural failures (19), 32% of the road failures (28), and 10% of the post-harvest failures (12) in the watershed (Map 14: Landform Block 1 - Landslides).

Riparian

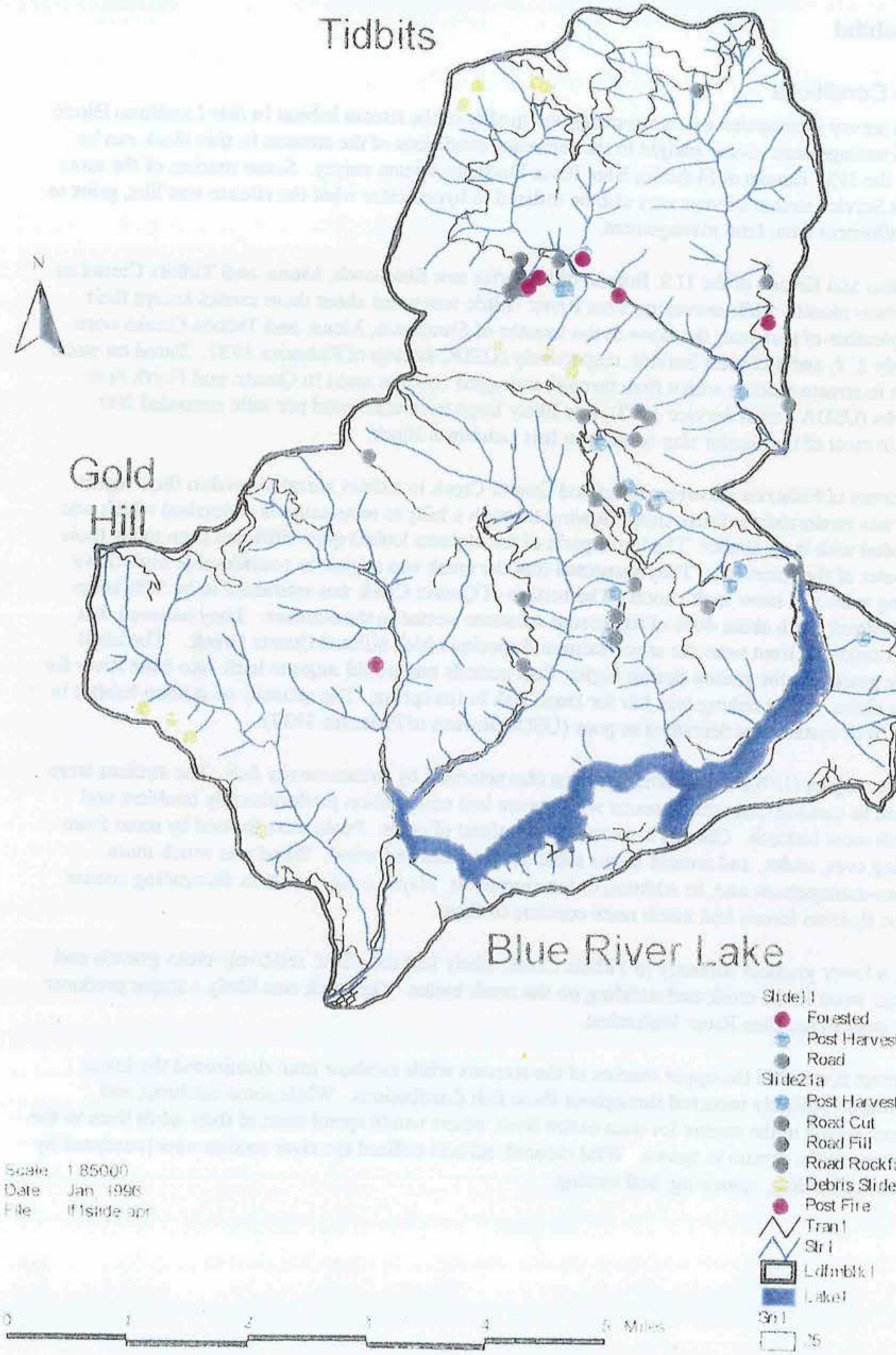
Current sediment delivery to streams in this block is due to road related failures, particularly in Tidbits Creek Full bench construction on steep slopes has resulted in chronic input of sediment. Unlike the debris slides and debris avalanches which historically pulsed various sized sediment and large woody debris into the streams, chronic input of sediment associated with roads in the Tidbits drainage are fines, gravels and cobbles that dribble into the stream virtually continuously. This road related sediment may fill some pools in Tidbits Creek, however, most sediment is probably flushed downstream into Blue River and Blue River Reservoir. Mass wasting has also resulted from harvesting in the Tidbits drainage, contributing large quantities of sediment to the stream channel. Old abandoned logging roads up the bottoms of Simmonds Creek, Quartz Creek, and North Fk. Quartz Creekprovided sediment to the channels especially during "construction". Harvest of riparian vegetation and yarding down the channel bottoms of Simmonds, Quartz and North Fk. Quartz caused extensive erosion of the floodplain and riparian areas. Riparian areas that were once dominated by conifers are now extensive hardwood stands.

Lamberti et. al. (1991) analyzed a large debris avalanche that occurred from a clearcut unit on the east side of the North Fork of Quartz Creek. 25 cm of rain occurred in a 96 hour period between February 20 and 23. The debris avalanche advanced into a class 4 tributary and traveled 500 meters downslope into Quartz Creek. 5,000 cubic meters were moved at a velocity of approximately 5-10 meters per second. It traveled 330 meters down Quartz Creek and lodged as a debris dam 25 meters wide, 40 meters long and 5 meters high. In comparison to the storm interval, "Average return interval for the debris flow was much longer, probably in excess of 50 yr."

They also noted that in general "Although landslides typically affect <1% of a watershed in a particular episode, debris flows may influence >10% of the channel network because of their ability to move down stream courses. In montane streams of the Pacific Northwest, floods occur once every 1-2 yr on average....In contrast, debris flows are rare, episodic events that may influence a particular stream reach only once every 50-200 yr or even longer (Swanson et al., 1987)." They concluded that in this instance "Disturbance size and timing thus favored rapid recolonization of the affected reaches. In general, this rapid recolonization may reflect some preadaptation to episodic disturbance imparted by adaptation to physically similar but more regular and frequent disturbance (i.e. floods)."

Anderson, in his 1992 paper on the same event noted in regard to population recovery that "While the perturbation was due to clearcutting, even in pristine streams a similar effect could result from beaver activity, wildfire, or debris torrents." and that "The debris torrent at Quartz Creek denuded 300 m of stream bed and the adjacent riparian strip but it was recolonized by a major component of the typical benthic community within a few months. This level of disturbance appears to increase biodiversity by opening up habitat patches and adding to the complexity of the physical habitat as well as to the variety of autochthonous and allochthonous foods."

Map 14: Landform Block 1 - Landslides



Aquatic Habitat

Reference Conditions

Little stream survey information exists regarding the quality of the stream habitat in this Landform Block prior to land management. Some insight to the reference conditions of the streams in this block can be gained from the 1937 Bureau of Fisheries Blue River Drainage stream survey. Some reaches of the more recent Forest Service stream surveys may also be utilized to hypothesize what the stream was like, prior to noticeable influences from land management.

In 1937, Baltzo and Koloen of the U.S. Bureau of Fisheries saw Simmonds, Mona, and Tidbits Creeks as they passed their mouths while surveying Blue River. Little was noted about these creeks except their flow. In September of that year, the flows at the mouths of Simmonds, Mona, and Tidbits Creeks were approximately 2, 2, and 8 cForest Service, respectively (USDC Bureau of Fisheries 1937. Based on wood counts taken in stream reaches which flow through unlogged riparian areas in Quartz and North Fork Quartz Creeks (USDA Forest Service 1993), it is likely large in-stream wood per mile exceeded 200 pieces/mile in most of the similar size streams in this Landform Block.

The U.S. Bureau of Fisheries surveyors described Quartz Creek in a short narrative within their report. The stream was moderately to fairly steep, flowing through a hilly to mountainous watershed which was heavily wooded with large timber. The lower parts of the streams looked quite different than today (now under the water of the reservoir). They suspected that the creek was subject to considerable high flows during spring rains and snow melt runoff. The bottom of Quartz Creek was estimated to be 56% large rubble and bedrock, with about 40% of the stream substrate wetted in the summer. They believed that rainbow and cutthroat trout were the major salmonid species which utilized Quartz Creek. The adult trout mainly would use the stream during higher flow periods and would migrate back into Blue River for summer low flows. Trout fishing was fair for small fish in the spring. The quantity of salmon habitat in the Quartz Creek system was described as poor (USDC Bureau of Fisheries 1937).

The more recent past (1970s and 1980s) has been characterized by stream survey data. The streams were characterized as cascade, stair step streams with stream bed composition predominantly boulders and cobbles, with some bedrock. Gravels occurred at the tailout of pools. Pools were formed by scour from water spilling over, under, and around larger substrate particles and wood. Wood was much more abundant pre-management and, in addition to forming pools, played a major role in dissipating stream energy. The riparian forests had much more conifers in them.

Ore Creek, a lower gradient tributary to Tidbits Creek, likely had abundant, relatively clean gravels and copious large wood in the creek and standing on the creek banks. The creek was likely a major producer of rainbow trout in the Blue River Watershed.

Cutthroat trout dominated the upper reaches of the streams while rainbow trout dominated the lower reaches. Sculpin probably occurred throughout those fish distributions. While some cutthroat and rainbow trout stayed in the stream for their entire lives, others would spend most of their adult lives in the river, returning to the stream to spawn. Wild chinook salmon utilized the river section now inundated by the reservoir for holding, spawning, and rearing.

Current Condition

Simmonds Creek

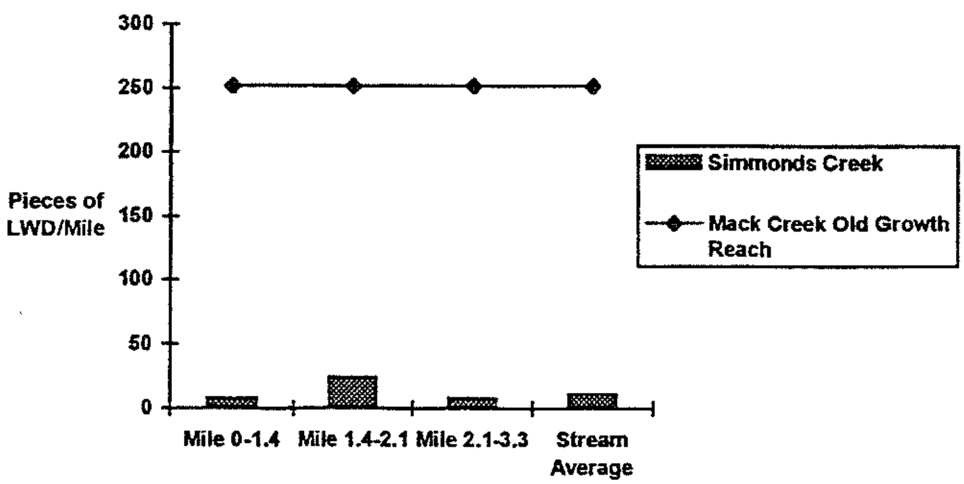
In August 1975, Armantrout and Shula, during an ambitious district-wide stream survey effort for the Willamette National Forest, estimated the flow of the creek to be 4 cForest Service at its mouth. They did not walk up the creek to document conditions but did mention that the watershed had been extensively logged, particularly on private land (USDA Forest Service 1975).

The extensive logging which had occurred close to the stream had added to the instability of Simmonds Creek, making it vulnerable to the effects of the 1964 flood. With only young vegetation to stabilize the stream banks and mostly logging slash to provide stream wood structure, the large flow from the flood roared through the stream, cutting banks and transporting wood out of the system. A large quantity of the wood collected in a jam at the Blue River Drive crossing, requiring several days of excavator time to remove it and place the culverts which currently exist (Mike Graney, local resident, personal communication).

Although early records of Simmonds Creek are limited , an August 1993 Forest Service stream survey provides current conditions data. This moderately sloped stream flows through a steeply incised valley. Hardwoods, particularly alders, dominate the riparian vegetation and most conifers that do exist in the floodplain or nearby slopes are young. Riparian canopy density is extremely high, effectively shading the stream from sunlight and maintaining cool water temperatures in summer. However, winter stream temperatures may be quite low, considering the loss of this deciduous canopy. Because of the lack of conifers in the floodplain, stream bank and channel stability is poor and the source for potential large in-stream wood is minimal. There is an extremely low amount of large wood in Simmonds Creek. The lack of in-stream wood within Simmonds Creek is quite apparent when compared with a similar size stream, Mack Creek, that flows through an old growth coniferous forest in the H.J. Andrews Experimental Forest (Chart 1).

Chart 1

**Simmonds Creek LWD/Mile
Compared With
Mack Creek Old Growth Reach LWD/Mile**



Using the Mack Creek large wood per mile data in these comparisons is not intended to mean all streams should achieve this amount of large wood per mile. Even if some of these streams were unmanaged, they would never likely completely reach the amount of large wood per mile in Mack Creek due to the greater frequency of slides in the Lookout Landform Block. However , based upon data from other stream reaches in the watershed that are less managed than Mack Creek, 150-200 pieces of large wood per mile is not an unrealistic expectation as streams recover.

The numbers from Mack Creek are used as a reference point and not necessarily a goal for each stream. Site specific conditions need to be considered when attempting to estimate a reasonable range of variability for large wood per mile.

Cover for fish consists mainly of stream substrate (cobbles) and turbulence in riffles. The stream substrate, primarily gravel and cobble, appears to be highly mobile and unstable. Mass failures were frequently documented in the survey report.

At Blue River Drive, Simmonds Creek flows through a pair of 10 foot wide pipe arches. One is at the grade of the creek and the other is more flat, emptying 2 feet above a 4 foot deep plunge pool. These culverts are passable for rainbow and cutthroat trout and juvenile chinook upstream migration, but would only be passable with difficulty for chinook salmon adults. Little habitat exists in this stream for chinook salmon spawning, so the culverts should be considered passable for the upstream migrating fish that would potentially utilize Simmonds Creek (USDA Forest Service 1993).

An August 1993 snorkel survey of Simmonds Creek identified populations of rainbow trout/steelhead, cutthroat trout, sculpin, Pacific giant salamanders, rough skin newts, and crayfish. Simmonds Creek appears to be an important nursery stream for rainbow trout/steelhead, as high densities of juveniles were found within the lower 1/4 mile of the creek. Steelhead, an introduced species, have been observed spawning in Simmonds Creek in the past. Although the run in the McKenzie above Leaburg Dam is now only residual, adults may continue to return to the stream to spawn. Adult rainbow trout have been observed in the creek during the 1993 snorkel survey. Fluvial cutthroat and rainbow trout may migrate into Simmonds Creek to spawn. Other cutthroat and rainbow trout in the creek may be resident. Rainbow trout numbers dominate cutthroat numbers in the lower 1/4 mile of the creek. Proceeding upstream, the proportion of rainbow to cutthroat trout decreases to a cutthroat dominance within a mile from the mouth of the creek. Within 2 miles from the mouth of the creek, only cutthroat occur. The range of cutthroat trout extends 3.5 miles up the creek. Pacific giant salamanders and crayfish were observed 2 miles up Simmonds Creek (USDA Forest Service 1993).

Table 6: Simmonds Creek Current Conditions at a Glance

FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-1.4	14	8	8	88
1.4-2.1	30	24	14	71
2.1-3..3	25	8	13	77
Total	21	11		

Quartz Creek

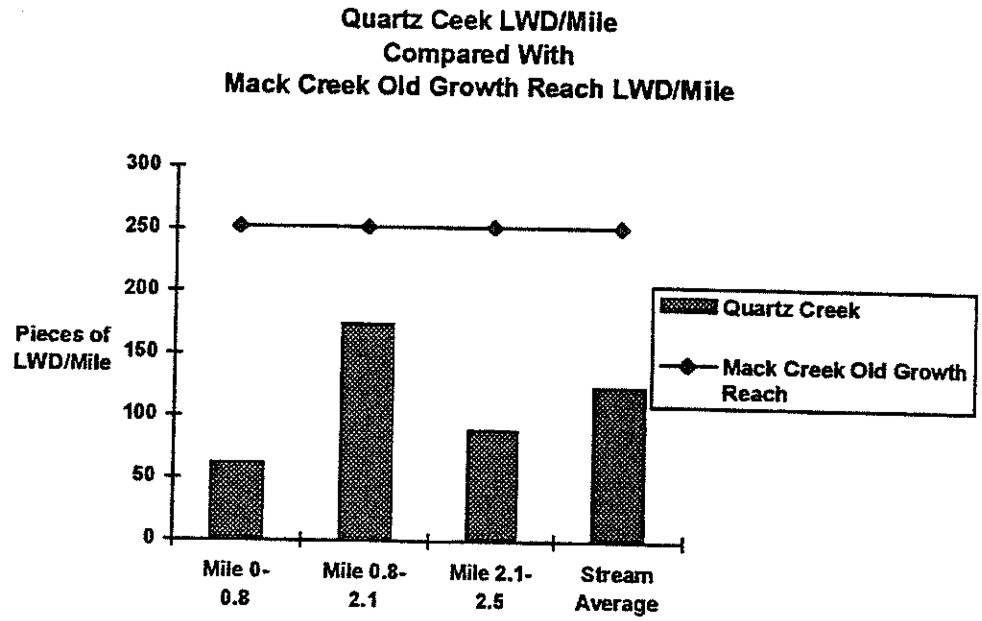
In 1975, Willamette National Forest stream surveyors Armantrout and Shula wrote general descriptions after a field visit to both lower Quartz Creek and lower North Fork Quartz Creek. Their visit to the Quartz Creek drainage was only less than a decade after Blue River Dam began operation. Reservoir full pool extends well up both forks of Quartz Creek. Minimum flood control pool extends approximately to the confluence of the forks. Quartz Creek was described going subsurface near its mouth in August. This is likely because of the deposition of Quartz Creek bedload as the creek empties into the slack water of the reservoir. The bottleneck created by the culvert near the mouth of the creek and within the reservoir further encourages bedload deposition. The stream was described as having much bedrock and boulders, its lower half mile had been logged, and it was heavily fished (probably because of good access and the presence of the reservoir) (USDA Forest Service 1975).

The stream substrate of North Fork Quartz Creek was bedrock, rubble and gravel, with some boulders. The smaller substrate was extremely clean and bright, indicating they were mobilized during high flows. Some evidence suggested extreme flows during spring and snow melt runoff. Several log jams were observed. Fishing pressure was moderate to heavy (USDA Forest Service 1975).

Quartz Creek was resurveyed in July 1993. The stream was characterized as rubble and boulder dominated cascades with stair-step pools. The upper part of the stream has steep valley walls with steep channel gradient (USDA Forest Service 1993).

With alder dominating the riparian forest closest to the creek (average zone width of 20 feet) and mainly young Douglas fir dominating the riparian forest from the edge of the hardwoods outward (average zone width of 80 feet), the source for potential in-stream wood is lacking. Some residual mature Douglas-fir stands were noted on the slopes above Reach 2 (mile 0.8-2.1), accounting for the higher amounts of large wood per mile in this reach as compared to others. A large amount of the wood in the lower section of stream, consisting primarily as logging slash, has been washed out of the stream and lay rotting in the floodplain (USDA Forest Service 1993). When compared with other streams within Blue River watershed that were managed for timber, Quartz Creek has a moderate amount of in-stream wood. Using the old growth section of Mack Creek as a standard, (Chart 2: Quartz Creek LWD/Mile Compared With Mack Creek Old Growth Reach LWD/Mile), Quartz Creek is slightly deficient in wood.

Chart 2



Pools consist mostly as pocket pools behind the larger substrate particles. Most spawning areas are located in the tail out of these pools. For the most part, these spawning areas have gravels which are relatively clean of fine sediments, considering embeddedness overall was documented as near 50% in parts of the stream. This may provide for somewhat successful spawning habitat but rearing habitat in the intersticial spaces of larger substrate particles may be marginal at best. Stream bed stained by mining leachate and rusting discarded mining equipment was common. A metallic liquid was found in the creek bed during the survey which may be mercury (USDA Forest Service 1993). Water quality, and, in turn, the health of aquatic fauna in this creek, are a concern due to the sediment and the presence of mercury.

Cutthroat trout are the only fish species observed during the 1993 snorkel surveys. Migration of spawning rainbow trout from the reservoir is blocked by the placement of the Forest Service Road 2620.125 culvert near the mouth of Quartz Creek. Although it is passable when the reservoir is full, it is impassable when the reservoir is at or near minimum flood control pool. The time the reservoir is near minimum flood control pool coincides with the time rainbow trout would migrate from the reservoir to the stream to spawn. There is ½ mile of habitat between the mouth of the creek and the first natural barrier, a 6 foot high falls (Map Significant upstream migration barriers).

Snorkelers observed Pacific giant salamanders and rough skin newts throughout the survey. Tailed frogs were observed in the lower reaches of the stream. A garter snake was seen in the upper reach (USDA Forest Service 1993).

Table 7: Quartz Creek Current Conditions at a Glance

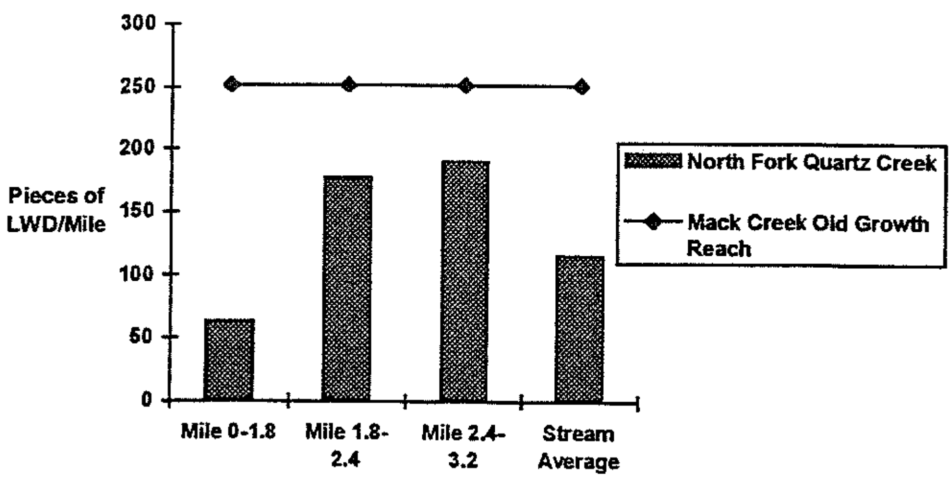
FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-0.8	14	62	6	76
0.8-2.1	19	174	13	69
2.1-2.5	8	89	2	81
Total	14	124		

North Fork Quartz Creek

North Fork Quartz Creek had more than double the flow that Quartz Creek had at their mouths in the summer of 1993. The creeks are similar in that they are both rubble and boulder dominated cascades with stair-step pools. Also similar to Quartz Creek, North Fork Quartz Creek pool habitat is primarily pocket pools formed behind large rocks. Spawning habitat is primarily in the tail-out of these pools. Embeddedness, the amount the larger substrate particles are surrounded by smaller substrate particles, is high. The important difference between the two creeks is the composition and maturity of the riparian forest. From 25 to 75 feet away from the stream bank, North Fork Quartz is dominated by mature and old-growth conifers (average diameter 32+")while Quartz Creek is dominated by smaller and younger trees (average diameter 8-21"). These conifers provide a good potential source of large in-stream wood now and in the future, particularly in the most upstream reach (USDA Forest Service 1993). The graph below depicts a comparison between the large wood per mile in North Fork Quartz Creek with an old growth section of Mack Creek, a similar tributary within the Blue River watershed (Chart 3: North Fork Quartz Creek LWD/Mile). When compared with other tributaries of Blue River managed for timber, North Fork Quartz Creek has a good amount of large in-stream wood.

Chart 3

NorthForkQuartz Creek LWD/Mile
Compared With
Mack Creek Old Growth Reach LWD/Mile



In February 1986, a landslide triggered by a rain-on-snow event, moved down a first order tributary of the North Fork. The slide is estimated to have carried 5,000 cubic meters of debris and originated on a road in a timber harvest unit. Wood and sediment traveled 500 meters down the tributary and another 330 meters down the North Fork before lodging as a debris jam that now spans the channel. This slide has been and is being intensively studied (Anderson 1992, Lamberti et al. 1991, Wildman personal communication 1995). Biotic recolonization of the stream channel impacted by the slide was rapid. Cutthroat trout populations were wiped out from the disturbance but, by the following year, recruitment of young-of-the year trout into the disturbed section of stream exceeded that of control section populations and had recovered to pre-landslide densities (Lamberti et al. 1989). In the same year as the debris torrent, macroinvertebrate emergence density was similar to that of an unaffected stream section. However, there was a major shift in populations from detrivores and moss associates to grazers, especially Baetis mayflies (Anderson 1992).

The North Fork Quartz fish community is apparently more diverse than in Quartz Creek. It consists of cutthroat trout, rainbow trout, speckled dace, longnose dace, and sculpin. Pacific giant salamanders and rough skin newts were also observed. Tailed frogs and crayfish were observed while surveyors snorkeled 2.5 miles upstream from the mouth of the creek. Although some embedded large wood may provide for temporary upstream passage barriers in the stream, long term passage barriers do not appear to exist to upstream migrating cutthroat and rainbow trout in the lower 2 miles of the North Fork. The rainbow trout population appears to be low in comparison to the cutthroat trout population within the sampling areas. Rainbow trout were only observed in the lower reach of the creek (USDA Forest Service 1993).

Table 8: North Fork Quartz Creek Current Conditions at a Glance

FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-1.8	11	64	6	78
1.8-2.4	18	177	9	87
2.4-3.2	21	190	13	69
Total	17	116		

Scout Creek

Scout Creek flows into the reservoir north of Saddle Dam. Little information exists regarding the historic or current condition of this small tributary to Blue River.

A historic Oregon State Game Commission, Fishery Division fish sampling data sheet sheds some light on the fish species that inhabit the creek. On 24 September 1968, the State Fisheries Division deposited rotenone, a pesticide, in Scout Creek and collected and measured the fish they poisoned. This was a common fish sampling technique in the 1960's. Young of the year to 2 year old rainbow and cutthroat trout were collected (Oregon State Game Commission 1968). This indicates Scout Creek may serve as a nursery stream for Blue River cutthroat and rainbow trout.

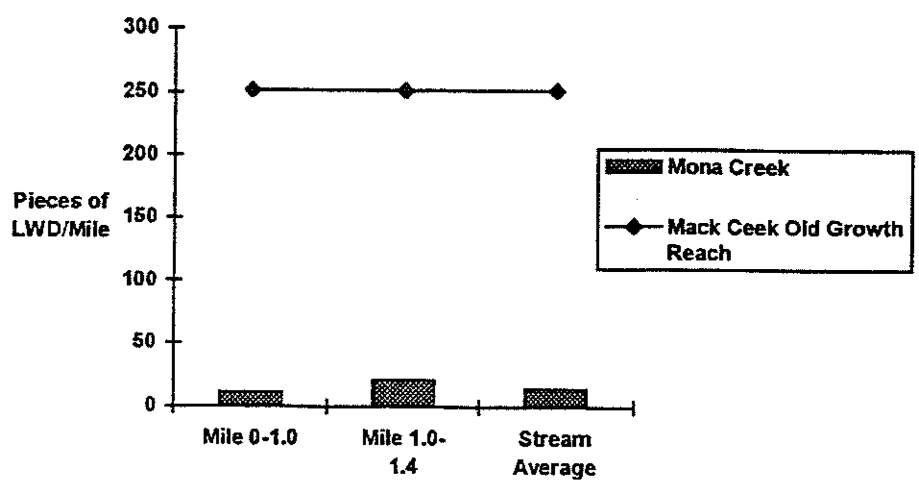
Mona Creek

Armantrout and Shula provide a short description of the condition of the creek in their 1975 Willamette National Forest stream survey report. By that time, timber harvest activities were well underway in the drainage. The upper watershed above Forest Service Road 1510 crossing was unlogged. The stream was steep with falls. Below the road crossing, the stream was impacted by logging activities. Logs and slash choked the stream channel. The stream had less of a grade below the road and shade was scarce in the timber harvest units which crossed the stream (USDA Forest Service 1975).

A Hankin-Reeves stream survey was conducted on Mona Creek in 1994. Near its mouth, the stream flows through a moderate V-shaped valley, but further upstream flows through a narrow V-shaped valley to the end of the survey. Most of the stream consists of cobble/ boulder cascade stair steps. Pool habitat is mainly pocket pools. The riparian forest is dominated by young hardwoods close to the creek and conifers farther away. While some of these conifers are in a mature condition and beginning to provide large wood to the creek channel, others are young and growing in previously harvested areas. These areas are sources of log slash and elevated temperatures. Logging slash and cull logs comprise most of the large woody material found during the survey (USDA Forest Service 1994). When compared with the amount of large in-stream wood per mile in Mack Creek, Mona Creek is extremely deficient (Chart 4: Mona Creek LWD/Mile).

Chart 4

**Mona Creek LWD/Mile
Compared With
Mack Creek Old Growth Reach LWD/Mile**



The first natural upstream migration barrier to fish is an 18 foot high bedrock waterfall, located one mile from its mouth. Below it exists 1 mile of spawning and rearing habitat for the cutthroat and rainbow trout which inhabit the stream. Although not documented, cutthroat trout may inhabit the stream above the falls.

Table 9: Mona Creek Current Conditions at a Glance

FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-1.0	9	11	6	93
1.0-1.4	10	21	8	83
Total	9	14		

Tidbits and Ore Creeks

In August 1966, a Forest Service surveyor named Kivett, performed a superficial physical survey of Blue River drainage, including Tidbits Creek. In the report introduction, he explains the purpose of the inventory was to determine potential for management of resident game fish within the drainage (USDA Forest Service 1966).

Willamette National Forest stream surveyors Heller and Baker were the first biologists to describe the Tidbits drainage in any detail (USDA Forest Service 1974). By 1974, Tidbits Creek and its major tributaries had been severely impacted by logging and road building. At the time of the survey, a large amount of the timber on slopes to the north of Tidbits Creek had been logged and the main road paralleling the creek from its mouth to 3 miles upstream had been constructed. Evidence of stream sediment loading from road associated mass movements, road side-cast erosion, and harvest related erosion were noted at a number of locations. A thin layer of fine sediment covered the large and small boulder and bedrock stream substrate, particularly in the areas of slow water movement. High water temperatures due to exposure to the sun was perceived as a problem. Stream surface shading within the lower 3 miles of the creek ranged between 10 and 20%. Stream cleaning , removing all wood from the creek after logging, was common in the 1970's and the stream survey report shows several before and after stream cleaning photographs of Tidbits Creek. Tidbits and Ore Creeks had much of their wood removed through stream cleaning which has resulted in decreases to channel complexity, available cover, the ability of the stream to dissipate stream energy, available nutrients, and the ability of the stream to scour pools and collect gravels.

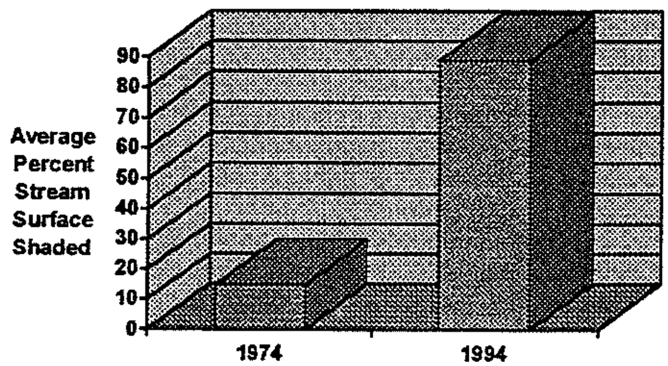
Armantrout and Shula (USDA Forest Service 1975) continued the investigation of Tidbits drainage with spot checks of some tributaries. Ore Creek was severely impacted by logging and road building. A road was built close to and paralleling the creek. Its poor drainage and side cast erosion had direct impacts upon Ore Creek. Both sides of the creek had been logged to the water and stream cleaned afterwards. Although not mentioned in the report, a survey photograph shows the culvert at the mouth of the creek emptying into Tidbits Creek. It is a definite barrier to upstream migration into Ore Creek from Tidbits Creek, plunging approximately vertical 10 feet to the surface of Tidbits Creek. The surveyors also discussed severe erosion problems related to logging which were occurring at Sluice and "D" Creeks, Tidbits tributaries.

Tidbits Creek was surveyed by Forest Service stream surveyors in August and September 1994. The lower 3 miles of the creek flows through a v-shaped moderate gradient valley. The mile closest to its mouth is low gradient riffles with stream bed substrates consisting mainly of cobble and small boulders. The next 2 miles are higher gradient rubble and boulder plunge pools. Gravel and small boulders are the dominant stream substrates. Huge boulders, the size of houses, deposited from the most recent glacial period, are common in the stream channel. Cobble embeddedness is minimal throughout the lower 3 miles of stream.

Stream shade canopy cover ranges between 85 and 93%, a marked improvement from the 10-20% range recorded in 1974. This shade is primarily provided by creek-side alders and maples (USDA Forest Service 1994). The graph below compares the percent of the stream surface that was shaded in 1974 with 1994 (Chart5: Tidbits Creek Percent Stream Surface Shading).

Chart 5

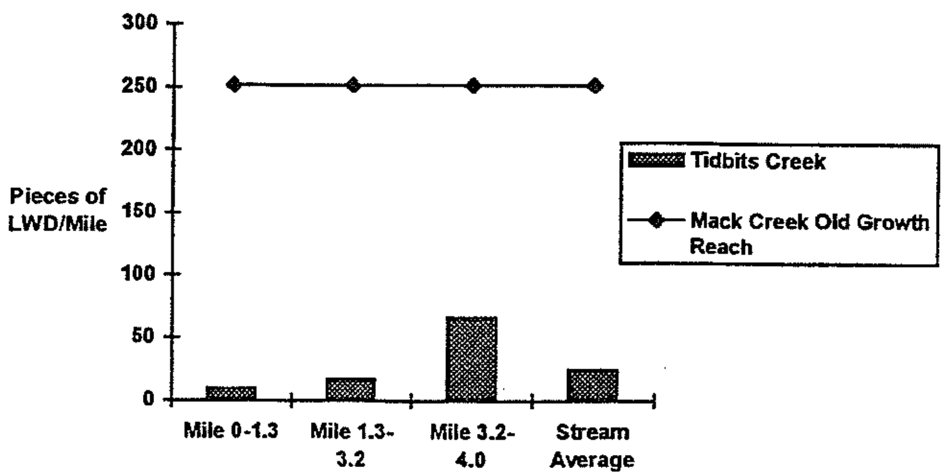
Tidbits Creek
Percent Stream Surface Shading



Both stream banks have been impacted by logging in the past. The conifers in the riparian area are predominantly young trees. The potential of these trees serving as a wood source for in-stream large wood is still far in the future. Spawning gravels and in-stream large woody debris is lacking in these 3 miles (USDA Forest Service 1994). The quantities of large wood in Tidbits Creek are low (Chart 6: Tidbits Creek LWD/Mile).

Chart 6

Tidbits Creek LWD/Mile
Compared With
Mack Creek Old Growth Reach LWD/Mile



The upper most mile of the stream flows through a moderate valley wall stream segment. The primary stream substrate is gravel and small boulder and embeddedness by fines is minimal. Young alder dominates the inner riparian area and mature Douglas-fir dominates the outer riparian area. Large instream wood and spawning gravels are more prevalent in this upper stream section than the 3 miles of stream below (USDA Forest Service 1994).

Cutthroat and rainbow trout, sculpin, and Pacific giant salamanders were documented during the 1994 biological survey of Tidbits Creek. The creek was sampled by electroshocking.

Table 10: Tidbits Creek Current Conditions at a Glance

FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-1.3	19	10	22	78
1.3-3.2	15	17	11	84
3.2-4	10	67	4	93
Total	14	25		

Prior to the intensive timber management in Ore Creek drainage, the creek may have been one of the primary rainbow and cutthroat trout nurseries in Blue River Watershed, second only to Lookout Creek. There are indications of past production and present potential which include potential for abundant, relatively clean gravels, once copious large wood in the creek and standing on the creek banks, the creek's relatively low gradient, and few natural migration barriers. The riparian area now consists of alder and vine maple with very young cedar begining to emerge from the hardwood canopy. Large boulders were deposited in the channel by the latest glacial episode, similar to the middle reach of Tidbits Creek. The creek sustained major damages during timber harvest activities. An impassable culvert was placed at its mouth which blocks the upstream migration of cutthroat and rainbow trout from Tidbits Creek and Blue River into Ore Creek. A road is located on the hillside east of and parallel to the stream. Drainage for the road is poor and road material was side cast into the creek. Today the road is closed and pole size conifers are established on its surface. When the road was closed, drainage structures were not pulled. Both sides of the creek have been logged. Only six mature conifers (in a clump) were counted within the first mile of creek. The stream was cleaned of its large wood, as evidenced by the piles of wood rotting on high floodplains and landings.

Blue River Reservoir

Oregon Department of Fish and Wildlife release 200,000 chinook salmon juveniles per year in Blue River Reservoir to rear throughout the summer. These fish augment and diversify the reservoir fisheries and supplement the commercial ocean and recreational river fisheries (particularly the inner city fisheries in Portland). They are evacuated from the reservoir during the fall reservoir drawdown. The release of these chinook juveniles can also be viewed as a small step at ecosystem restoration, considering a small run of chinook salmon apparently historically reproduced here. The juvenile chinook are a prey source for other fish.

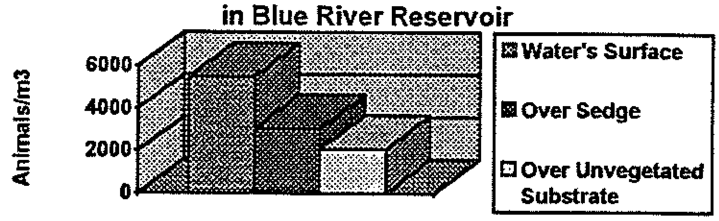
Every spring, 18,000 catchable size rainbow trout are released into Blue River Reservoir for what appears to be a very popular reservoir fisheries.

During the last decade, there has been an effort to plant vegetation in the drawdown zone of Blue River Reservoir to decrease erosion, increase aquatic habitat complexity, and increase nutrients and cover available to aquatic and terrestrial life that inhabit the reservoir drawdown zone. At first wholly experimental, over the years, successful plant species and planting techniques have been identified. The key has been to utilize plants that survive being inundated for a long period of time. Native and non-native plant species have been used in the past. Plant species that have been planted in the past and seem to survive the adverse conditions of the reservoir include willow, sedge, and cypress. Structural materials, including erosion cloth, fiber logs, and tree bundles have also been used. Plantings have been monitored by both Forest Service personnel and independent scientists and reports can be found at Blue River Ranger District files.

Taxon Aquatic Monitoring Company (1993) studied the role of terrestrial vegetation in Blue River Reservoir. Zooplankton tows were made from 3 habitats during the study; at the surface of the water, immediately above the sedge, and over unvegetated substrate. The largest number of animals were collected at the water surface, a mean of 5492 animals/m3. Tows above the sedge collected a mean of 3,042 animals/m3 and above unvegetated substrate, a mean of 2,082 animals/m3 (Chart 7: Average Zooplankton Collection Over 3 Habitats in Blue River Reservoir). The highly photic zone of the reservoir has an abundance of phytoplankton for zooplankton to feed upon, accounting for the high numbers of animals per cubic meter. Zooplankton tows over sedge collected more animals than over unvegetated substrate because of the nutrients and habitat provided by the sedge.

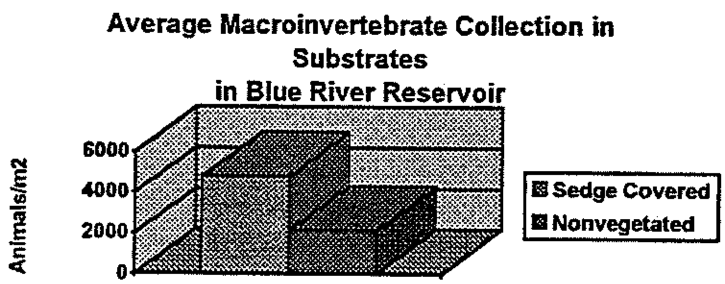
Chart 7

Average Zooplankton Collection Over 3 Habitats in Blue River Reservoir



Taxon Aquatic Monitoring (1993) also sampled the reservoir substrate for macroinvertebrates. In the sedge covered substrate, an average of 4,793 animals per square meter was collected. In unvegetated substrate, an average of 2,120 animals per square meter was collected (Chart 8: Average Macroinvertebrate Collection in Substrates in Blue River Reservoir). More than twice as many macroinvertebrates inhabited the sedge covered substrate than the unvegetated substrate because of the nutrients and habitat provided by the sedge. During this study, dace were observed utilizing the sedge for habitat. Adult roughskin newts were also observed during the study. Aquatic insects are a major component of their diet.

Chart 8



The most fish species diversity within Blue River Watershed can be observed in the reservoir and the 3 to 4 miles of river above the reservoir. Cutthroat and rainbow trout, chinook salmon, sculpin, longnose and speckled dace, redside shiner, and largescale sucker inhabit these waters.

The reservoir intercepts gravel and wood that would have otherwise benefited aquatic habitat downstream of Blue River Dam. When it is stationary between movement, these elements provide important habitat for aquatic and riparian-dependent species. The river bed load settles to the bottom of the reservoir and the wood floats around until it lodges against the reservoir wall or is removed by reservoir sweeping. While in the reservoir, this wood likely functions as a source of nutrients and cover for aquatic life.

Riparian Areas

The entire watershed is located within the Central Cascades Adaptive Management Area. Flexibility is provided to achieve riparian protection and meet objectives in a manner different than that prescribed for other areas. For the purposes of this analysis and in order to display conditions in and adjacent to riparian areas the distances described as interim widths for Riparian Reserves in the Northwest Forest Plan were used. The landscape design will use this information to determine prescriptions for riparian areas that will meet the Aquatic Conservation Strategy objectives.

The riparian reserves as defined by the ROD for this Landform Block have 44% of the area harvested and 2% roaded. How this management is distributed along the stream network is displayed in (Figure 20: Landform Block 1 - Road and Harvest Within Riparian Areas). Class II and Class IV streams, along with the area surrounding the reservoir have been the most heavily managed.

Focusing in on the particular drainages and their management history, one can see that several of the smaller drainages have had 50% or more of their riparian areas harvested and roaded, such as Mona, Reservoir Face, N. Fk. Quartz, Scout, and Simmonds. (Figure 21: Landform Block 1 - Road and Harvest by Smaller Drainages).

Within the Scout drainage, the majority of harvest has taken place along the main, Class II stream, with the remaining harvest occurring along the Class IV tributaries to Scout Creek (Figure 22: Scout Drainage Road and Harvest Within Riparian Areas).

A look at Simmonds drainage reveals that nearly the entire length of the main, Class II channel had been harvested in the past when it was in private ownership (Figure 23: Simmonds Drainage Road and Harvest Within Riparian Areas). Approximately half of the Class III riparian areas and one third of the Class IV riparian areas had also been harvested.

The major drainage, Tidbits, (excluding the tributary Ore Creek) has had one or both sides of it's entire main channel length harvested, and a road running up it's valley bottom. The result is approximately 60% of the Class II riparian area of Tidbits Creek in a managed condition (Figure 24: Tidbits Drainage Road and Harvest Within Riparian Areas).

Quartz and North Fk. Quartz drainages, like Simmonds, was harvested in the 1930's and 1940's under private ownership. Harvest occurred directly up the bottom of the channel, resulting in harvest along the main Class II channels. Harvest within North Fk. Quartz was more extensive than in Quartz Creek., with tractor logging up many of the Class IV tributary channels (Figure 25: Quartz Drainage Road and Harvest Within Riparian Areas).

Figure 20: Landform Block 1 - Road and Harvest within Riparian Areas

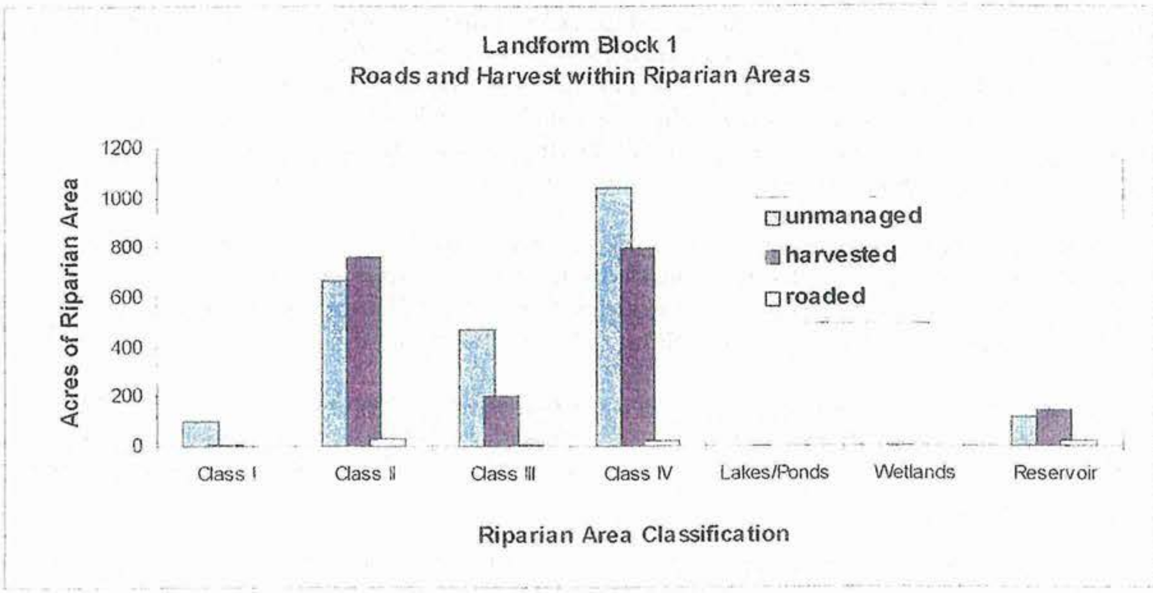


Figure 21: Landform Block 1 - Road and Harvest by Smaller Drainages

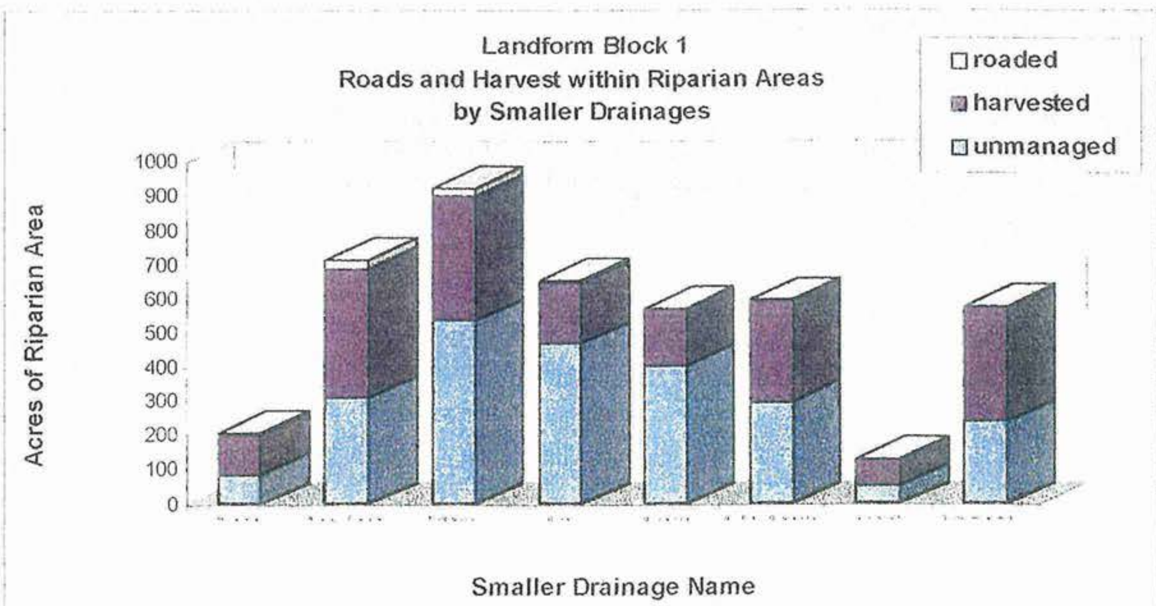


Figure 22: Scout Drainage Road and Harvest Within Riparian Areas

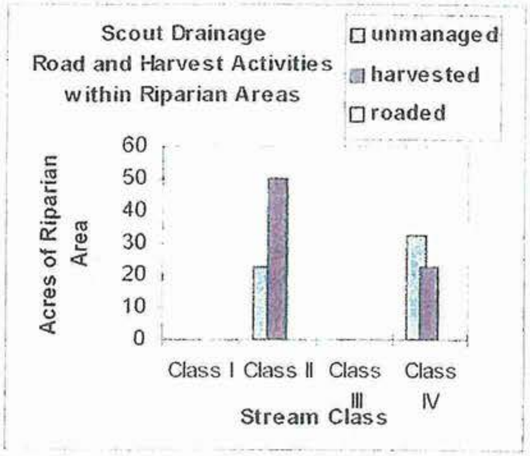


Figure 23: Simmonds Drainage Road and Harvest Within Riparian Areas

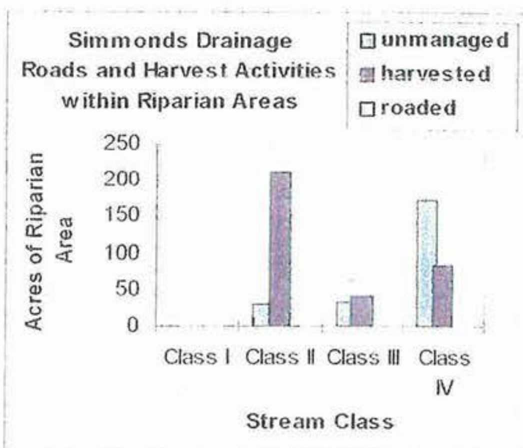


Figure 24: Tidbits Drainage Road and Harvest Within Riparian Areas

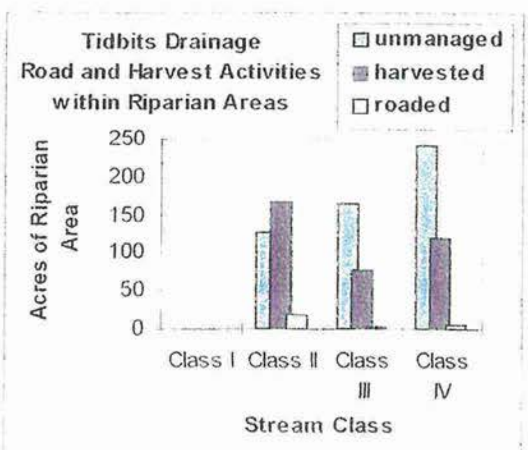


Figure 25: Quartz Drainage

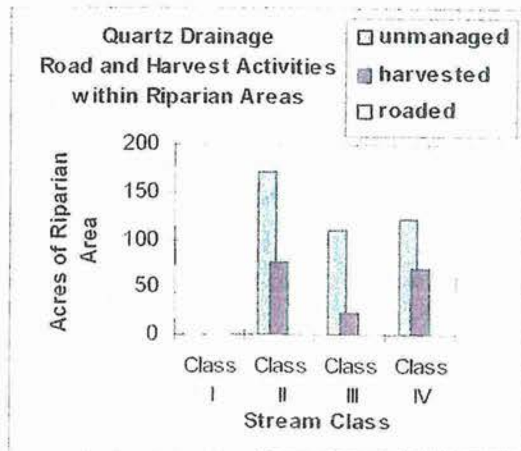
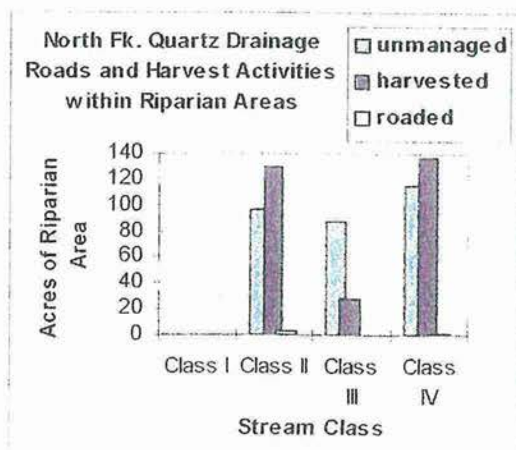


Figure 26: North Fork Quartz Drainage Road and Harvest Within Riparian Areas



LANDFORM BLOCK 2

Cook-Quentin Creeks -Western Cascade Cirque Ridge System

Erosional Processes

Refernce Conditions

Geologic Formation

This Landform Block is similar to Landform Block 1 in that the lower portion much of the topography is dominated by steeply incised valleys with high gradient streams. However, the upper reaches of Cook and Quentin Creeks are typically wide, cirque-like basins containing low angle slope deposits that are probably the result of small, headwall glacial scour. Differential erosion occurs as well in these area due to younger Early High Cascade ridge-capping basalts overlying older Western Cascades pyroclastic bedrock.

Riparian

Debris slides and debris avalanches were prevalent in the upper drainage of Cook Creek, causing scouring of the main channel and opening of the canopy. Slides would have also resulted from fire in steep, tributary streams of Quentin Creek Streamside slides would have been asscociated with burning of riparian vegetation within patchy areas in the mid-section of Quentin Creek These patchy areas of burn in the riparian area would have allowed for transport of riparian area substrate and bank material. Both Cook and Quentin Creeks are considered "transport" streams, which route sediment downstream to lower gradient reaches. However, much of the main channel length of both creeks have localized sections of "response" reaches, where lower gradient reaches with a relatively wide floodplains are capable of storing sediment.

Current Conditions

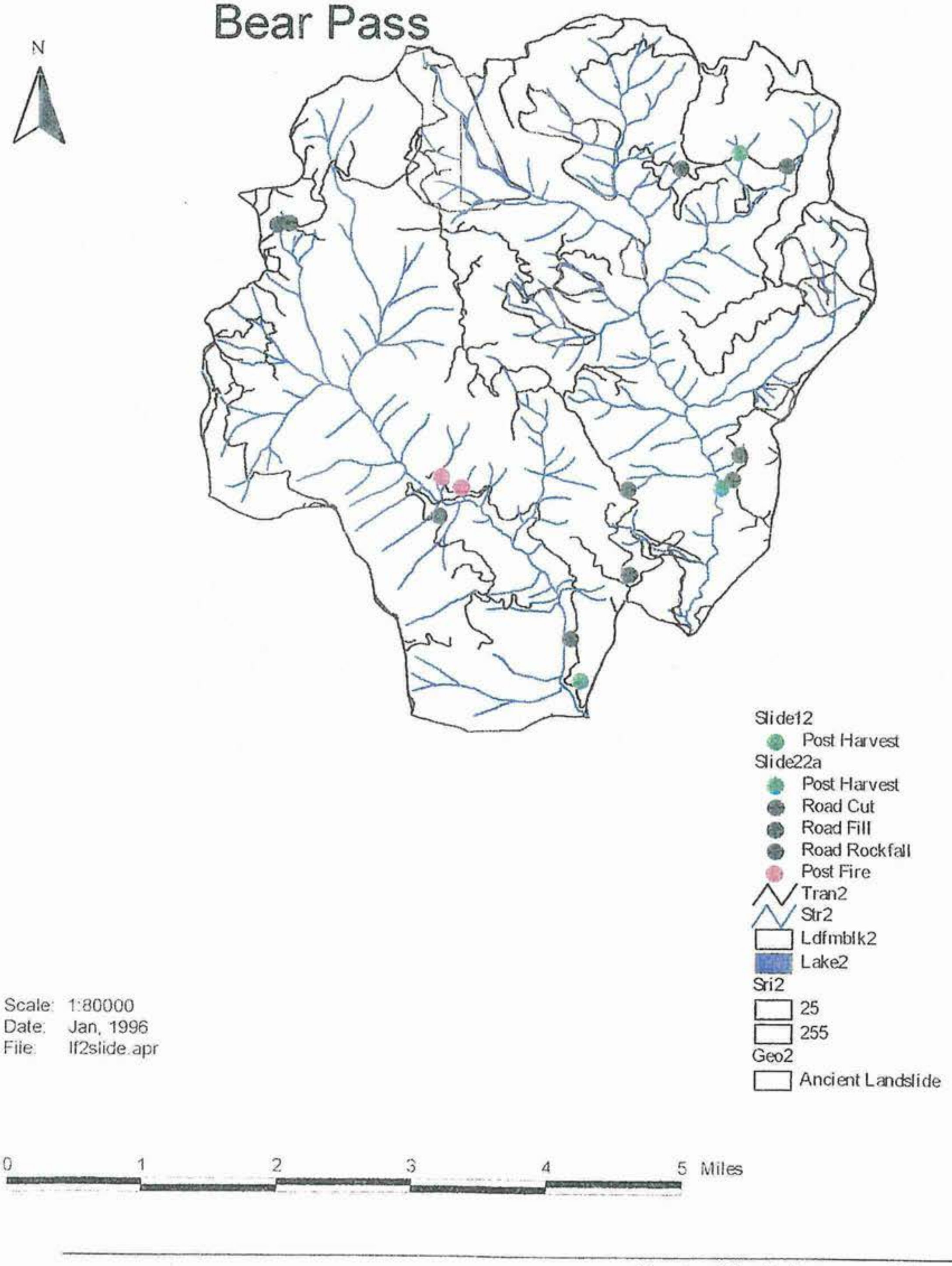
Upslope

Landform Block 2 contains relatively fewer site specific slope failures than any other of the landform blocs in the watershed with only 2% of the total natural failures (2), 11% of the road failures (10), and 3% of the post-harvest failures (3) in the watershed. In addition, one ancient landslide occupies 400 acres, and 14 areas of unstable S.R.I. soils account for an additional 600 acres. All slope failures account for 8.5% of the total Landform Block area. (Figure 27: Landform Block 2 - Landslide Distribution)

Riparian

There have been few harvest and road related failures causing stream channel scour. This is due to the relatively low harvest rates, consideration of road placement, low road density, and the fact that much of the upper portions of these drainages were unmanaged during the 1964 flood. Road related slides triggered by the 1964 flood provided sediment that aggraded the channel bottoms of Cook and Quentin Creeks, with accumulation principally at the mouth of Cook Creek

Figure 27: Landform Block 2 - Landslide Distribution



Aquatic Habitat

Reference Conditions

Very little information is available in the stream survey reports regarding the reference condition of this Landform Block. The 1937 U.S. Bureau of Fisheries survey of Blue River ended at the mouth of Cook Creek. Other than mentioning the flow, 3 cForest Service., Cook Creek was not described (USDC Bureau of Fisheries 1937).

Forest Service employee Kivett performed a superficial survey of Quentin Creek in 1966, prior to land management in this watershed. He described the lower section as dominated by bedrock substrate with a few pockets of gravel. The upper part of the creek had predominantly boulder and rubble substrate (USDA Forest Service 1966). Similar conditions probably existed for Cook Creek.

Current Conditions

Cook Creek

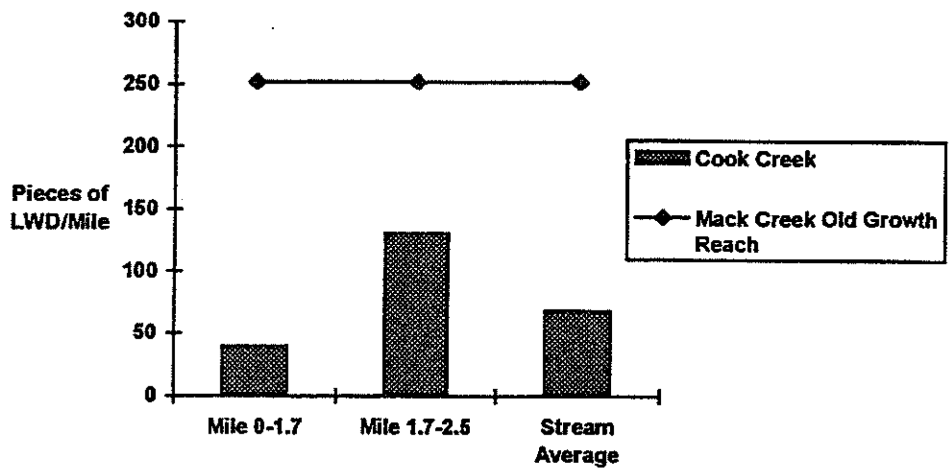
Cook Creek was first surveyed by Forest Service surveyors in 1975. They documented erosion generated by logging activity and roads in the drainage. In places, the canyon bottom was filled with slash and debris. They observed some good spawning areas and deep pools and speculated the creek was subject to high winter flows because the bottom of the stream appeared scoured free of vegetation (USDA Forest Service 1975).

The creek was revisited by McKenzie Zone stream surveyors in 1994 and described as a moderate incised valley with low to moderate gradient. Bedrock dominates the substrate in the lower stream section while cobble and gravel are subdominant. Cobble and small boulder dominates the substrate composition farther upstream, although large areas of bedrock remain prevalent.

Small alder and big leaf maple dominate the riparian zone that borders the stream channel (average zone width of 45 feet). Further inland, the riparian area is dominated by mature and large Douglas-fir and Western hemlock, interrupted periodically by timber harvest units (average riparian zone width of 55 feet) (USDA Forest Service 1994). Stream canopy shading is low throughout the survey due to clearing of riparian vegetation during high flows and the southerly aspect of the drainage. In the graph below (Chart 9: Cook Creek LWD/Mile), the amount of large wood per mile in Cook Creek is compared with the amount present in Mack Creek old growth section. There is a low amount of wood in Cook Creek, likely due to the low amount of naturally occurring slides within the Cook drainage. Landslides are a mechanism for large wood delivery.

Chart 9

Cook Creek LWD/Mile
Compared With
Mack Creek Old Growth Reach LWD/Mile



A 12 feet high waterfall located 0.3 mile upstream from the mouth is a barrier to upstream migration (A map of migration barriers is located in the Appendix). Cutthroat and rainbow trout, sculpin, and chinook salmon juveniles are known to inhabit the creek. Both wild and hatchery rainbow trout utilize the creek. Chinook juveniles migrate upstream from the reservoir where they were planted and some have been seen in lower Cook Creek.

Table 11: Cook Creek Current Conditions at a Glance

FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-1.7	16	40	35	62
1.7-2.5	10	131	12	80
Total	13	69		

Quentin Creek

Forest stream surveyors Heller and Baker surveyed Quentin Creek in 1974. They described a stream with steep gradient and a dominant substrate of boulders and cobbles. The lower half mile of the stream, however, is dominated by bedrock. A number of road related debris slides have contributed large quantities of sediment and debris to the creek. The two main roads within the drainage, far upslope from the stream channel, were both closed at the time of the survey due to mass movement damage. Stream surface shading was generally poor due to past removal of riparian vegetation by scouring and the southerly orientation of the stream which precluded effective shading from lower and mid-slope stands of old growth Douglas fir. A 15 foot high falls 1.1 mile upstream from the mouth was identified as the first upstream migration barrier fish encounter as they move up from Blue River and lower Quentin (see map of migration barriers in the appendix)(USDA Forest Service 1974).

In 1994, McKenzie Zone stream surveyors visited Quentin Creek. The stream was described as a steeply incised valley with a moderate to high channel gradient. Nearer to its source, the stream takes on the characteristics of a headwater tributary. The channel is bedrock controlled throughout the length of the stream. In the lower reach, bedrock is the dominant substrate, followed by cobble and gravel. Farther upstream, cobble and small boulder dominate the stream bed, although bedrock is still prevalent. The upper reach is cobble and gravel dominated (USDA Forest Service 1994).

There is more of an abundance of large wood throughout Quentin Creek than in many of the other managed creeks within the watershed due to the presence of mature conifers in the outer riparian area which serve as a source. Sapling and pole sized alders, vine maples, and willows comprise the riparian vegetation close to the stream channel (average riparian zone width of 20 feet). Stream canopy shading remains low (USDA Forest Service 1994). Below, the amount of large wood per mile in Quentin Creek is compared with Mack Creek old growth section (Chart 10: Quentin Creek LWD/Mile). When using the old growth section as a standard, Quentin Creek has a moderate to low amount of large wood. This may be because Mack Creek receives more wood because of a higher frequency of slides.

Rainbow and cutthroat trout and sculpin inhabit Quentin Creek. The rainbow trout are both wild and hatchery.

Chart 10

**Quentin Creek LWD/Mile
Compared With
Mack Creek Old Growth Reach LWD/Mile**

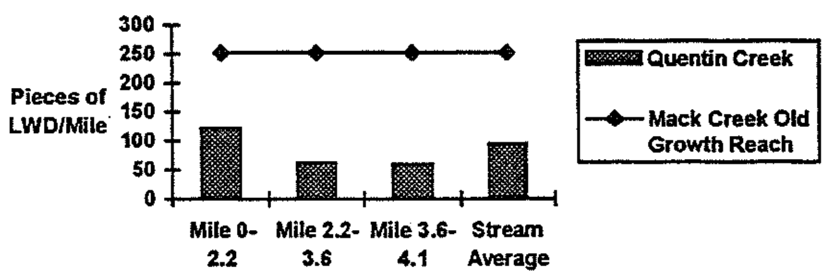
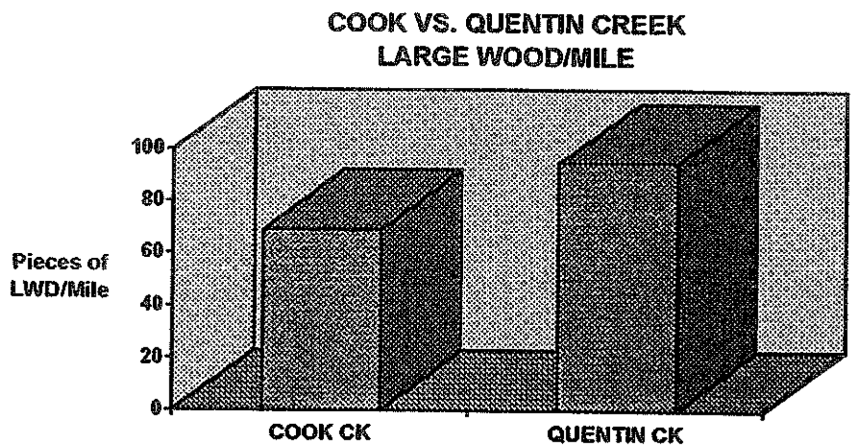


Table 12: Quentin Current Creek Conditions at a Glance

FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-2.2	15	123	26	65
2.2-3.6	19	62	32	68
3.6-4.1	2	60	4	96
Total	12	95		

There is more large wood per mile in Quentin Creek than in Cook Creek. This may be due to the impacts that logging activities have had upon Cook Creek, leaving a younger seral stage riparian forest along Class II sections (Chart 11: Cook vs. Quentin Creek Large Wood/Mile). This is also due to addition of large wood resulting from a large, stream-side slide originating in forested terrain in Quentin Creek Drainage.

Chart 11



Riparian Areas

This block has the lowest percentage of managed riparian area of all four blocks, with 26% harvested and 1% roaded. The breakdown between the two drainages are nearly identical for management in riparian areas, with 26% and 28% harvested and roaded for Cook drainage and Quentin drainage, respectively (Figure 28: Landform Block 2 - Road and Harvest Activities Within Riparian Areas by Smaller Drainages)

Most of the harvest within this block has occurred along Class IV stream channels, with some also along the main, Class II and III channels. (Figure 29: Landform Block 2 - Road and Harvest Activities Within Riparian Areas)

Figure 28: Landform Block 2 - Road and Harvest Activities Within Riparian Areas by Smaller Drainages

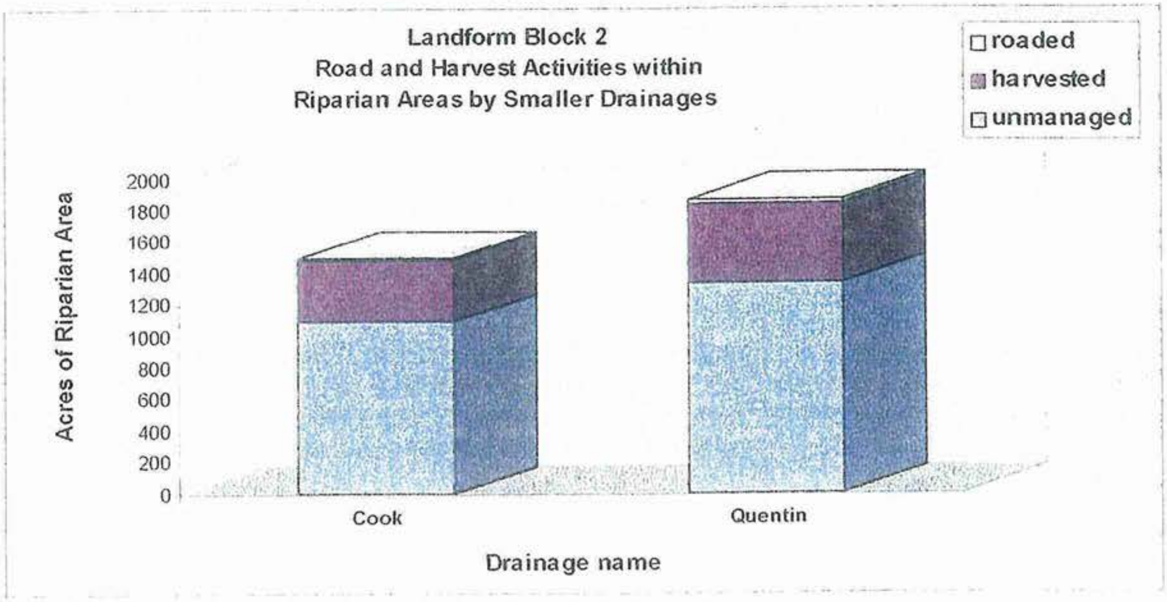
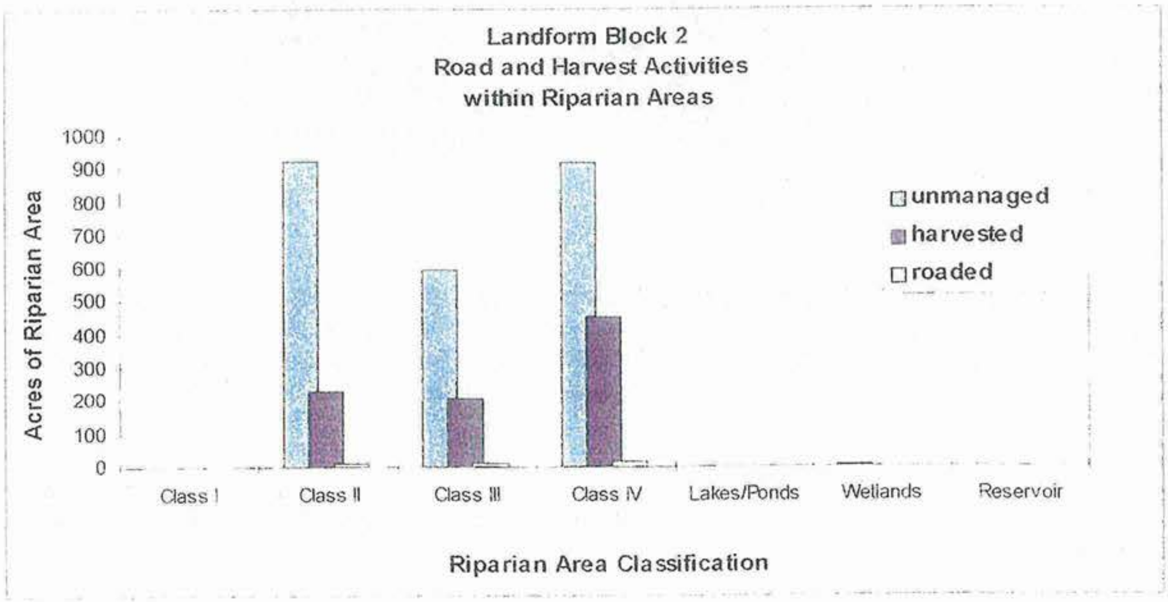


Figure 29: Landform Block 2 - Road and Harvest Activities Within Riparian Areas



LANDFORM BLOCK 3

Wolf-Mann Blue River - Western Cascade Cirque Ridge, Plio Cascade Systems

Erosional Processes

Reference Conditions

Geologic Formation

Marion (81) described "The landscape of the BRD [Blue River Drainage] is for the most part composed of erosional landforms with rugged relief. Elevations ranges from 1357 ft. at Blue River Lake to 5349 ft. on Carpenter Mountain. Slopes are steep with average gradients between 25 and 30 degrees. Convex slope profiles are predominant and footslopes are lacking except along the upper reaches of Blue River. The present form of the BRD is primarily a product of stream dissection, mass movements and past glaciation. Mass movement terrain is apparent in several places along Blue River. Pleistocene glaciation is evident from cirque features on the northern flanks of Carpenter, Buck, and Tidbits Mountains and scattered till deposits observed above Blue River. These deposits all occur above 730 m, which is in agreement with Swanson and James'(1975) findings for pre-latest Wisconsin glaciation in the HJA [H.J. Andrews Experimental Forest]."

In the upper reaches of the Landform Block, Early High Cascade ridge-capping basalts from the Squaw Mountain flows are present as well as numerous small near-surface basalt and andesite intrusives in the form of stocks and dikes. A large volcanic intrusion and glacial remnant that is prominent on the landscape is Wolf Rock which has been interpreted to be a micro-norite (fine grained gabbro) plug of late Pliocene age, 2-4 million years old (Avramenko, 81).

Riparian

Mass wasting in the form of debris slides, debris flows, debris avalances, and streamside slides dominate the erosional processes within the riparian areas and stream channels. Debris flows initiated in the headwaters of Mann Creek run for long distances, causing scouring and opening of the main Mann Creek channel canopy. Debris slides in small side tributaries of upper Blue River also cause canopy opening. Fire that burned riparian vegetation adjacent to Blue River began just upstream from the mouth of Quentin Cr and ran for a two mile stretch upstream, likely resulting in some small streamside slides and erosion of riparian area substrate during peak flows. A large glacial terrace adjacent to Blue River located approximately 2 miles upstream from the mouth of Quentin Creek is unconsolidated material that chronically erodes into Blue River. Following large storm events, the slopes are undercut by the river, causing the sideslopes to mass waste as streamside slides into the river. Following the mass wasting event, local deposition of the material directly downstream of the streamside slides causes localized channel widening.

Current Conditions

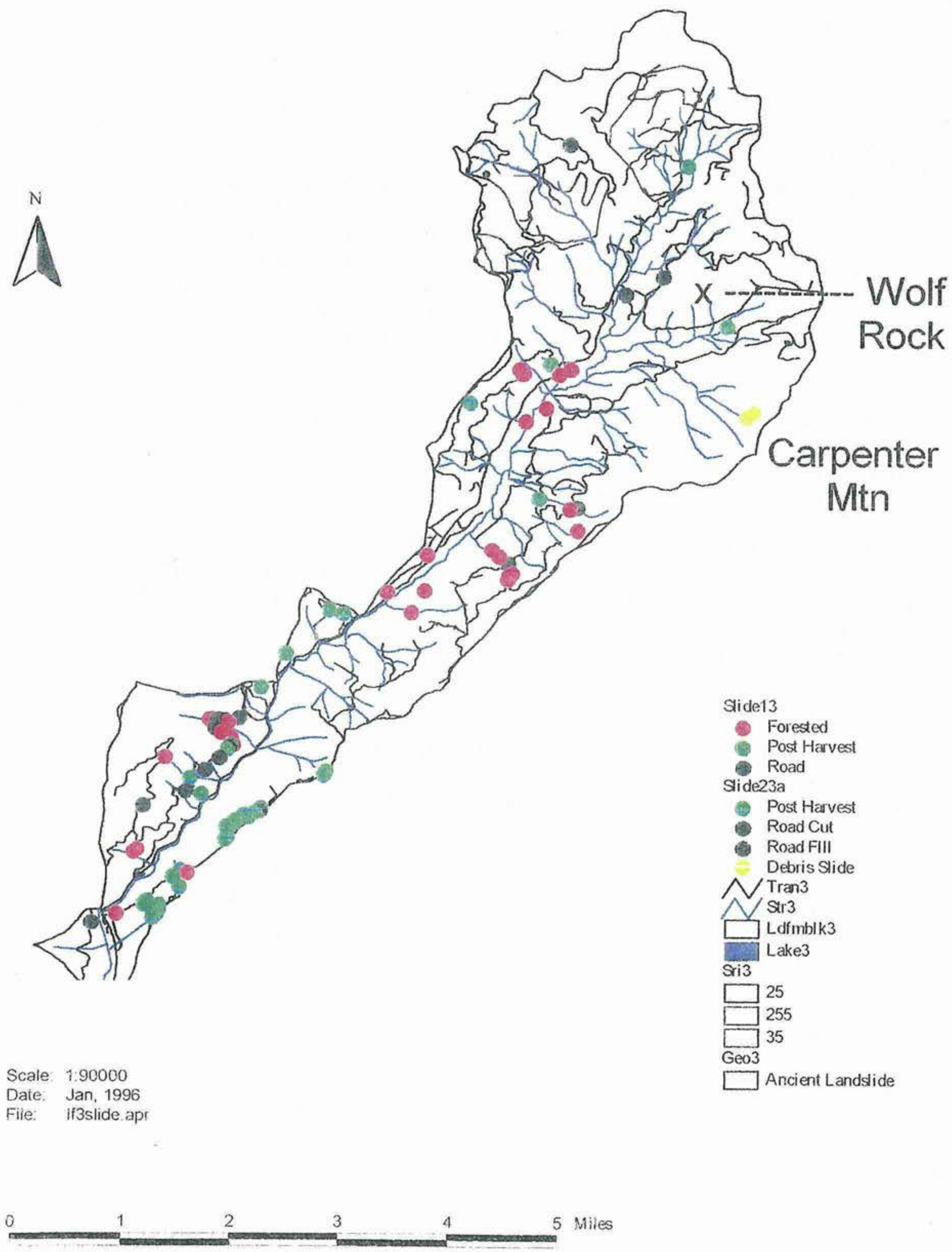
Upslope

The area contains 28% of the total natural failures (32), 18% of the road failures (16), and 36% of the post-harvest failures (41) in the watershed. The Landform Block also contains 2 ancient landslides with over 400 aces, and 9 areas of unstable S.R.I. soils containing over 500 acres. (Table 13: Natural Earthflow-Slump Complexes in Acres, Figure 30: Landform Block 3 - Landslide Distribution)

Table 13

Natural Earthflow-Slump Complexes in Acres						
Landform Block	1	2	3	4	Total	% Total Watershed Failure Acres
	Quartz-Tidbits	Cook-Quentin	WolfMann-Blue River	Lookout		
Ancient Landslides Occurances and Acres	None	1 @ 400 ac.	2 @ 426 ac.	3 @ 1,921 ac.	2,747 acres	47
Unstable Soil Units SRI 25/255/35 Occurances and Acres	25: 1 @ 24 ac.	25: 12 @ 407 ac. 255: 2 @ 172 ac.	25: 6 @ 479 ac. 255: 1 @ .1 ac. 35: 1 @ .3 ac.	25: 6 @ 472 ac. 255: 2 @ 948 ac. 35: 1 @ 21 ac.	2,523	48
Total Acres of Natural Failures	24	979	905	3,362	5,270	
Total Acres in Landform Block	20,398	11,685	11,255	15,738	59,076	
% Landform Block with Natural Failures	0.1	8.4	8.0	21.4		

Figure 30: Landform Block 3 - Landslide Distribution



Riparian

Mass wasting of harvest units have generally occurred in the lower sections of Blue River, triggered by the 1964 flood. Most of the sediment generated by these slides was transported down into what is now Blue River Reservoir, with some local deposition within the river at small meander bends. A debris flow scoured Mann Creek to bedrock when a small earthen dam located on provate ground failed during the winter of 1982/1983.

Aquatic Habitat

Reference Condition

Although no pre-management surveys exist for Mann and Wolf Creeks to provide stream reference conditions, a survey was performed on Blue River. In the late 1930's and early 1940's, the U.S. Bureau of Fisheries dispatched surveyors throughout the Columbia River Basin to document the extent and quality of anadromous fish habitat. Baltzo and Koloen are 2 surveyors that traveled up the McKenzie River and surveyed Blue River. They surveyed from the mouth of the river to Cook Creek, approximately 9 miles. They described the river as being fairly steep in the lower mile, moderately steep in the next 5 miles where the valley widens, and increasingly steep in the upper section. Except for the one slightly wider section, the valley was described as narrow and the walls were steep and heavily wooded.

The Bureau of Fisheries surveyors noted a 9 foot falls located 1.5 mile upstream of the mouth of Quartz Creek. This was prior to the building of the reservoir and today the falls is under the reservoir all year. They considered this falls to be impassable to upstream migrating fish at low flow, but passable at higher flows. They observed 8 adult chinook salmon holding in the plunge pool at the foot of this falls in mid-August. Considering the fish racks were being operated at Hendricks Bridge that year in an attempt to intercept all of the upstream migrating chinook and only occasionally fish passed this gauntlet, 8 is a good number of salmon in one hole (USDC Bureau of Fisheries 1937). It seems likely fish would pass this falls in 2 conditions; if the fish were moving up Blue River in high spring flows to hold in the deep pools in Blue River above the falls during the summer or if there were September/early October rains that raised the river level enough to provide passage over the falls. For a map of the location of this falls, please refer to "Significant Barriers to upstream Migration" located in Appendix C.

A large part of the stream bed was described as large rubble, boulder, and occasionally bedrock dominated. The gravel suitable for spawning was evenly distributed throughout the larger material so it was thought that it was not utilized by fish to its fullest extent. The only good salmon spawning areas observed were at the tail-out of the numerous large resting pools. The surveyors speculated that there was potential spawning area available for at least 2,000 salmon.

In their report Baltzo and Koloen (Bureau of Fisheries 1937) wrote, "Blue River's long suit is its trout population. They are scarce near the road but become increasingly numerous above the road end and very abundant in the upper reaches. These McKenzie rainbow trout grow to 15" with an average of 10". There are many large pools and an abundance of food. At that time, no hatchery stocking occurred in the Blue River Watershed.

They reported an abundant population of rainbow trout, a scarce population of suckers, and fair numbers of dace.

They described the vegetation in the hills and mountains surrounding Blue River as being heavily wooded with large second growth conifers, a rather open underbrush, and a scattering of alder and maple. They said that the dense covering of these trees prevented any noticeable erosion from the valley walls, which are very steep (USDC Bureau of Fisheries 1937).

Current Condition

Mann Creek

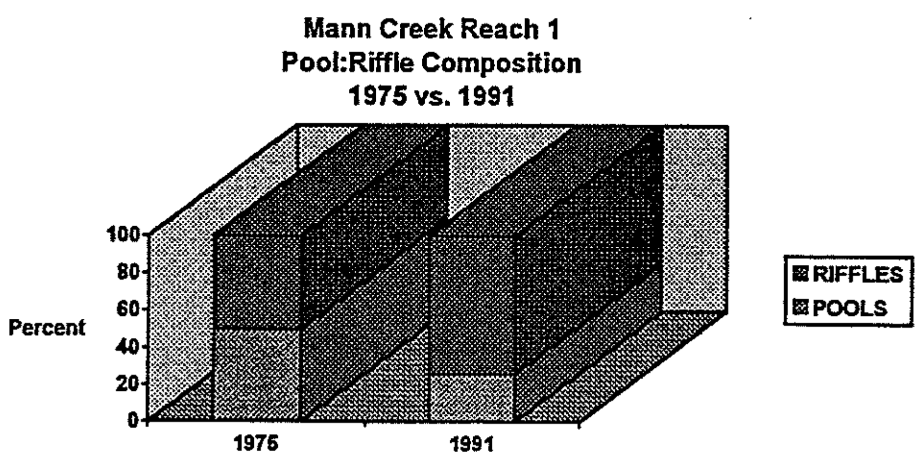
Mann Creek was surveyed by Forest Service surveyors Armantrout and Shula in 1975. They described the length of stream below Forest Service Road 15 to be in good condition, with deep pools, fair spawning gravels, and good cover. The stream bottom, scoured of algae and deficient in macroinvertebrates, and sparse stream side vegetation suggested highly variable flows. Cutthroat trout, crayfish, and garter snakes were observed. Stream shading was at 65% of the stream surface. The pool:riffle ratio for this section was 50:50.

The mile they surveyed upstream of Forest Service Road 15 had been more impacted by land management, particularly erosion from logging and road building. In places, the channel was filled with gravel, silt, and fines. Road cuts and fills were badly eroding. They observed pools filling with sediment. Stream canopy shading was only 40%. Pool:riffle ratio was estimated at 40:60 (USDA Forest Service 1975).

When the earthen dam on private land failed in the early 1980s the debris torrent simplified the creek, scoured the stream bed and riparian vegetation, and washed out Forest Service Road 15. There was some good that came of it too. When Forest Service Road 15 was originally constructed, the culvert at Mann Creek was a barrier to upstream migrating fish. When the road was fixed following the debris torrent, a properly placed culvert was substituted, restoring fish passage. In 1991, Willamette Forest stream surveyors Robb and York returned to Mann Creek. They described it as flowing through a V-shaped valley with a moderate slope. Two miles upstream of its mouth, the stream increases to a steep gradient and a high frequency of falls. The first 2 reaches of their survey corresponds with the 1975 stream survey, allowing for some comparison.

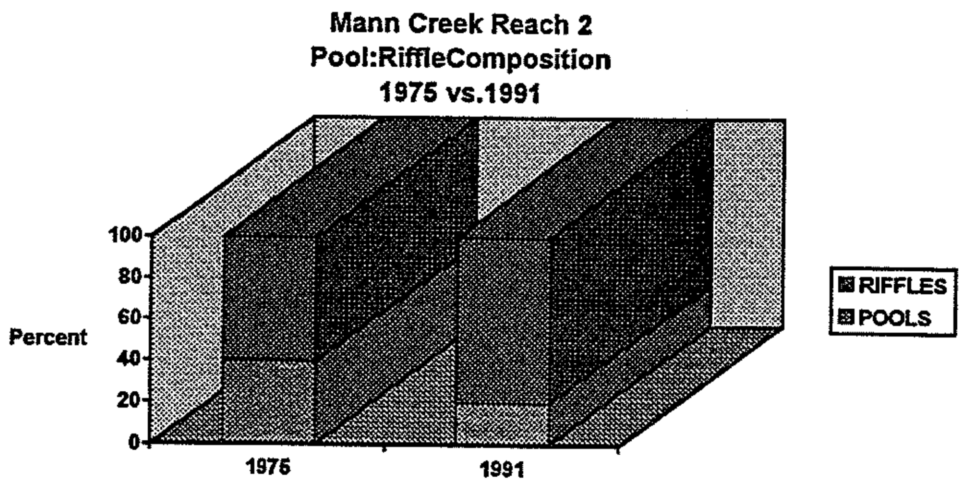
Downstream of Forest Service Road 15, clearcuts and roads could be seen from the creek, but buffers were maintained between the stream and these features. The riparian vegetation closest to the stream consists of sapling to mature hemlock, alder, and red cedar (average zone width of 50 feet). The outer riparian forest consists mainly of mature Douglas-fir (average zone width of 50 feet). Stream canopy shading is a 19%. Stream bed substrates are dominated by cobble and gravel. The pool:riffle ratio is 26:74, a decrease from the 1975 estimate of 50:50 (USDA Forest Service 1991). Even considering observer bias/error, the decrease in pools from 1975 to 1991 still appears to be significant. The decline in the frequency of pools in this reach may be due to the filling of pools observed by the 1975 surveyors (Chart 12: Mann Creek Reach 1 Pool:Riffle Composition).

Chart 12



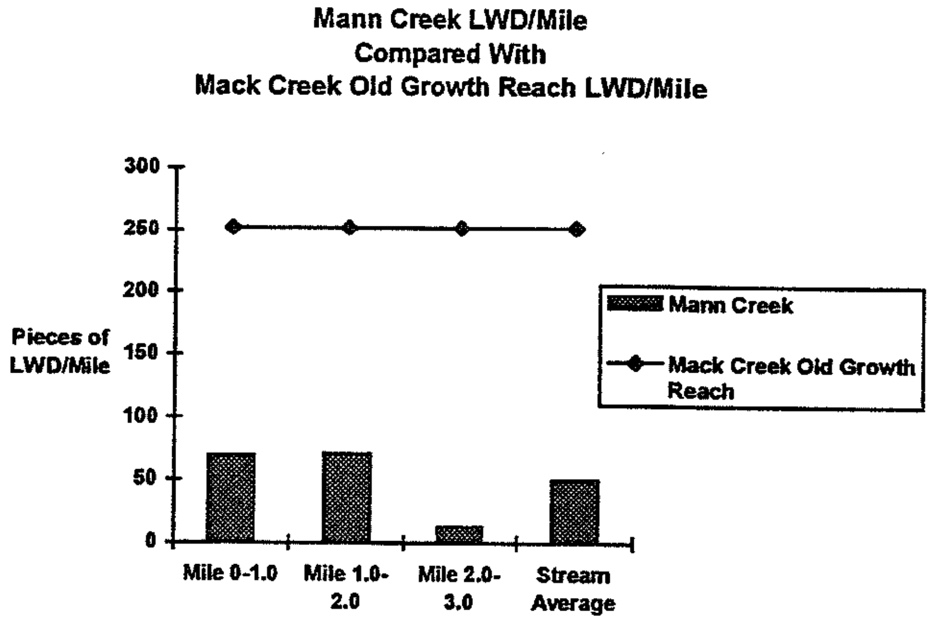
From Forest Service Road 15 upstream 1 mile, the valley width narrows and the stream gradient increases. Clearcuts dominate the riparian areas and blowdown of remaining trees is common. Riparian vegetation close to the stream is dominated by shrub to small tree size alder, willow, hemlock, and Douglas fir. Further from the creek, the riparian forest is dominated by sapling pole sized Douglas fir. Some mature Douglas-fir and hemlock remain in small tree and mature sizes. Stream canopy shading remains poor at 19% of the stream surface. Stream bed substrates are cobble dominated (USDA Forest Service 1991). The pool:riffle ratio is 20:80, decreasing from the 40:60 ratio estimated in 1975. Allowing for some observer bias, the decrease in pools between 1975 and 1991 may still be considered significant. This apparent decline can be attributed to the simplification of the stream channel over the last 2 decades from accelerated erosion and sedimentation and debris torrents (Chart 13: Mann Creek Reach 2 Pool:Riffle Composition).

Chart 13



Although the amounts of large wood per mile in Mann Creek appear similar to a creek which flows through old-growth in the first and second miles, the first mile of the creek has larger size pieces of wood because of the existence of a more mature forest within the riparian area. The third mile of the stream flows through lands intensively managed for timber (Chart 14: Mann Creek LWD/Mile).

Chart 14



A stream restoration project was implemented in Mann Creek near its confluence with Wolf Creek during the fall of 1991. A chainsaw powered winch was used to pull large wood into the stream. The wood was attached to the bare bedrock stream substrate to increase pools and cover and collect stream bedload. Effectiveness monitoring has determined that the objectives of this project were met.

Table 14: Mann Creek Current Conditions at a Glance

FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-1	34	70	26	74
1-2	26	71	20	80
2-3	30	13	11	89
Total		51		

Wolf Creek and Wolf Lake

Kivett performed a superficial survey of Wolf Creek in 1966. Timber harvest had already begun in this drainage and he noted large amounts of silt and slash in the stream from nearby clearcuts. Side cast from Forest Service Road 15 also reached the creek (USDA Forest Service 1966). In 1975, Armantrout and Shula returned to Wolf Creek. They described the creek as being buffered from most timber harvest activity with a thin buffer. They commented that these buffers were not very effective in reducing slash and erosion from reaching the creek. They observed much bank cutting and erosion due to logging activities and roads. Although the stream bed was primarily bedrock near its mouth, it was described as unstable and full of fines, silt, and gravel further upstream (USDA Forest Service 1975).

Information on the current condition of Wolf Creek is sparse. A 1990 Willamette National Forest survey of Wolf Creek observed cutthroat trout utilizing the stream.

In 1981, Wolf Lake Meadow was designated a special interest area and a management plan was developed. The objectives of the plan were to minimize human impacts and increase wildlife production. A suggestion to discontinue fish stocking in favor of natural production was made to Oregon Department of Fish and Wildlife. Maintenance of the beaver dam through beaver reintroductions was discussed. Fertilizing riparian areas was discussed to enhance a road buffer and wildlife habitat despite a main objective that called for slowing the eutrophication of the lake. It is unclear whether the fertilization occurred.Further timber harvest was halted around the lake, although comments about logging to maintain a healthy hardwood component as beaver food were discussed. Some dispersed camping sites around the lake were closed and rehabilitated (USDA Forest Service 1995).

Wolf Lake was surveyed in August 1995. The 21 acre lake is formed by a beaver dam which backs up Wolf Creek at the headwaters. The meadow portion of the stream in which the lake is located has a gradient of 3% and is formed by a bedrock nick-point approximately 2000 feet downstream of the lake outlet. This geological hard-point has preserved the meadow because it is erosion resistant and has impeded the formation of an incised channel. A 4 foot waterfall flows over the bedrock nick-point and down a stream channel with 10% gradient (USDA Forest Service 1995).

Wolf Lake substrate is mainly silt and there are signs of anaerobic conditions. Northwestern salamanders, rough skin newts, and Pacific treefrogs were observed in the lake. A high diversity and abundance of macroinvertebrates were found in the lake. Despite a lengthy history of periodic stocking since at least 1963, no fish were observed in the lake (USDA Forest Service 1995). In the past, Oregon Department of Fish and Wildlife have stocked brook and cutthroat trout here. The absence of fish may be due in part to the very low dissolved oxygen levels, which were below the minimum 4.0 mg/l required to sustain salmonids. The abundance and diversity of macroinvertebrates in Wolf Lake also may indicate the lake is fishless. Predation by fish typically reduces abundance and diversity of prey species, including macroinvertebrates.

Blue River

By 1966 when Kivett performed a superficial survey on upper Blue River, the dam had been constructed and the reservoir was filled. He also observed most of the spawning gravel existing at the tail-outs of the large resting pools. He made note of the effects of the 1964 flood by identifying areas cleaned to bedrock from the flows. In his report, Kivett identified some locations of what he described as "merchantable trees" in the stream, indicating the acceptability of in-stream salvage logging in the 1960's (USDA Forest Service 1966).

In the late 1960's, Oregon Department of Fish and Wildlife began an intensive catchable trout stocking program for Blue River Reservoir and Blue River. This activity is funded by U.S. Army Corps of Engineers in mitigation for effects Blue River Dam has upon resident trout. Every Spring, 26,000 catchable size rainbow trout are released in the reservoir and the river upstream. Eighteen thousand are released in the reservoir and 8,000 in the river. Historic release sites include the Saddle Dam Boat Ramp, the Lookout Boat Ramp, 2.1 miles upstream of Mona Campground, 3.2 miles upstream of Mona Campground, the mouth of Cook Creek, and the mouth of Quentin Creek (Calavan 1995). Stocking hatchery rainbow trout continues annually.

The stocking of catchable size hatchery rainbow trout has occurred every spring in Blue River and Reservoir for more than two decades. A mitigation established in the 1960's for the environmental impacts of Blue River Dam, Objective 3 of the Oregon Department of Fish and Wildlife Fish Management Plan states that the river and reservoir will be planted. Today, many fisheries scientists look differently upon the stocking of hatchery fish in habitat occupied by wild fish of the same species. Recent papers (Vincent 1987, Waples 1991, Lund 1991) identify negative effects on the wild fish from stocking.

Hatchery fish are more aggressive than wild fish and utilize similar food items and habitat. Hatchery fish may displace wild fish. Four years after the last catchable size rainbow trout were stocked in the Madison River, Vincent (1987) found wild rainbow trout numbers increased 8 times, and their biomass increased 10 times. Stresses resulting from stocking may increase wild trout susceptibility to angling. McLaren (1979) found that the introduction of hatchery trout altered wild fish activity frequency and patterns to coincide with those of hatchery trout. During the years of stocking the river in the Madison River study, there were less anglers fishing and more wild fish reported caught than in the years that no stocking occurred.

The actual mechanisms that cause declines in wild fish abundance when hatchery fish are stocked is not totally understood, but disruption of existing social behavior may be a factor (Vincent 1987). Wild trout appear to have a relatively stable social hierarchy based on the size of the fish. They have been observed in set feeding stations in pools, the most dominant, larger fish get the most advantageous and successful feeding stations. Aggressive behavior may be displayed at drift feeding sites if these established stations are not observed. Bachman (1982) suggested that, because significant social interaction occurred during feeding, the number of available feeding sites may determine the carrying capacity of a stream. Competition and interactions between wild and hatchery trout at these feeding stations may reduce the system's natural carrying capacity and add stress to the wild trout population.

Some genetic mixing may occur (Lund 1991, Waples 1991). Genetic interactions between the hatchery and the wild rainbow trout in Blue River has not been monitored, but it is assumed that selective breeding of the hatchery fish for a later spawning time may preclude most interaction (J. Ziller, Oregon Department of Fish and Wildlife, Personal communication).

Although not directly studied in Blue River, the literature supports the assumption that stocking of catchable size rainbow trout in the river may have a negative effect upon wild trout populations. There is a need to estimate the effect of stocking catchable size hatchery rainbow trout on the Blue River wild rainbow trout population, estimate the popularity of the river catchable rainbow trout fisheries, and develop recommendations.

The effects of stocking hatchery rainbow trout in the reservoir is not completely understood. Since the reservoir is not a natural habitat for the wild trout populations in Blue River, it is assumed that stocking the reservoir may not affect the wild trout population. Stocking the reservoir provides a popular reservoir fisheries.

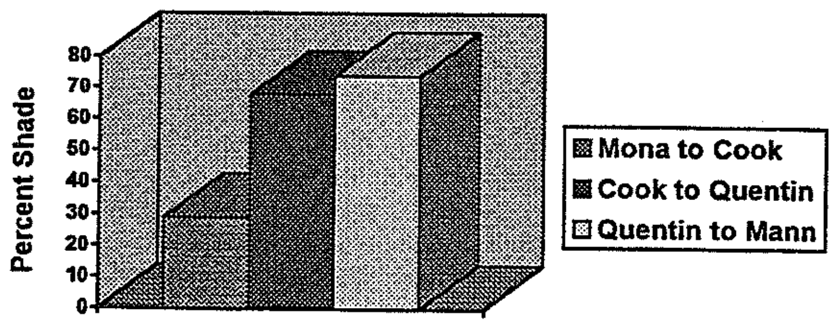
Oregon Department of Fish and Wildlife release 200,000 chinook salmon juveniles per year in Blue River Reservoir to rear throughout the summer. These fish augment and diversify the reservoir fisheries and supplement the commercial ocean and recreational river fisheries (particularly the inner city fisheries in Portland). They are evacuated from the reservoir during the summer reservoir drawdown. The release of these chinook juveniles can also be viewed as a small step at ecosystem restoration, considering a small run of chinook salmon apparently historically reproduced here. The juvenile chinook are a prey source for other fish. However, an important component of the chinook salmon life history is missing, adults spawning above the dam. The large amounts of nutrients released from the decomposing carcasses of spawned out chinook adults would be captured by the aquatic ecosystem. Gregory et al (1993) added nutrients in the form of ammonium sulfate to the lower 600 meter section of Lookout Creek from June through September in 1991 and 1992. They observed primary production in the treatment reach increase to 2.5 times more than that in the control reach. Their findings suggest that the greater production was captured by aquatic invertebrates through consumption. Also, trout fry biomass increased by approximately 20% in the treatment reach, suggesting potential benefits to higher trophic levels with the restoration of some stream nutrients.

In 1993, McKenzie Zone stream surveyors performed a Hankin-Reeves stream survey on Blue River, from Mona Creek to Mann Creek. The river between Mona and Quentin Creeks was described as a long pool/rubble complex with transverse bars, flowing through a v-shaped moderate gradient valley. Cobble dominates the substrate with embeddedness between 20 and 30%. The farthest reach upstream in the 1994 survey was between Quentin and Mann Creeks and was described as a gravel/cobble meander complex flowing through deposits formed from streamside glacial terraces. Cobble embeddedness is less than the other parts of the river, at 10%.

Forest Service Road 15 is near the river between Mona and Cook Creek, but further away from the river between Cook and Mann Creek. This influences the habitat quality of the river in these 2 sections. Stream shade averaged 29% between Mona and Cook Creeks, 68% between Cook and Quentin Creeks, and 74% between Quentin and Mann Creeks. Stream shade keeps the river temperatures cool (Chart 15: Blue River Stream Canopy Shading).

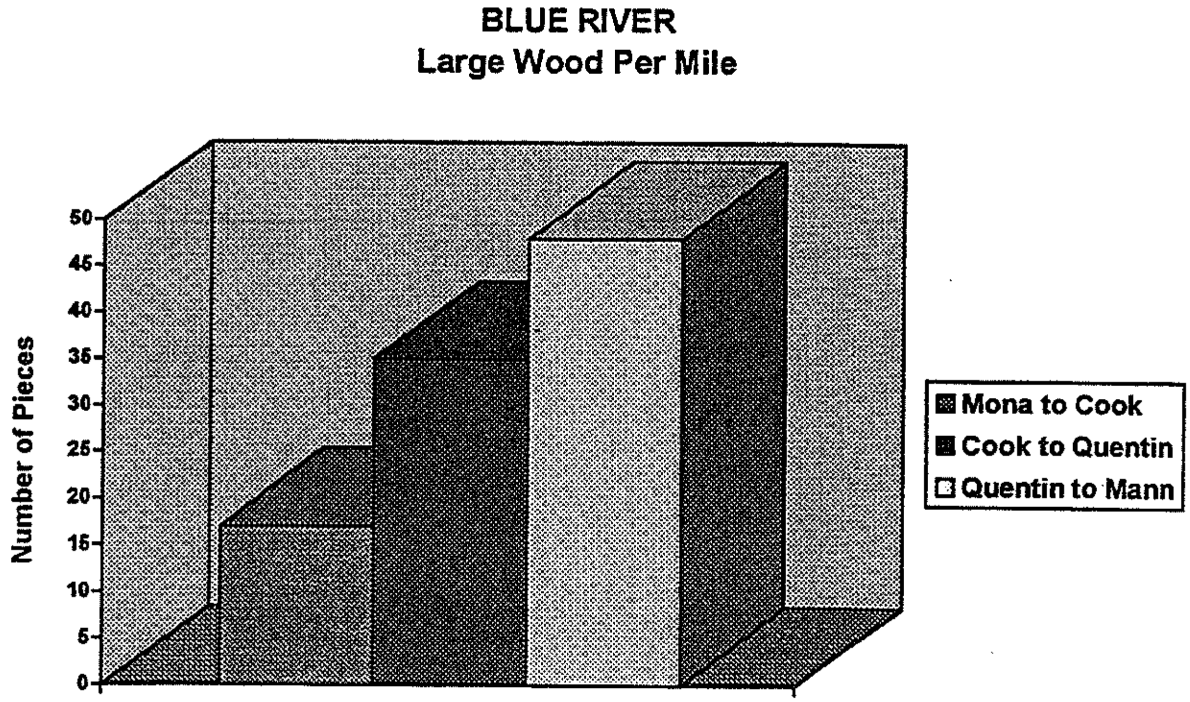
Chart 15

BLUE RIVER
Stream Canopy Shading



All 3 river reaches have an overstory dominated by large and mature Douglas-fir and western red cedar, but the lower reach has less of an overstory due to the proximity of the road. The presence of the road has also influenced the amount of large wood in the river, 17 pieces/mile in the lower section, 35 pieces/mile between Cook and Quentin Creeks, and 48 pieces/mile between Quentin and Mann Creeks (USDA Forest Service 1994). In addition to the road decreasing the source of potential large wood for the river, it was a convenient staging area for past salvage efforts of large in-stream wood (Chart 16: Blue River Large Wood Per Mile).

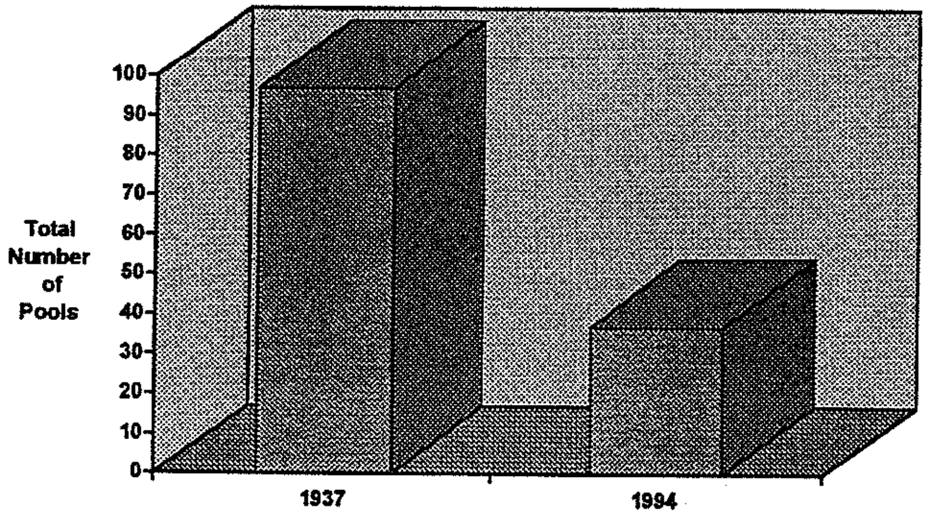
Chart 16



Since the 1937 survey reach between Lookout and Cook Creeks almost coincides with the 1994 survey reach between Mona and Cook Creeks, there is a good opportunity for some temporal comparisons of pools per mile. During the 1994 survey, the reservoir was still up above the mouth of Lookout Creek, so the reach commenced at the mouth of Mona Creek. In November 1995 the pools were counted in the short river section between the mouths of Lookout and Mona Creeks. Adding this number with the number of pools observed during the 1994 survey provides a total number of pools in the river between Lookout Creek and Cook Creek for existing conditions. In 1937, 97 total pools existed in the river between the mouths of Lookout and Cook Creeks (25 pools/mile). Today, there are 37 (9 pools/mile). This may be due to the effects of natural and human accelerated erosion (logging and road-building) in the watershed filling some pools. The lack of large wood in this reach probably plays a minor role, at best, in the decrease in total pools over the years. The reach immediately upstream has nearly twice the amount of large wood per mile than the Mona-Cook Reach, but has the same pool/mile rate of 9 (Chart 17: Blue River Between Lookout and Cook Creeks Total Number of Pools).

Chart 17

Blue River
Between Lookout and Cook Creeks
Total Number of Pools
1937 vs. 1994



McIntosh (Oregon State University, personal communication), an Oregon State University Research Associate, has documented similar decreases in large pools in many other rivers and streams throughout Oregon. McIntosh uses a more conservative approach in the utilization of the 1937 pool data. Instead of total pools, he uses large pools in comparisons between 1937 and today. Before comparisons with present counts of pools, he extracts pools less than 3 feet deep from the 1937 survey data to minimize observer error/bias and to account for small differences in water elevation during the past and present survey. Using this technique, there were 63 large pools in Blue River between Lookout Creek and Cook Creek in 1937 compared to the 37 total pools we observed in the 1994 survey of Blue River. All pools counted in the 1994 survey can be classified as large utilizing the criteria above. Regardless of the technique used in comparison, the message is the same. There has been a serious decrease in pools, an indicator of quality fish habitat, between 1937 and 1994 (Chart 18: Blue River Between Lookout and Cook Creeks Number of Large Pools).

Chart 18

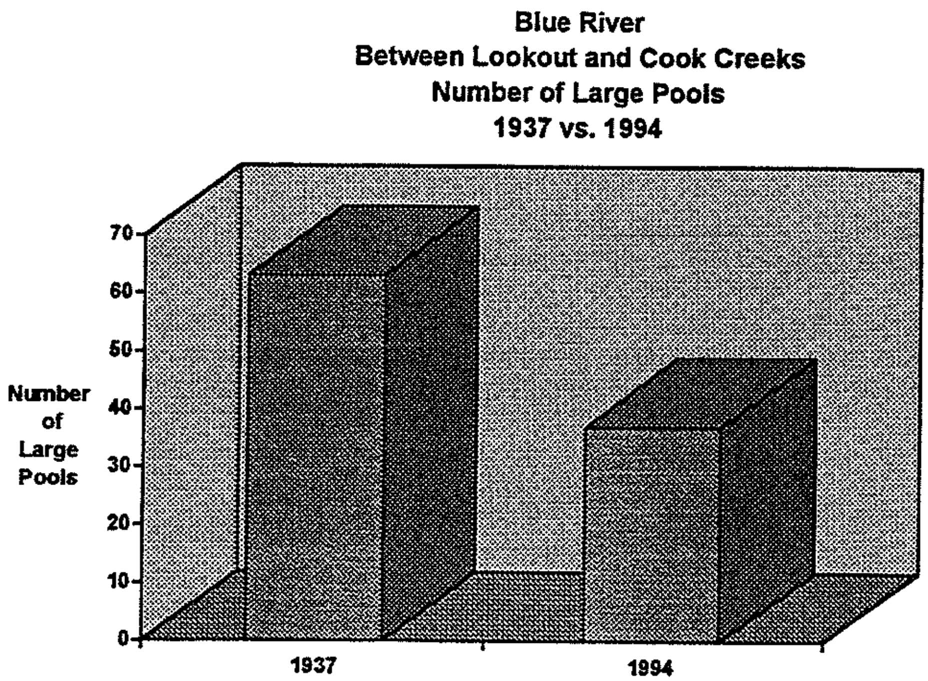


Table 15: Blue River Current Conditions at a Glance

FROM MILE TO MILE	POOLS/MILE	LWD/MILE	%POOLS	%RIFFLES
0-3.9	9	17	33	67
3.9-5.1	9	35	31	69
5.1-9.1	3	48	5	95
Total	7	33		

Recent restoration activities within Blue River include the placement of large wood in the river and reservoir drawdown zone stabilization. In 1993, large wood was placed in a mile stretch of Blue River just upstream of Quentin Creek by a walking excavator. Photo-points were established to assess project effectiveness. The objective of the project was to increase the amount of in-stream wood in this stretch of river. This wood would provide cover, collect gravels and nutrients, and dissipate river energy. Two years of photo-point monitoring indicates these goals are being met at the project location.

The most fish species diversity within Blue River Watershed can be observed in the reservoir and the 3 to 4 miles of river above the reservoir. Cutthroat and rainbow trout, chinook salmon, sculpin, longnose and speckled dace, redside shiner, and largescale sucker inhabit these waters. Blue River was never utilized by bull trout for spawning and early rearing because they require cold water with relatively constant flows for these parts of their life history. Historically, adult and sub-adult bull trout may have utilized the lower couple of miles of the river for foraging, especially in the winter when temperatures were cooler. However, this is less likely today, considering the low quality of habitat which exists below the dam.

Riparian Areas

This block, together Block 1, has had the most management within riparian areas of all four blocks in the watershed. Forty-four percent of the riparian area has been harvested, while 4% is in a roaded condition. Most of the harvest has occurred within riparian areas adjacent to Class II, Class III, and Class IV stream channels (Figure 31: Landform Block 3 - Road and Harvest Activities Within Riparian Areas) As displayed in (Figure 32: Landform Block 3 - Road and Harvest Activites Within Riparian Areas by Smaller Drainages) all drainages have riparian areas that have been heavily managed, with percent managed of 40%, 66%, and 48% for Blue River Face, Mann, and Wolf drainages, respectively.

The most heavily managed of the drainages, Mann, has more riparian acres managed along all stream classes and surrounding wetlands, than are unmanaged. (Figure 33: Mann Drainage Road and Harvest Activities Within Riparian Areas) These high percentages are due, in part, to the section of privately owned ground which has been entirely harvested. Although there is only Forest Service ownership of the Wolf drainage, extensive harvest (63%) has also occurred within riparian areas of this drainage. Much of the harvest has taken place along the main channel of Wolf Creek, a Class II stream, along Class IV tributaries, and around Wolf Lake. (Figure 34: Wolf Drainage Road and Harvest Activities Within Riparian Areas)

The adjacent slopes immediately surrounding Blue River make up the Blue River Face drainage, which has had 35% of it's riparian area harvested, and 5% roaded. Forest Service Road 15 which goes up the Blue River valley accounts for a good portion of the roading percentage. Together, roading and harvest along the Class I stream of Blue River totals 34% of the riparian area. (Figure 35: Blue River Face Drainage Road and Harvest Activities Within Riparian Areas) The remaining riparian areas within this drainage are tributaries to the main river and have also been extensively harvested within their riparian areas.

Figure 31: Landform Block 3 - Road and Harvest Activities Within Riparian Areas

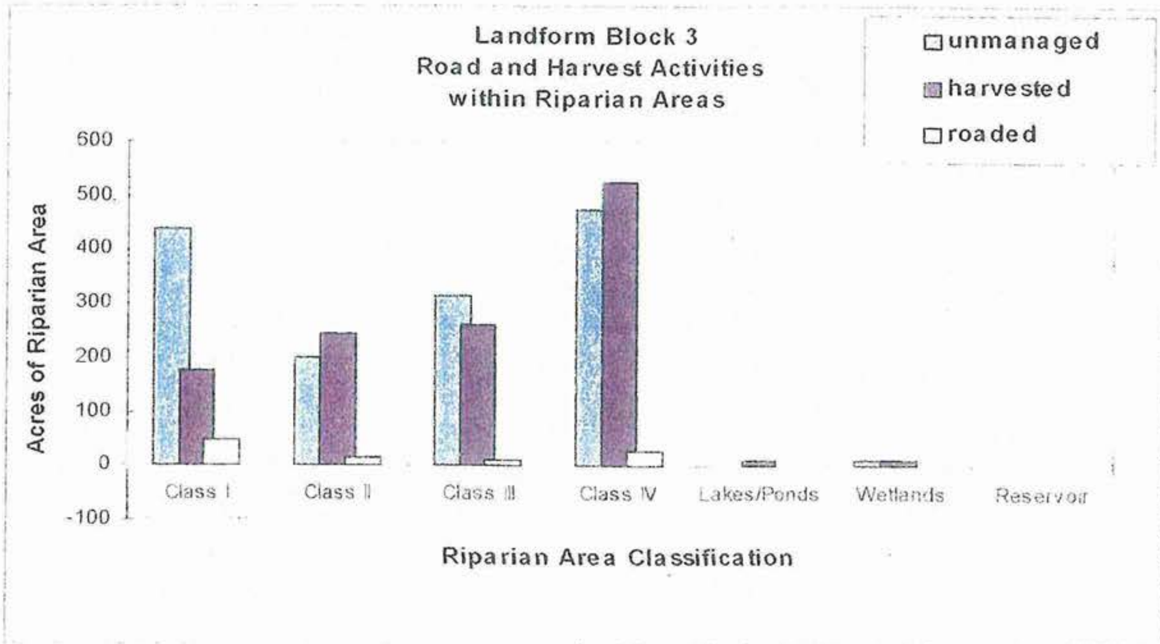


Figure 32: Landform Block 3 - Road and Harvest Activities Within Riparian Areas by Smaller Drainages

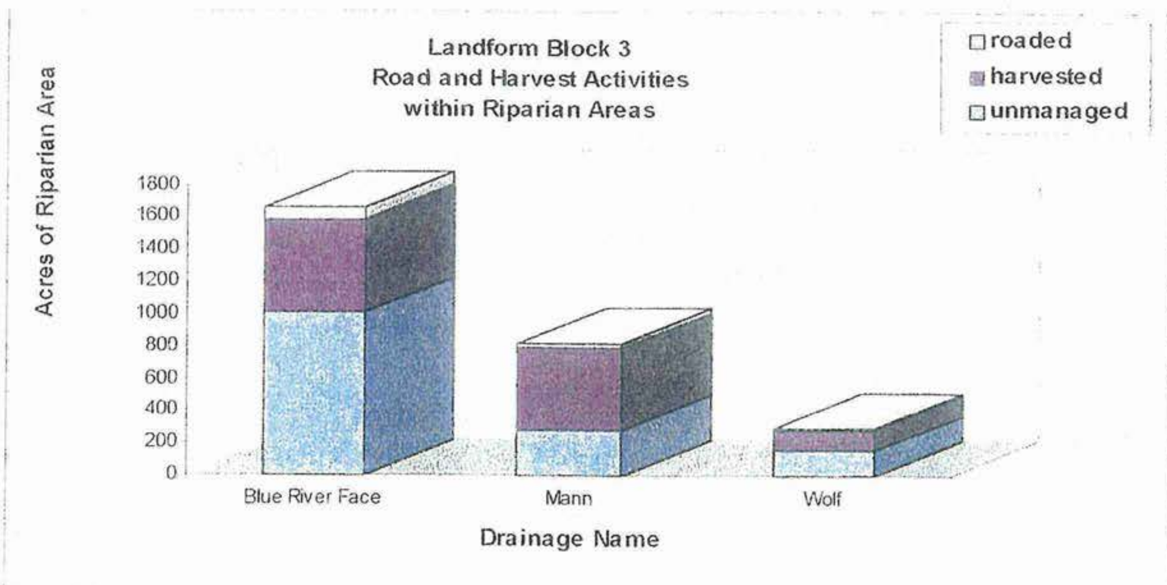


Figure 33: Mann Drainage Road and Harvest Activities Within Riparian Areas

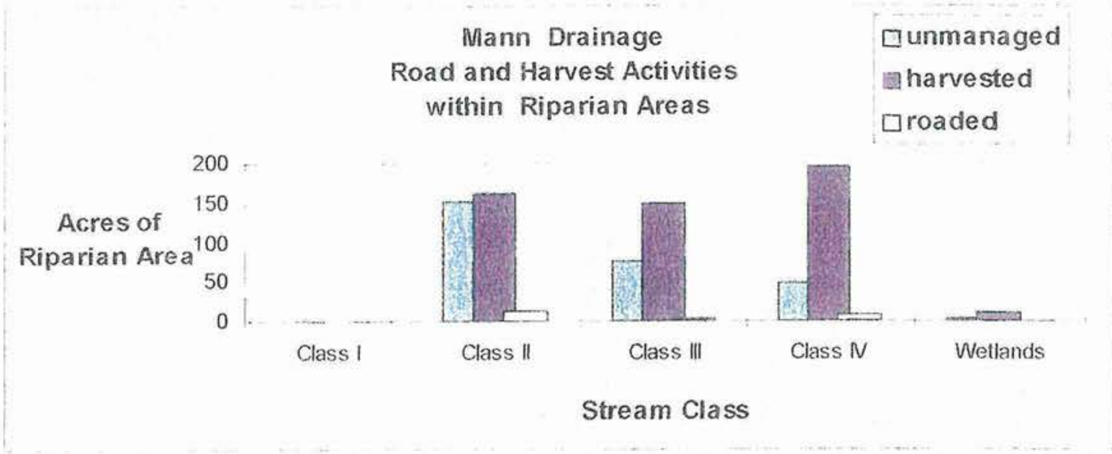


Figure 34: Wolf Drainage Road and Harvest Activities Within Riparian Areas

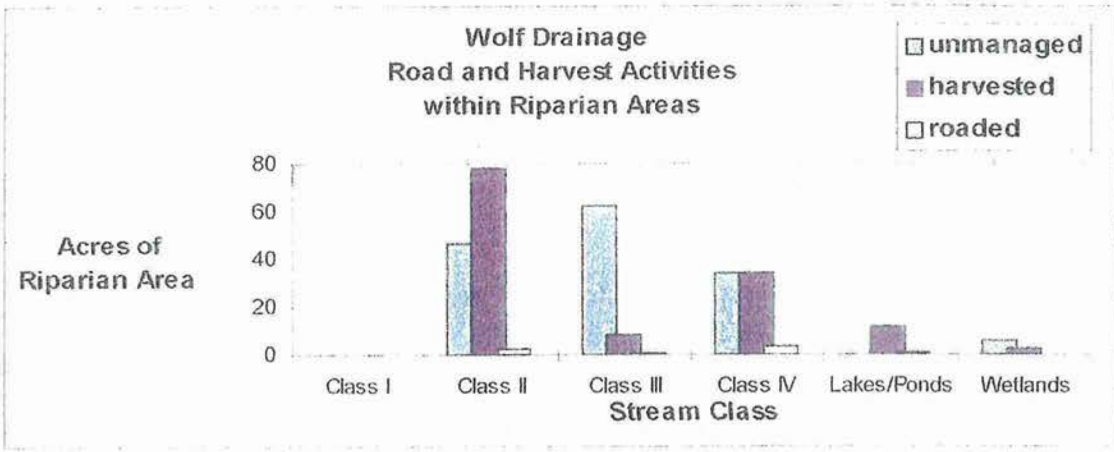
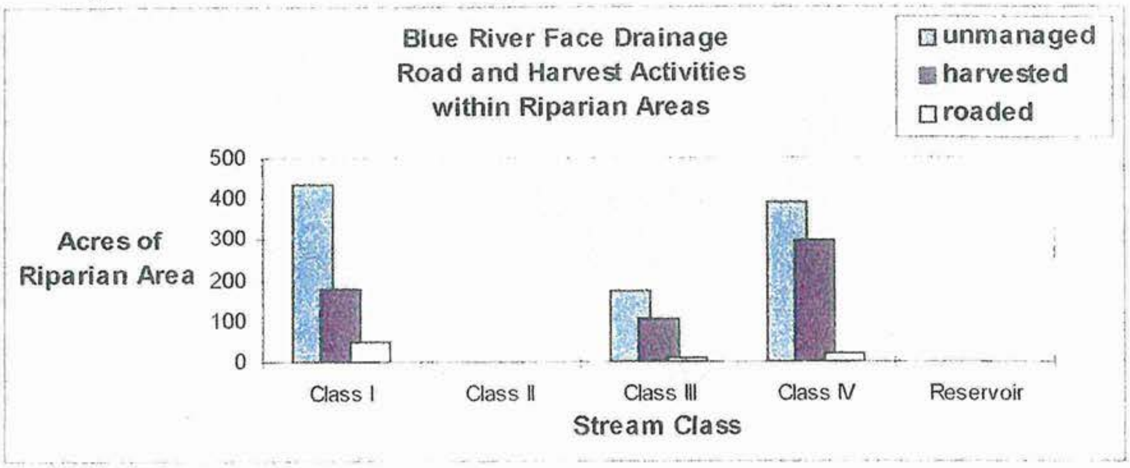


Figure 35: Blue River Face Drainage Road and Harvest Activities Within Riparian Areas



LANDFORM BLOCK 4

Lookout, McRae, Mack Creeks - Western McKenzie System

Erosional Processes

Reference Conditions

Geologic Formation

Wilson (81) generalized this type of landform as "Massive earth flows and slumps with benches of moderately sloped, hummocky surfaces are the significant features of the system. Debris avalanches and debris torrents further remove material to streams and down steep valleys. Subsequent undermining of slump-toes keeps the earthflows unstable." Two of the mechanisms responsible for the characteristic unstable terrain (differential erosion and glacial processes) are described by Swanson and James (75). Early High Cascade ridge-capping basalts of Lookout Ridge, Frissel and Carpenter Mountain lavas can be seen in the upper reaches of Mcrae, Mack and Lookout Creeks. The contact between these younger, more resistant basalt flows and the older, more altered underlying Western Cascade volcanics is characteristic of other layered rock sequences such as sandstone and shale beds where differential erosion takes place. As the older rocks are exposed in the valley sidewalls, they chemically and physically degrade faster than the overlying rocks. This results in valley sideslope collapse and subsequent overloading of lower elevation alluvial and colluvial slopes which can trigger earthflows. This bedrock geology was subsequently scoured and stressed by valley glaciers that advanced and retreated during the Pleistocene.

Riparian

Erosion of floodplain surfaces and cutting of earthflow toe slopes are the dominant erosional processes within this block. The wide, unconstrained stream channel of Lookout Creek allows for free movement of the channel across the floodplain. Over time, erosion of the floodplain surfaces and deposition of new ones takes place slowly as the channel naturally migrates across the floodplain. However, large storm events may cause erosion and deposition of floodplains over a relatively short period of time. If the storms are large enough, such as the 1964 flood, floodplain surfaces would be eroded, devastating the riparian vegetation, and new floodplain surfaces would be created through deposition of fresh cobbles and gravels. Vegetation on the new floodplain surfaces would be set back to early seral condition.

The earthflow terrain within this block actively moves downslope as a large mass, impinging on Lookout Creek The easily erodible, consolidated mass is undercut by the stream channel, particularly during large storm events, and sloughs off as large chunks into the stream channel.

Current Conditions

Upslope

Swanson and James (75) describe the Landform Block "At a point about 3 miles upstream from the mouth of Lookout Creek, the character of landforms on the valley floor changes markedly. Downstream the valley bottom is narrow, generally 300 to 1,000 feet wide, and the terrace is a prominent landform. Upstream to a point about half a mile below Mack Creek, alluvial deposits extend from 1,000 to 1,300 feet across the valley floor and have a definite asymmetry with thickest deposits occurring on the south side." A massive earthflow is the contributing factor involved in the change of stream gradient and valley width upstream.

Mills, in his 1983 study of the Lookout Creek earthflow determined that it was moving at a rate of almost 5 inches per year over a two year period. A wood sample from 77 feet below the surface in an exploration bore hole was Carbon 14 age dated at >40,000 years, indicating that this type of slope failure typical of this Landform Block is chronic producer of stream sediment rather than the pulse type typical of the debris avalanche failures in shallower soils of the other Landform Blocks.

He also determined that "Tree scar tissue growth caused by ground deformation indicated that the Lookout Creek Earthflow has been moving for at least 80 years." and that the earthflow moved in pulses controlled by climate "Based on the crackmeter data correlated with the stake array survey, measured yearly surficial movement has varied from 0.1 in. in the 1976-77 water year to 10 in. in the 1981-82 water year."

This Landform Block contains 3 ancient landslides with a total area of about 1,900 acres and another 1,400 acres containing unstable SRI soils. In addition, the Landform Block contains an additional 152 mapped site specific road, harvest and natural failures. All types of slope failures amount to 22% of the entire Landform Block, the largest in the watershed. (Figure 36: Landform Block 4 - Landslide Distribution)

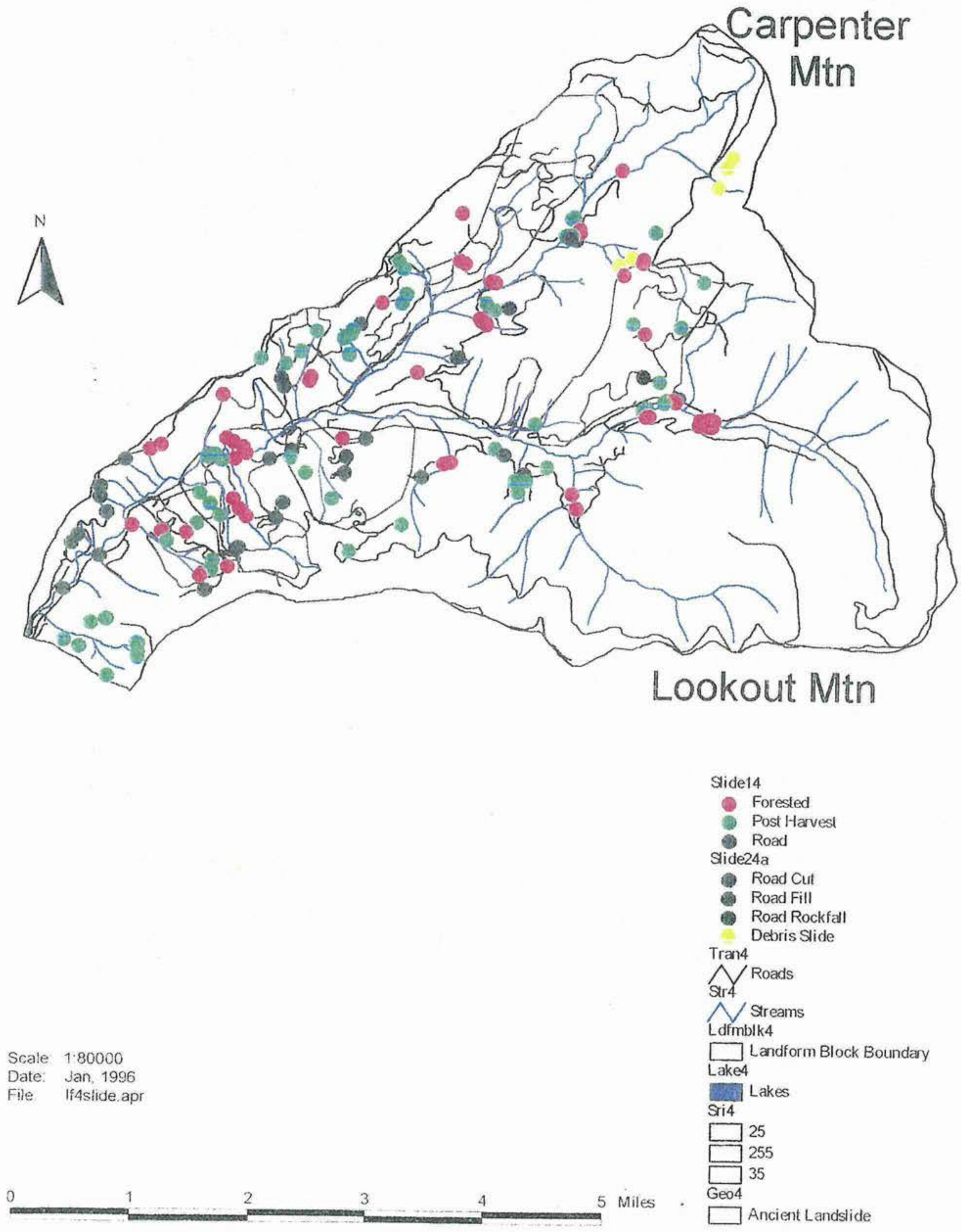
As was mentioned previously, Wallenstein's 1995 study on controls on landslide distribution compared the landslide hazard ratings for the Blue River and Lookout drainages and noted that the highest hazard rating and recovery rate were coincidental with 1964 and 1986 storm events and the level of road and timber harvest that was in place during each event in each Landform Block.

He noted that "The H.J. Andrews Experimental Forest was cut heavily in the decades of the 1950's and 1960's. Consequently, it suffered numerous landslides in severe storms of this period, including 43 slides from a series of strong storm events in December 1964 and January 1965." and that "Forest cutting was minimal in the UBR [Upper Blue River] through the 1950's but was heavy from about 1960 to 1990. This unit did not suffer as heavily in the strong storms in 1964, but produced more landslides during a 1986 storm event."

Wallenstein's results showed that "When a 100 meter square was applied to the site, 205 out of 15,525 grid cells contained landslides" and that "The greatest percentage of landslides occurred on class 5 slopes (40-50 degrees). However, there was no clear trend of landslide distribution with respect to slope... indicating that slope was not a significant control on landslide occurrence."

He noted that "While past studies have indicated that slope and aspect are important factors, in this study they were not significant. While the results seem to indicate that slope is not a significant control on landslide occurrence, this contradicts many previous studies as well as common sense." New information is currently being gathered to assess conditions after the 1996 flood event. An opportunity exists to do a comparison to the 1995 study.

Figure 36: Landform Block 4 - Landslide Distribution



He concluded that "Since other studies have shown that slope should correlate to landslide occurrence, the result indicates that there is a problem in using GIS-generated slope data as a predictive tool." but that "Landslides occupied a higher percentage of land classified as having weak rocks..indicating rock strength was a significant control on landslide occurrence...aspect was not statistically significant control on landslide occurrence. 3% of grid cells that contained roads and 0.5% containing no roads contained slides...2% of cells with clearcuts contained slides and 1% of grid cells with no clearcuts contained slides." and that "Both forest cuts and roads were significant controls on landslide occurrence."

He did not conclude from this limited study what exactly were the other limiting parameters that could be used to predict landslide distribution and control but he said "The results indicate that physical controls on landslide occurrence may be more complex than was assumed for the purposes of this study. There may be other physical controls that play an important role, such as geomorphic setting, hydrological features, and geologic structure. It is likely that one or more of these factors is/are not randomly distributed with respect to slope."

Other properties that have a much more direct influence on landslide behavior are soil shear strength, ground water fluctuation and slope geometry. Uncontrolled wildfire can be a direct contributing factor influencing the first two. The results can be estimated using the infinite slope equation in a limiting equilibrium analysis, probability and cumulative distribution functions for a set range of shear strength variables, and a Monte Carlo simulation algorithm to iterate the equation 1,000 times. Soil Transfer Rates can then be calculated based on the historical fire return interval, and the probability of failure. This method is described in detail under Reference Conditions on page 30.

Riparian

Both road and harvest related mass wasting has contributed sediment to Lookout Creek The amount of sediment delivery into Lookout Creek was high during the 1964 flood due to the relatively large number of harvest and road acres in existence prior to the 1964 flood, and the unstable, earthflow terrain on which the roads and harvest units were located. The large volume of sediment and debris provided ample material for devastating the riparian vegetation on the wide, unconstrained valley bottom, and creating new floodplains through deposition of sediment. Within the upper, more constrained sections of Lookout Creek, erosional material moved downstream to the lower gradient, wider valley bottom section, with local accumulation within the upper channel reaches.

Aquatic Habitat

Reference Conditions

In August 1937, Baltzo and Koloen, stream surveyors from the U.S. Bureau of Fisheries, surveyed 2.3 miles of Lookout Creek from its confluence with Blue River. Their report described Lookout Creek prior to modern land management. They stated that it ran through a U-shaped valley which tapered from 1 mile width at the mouth to ½ mile width at a distance of 2 miles upstream. The watershed was covered with large "first growth" conifers of moderate density. Stream bed substrate was sand, silt, large cobble, and bedrock. Near bank riparian vegetation consisted of maple, willow, alder, and conifers and it provided good overhanging cover. Fluctuation in water level appeared to be only 3 to 4 feet with only slight erosion of the banks. Large pools over 50 square yards surface area and over 6 feet deep were numerous, particularly in the lower mile of stream. Suitable spawning areas for salmon were scarce and gravel that did exist was not suitable because it was dispersed. They believed that 3 bedrock falls within the within the first 2 miles of the creek were passable for upstream migrating fish only with difficulty during low flow periods (USDC Bureau of Fisheries 1937).

Baltzo and Koloen's responsibility was to ascertain the value of Lookout Creek for chinook salmon habitat. Although many large holding pools existed in the first couple of miles of the creek, the scarce spawning gravel and potential barriers to low flow upstream migration within the first 1.5 mile of the creek made them suspect that chinook salmon only utilized Lookout Creek to a small extent.

The mouth of Lookout Creek appeared to be a popular fisheries as far back as 1937, when the U.S. Bureau of Fisheries surveyors observed anglers there. Access farther up the creek was limited, though. rainbow trout appeared to be the main catch.

Sixty large resting pools were counted in the first 2.3 miles of Lookout Creek, providing 26 resting pools per mile (USDC Bureau of Fisheries 1937).

Current Condition

Lookout, McRae, and Mack Creeks

On 25 April 1959 (opening day of the fishing season), Clifford Soderstrom, a U.S. Bureau of Commercial Fisheries Biologist, conducted a road block on Lookout Creek Road to check the size of the catch from Lookout Creek. He stopped 10 of the 18 cars he spotted. A total catch of 102 fish were within those 10 cars. All of the fish were cutthroat trout. The majority of the fish were caught on single eggs. Soderstrom's report, dated 28 April 1959 documents the popularity of Lookout Creek, particularly during opening day (USDC Bureau of Fisheries 1959).

In 1966, a superficial survey was performed on Lookout Creek by Kivett, a Forest Service employee. He started the survey at the mouth of the stream and surveyed upstream in 1000 yard sections dispersed nearly to the headwaters. He recorded points of interest within each 1000 yard section. The lower 2 miles of the creek flowed through a wide valley bottom. Impacts from the 1964 flood, timber harvest, and tree salvage were documented in his report. Kivett noted much erosion and disturbance from the 1964 flood in the section from the Lookout Creek Road concrete bridge upstream to McRae Creek. He also noted good gravel through this section. A concentration of cull wood from past timber harvest was noted on the floodplain at the mouth of McRae Creek. Between McRae and Mack Creeks, a wood salvage operation was underway. From McRae Creek upstream, spawning gravel was limited. Two hundred yards upstream from the mouth of Mack Creek, slash was in the stream. Kivett reported that the slash would be removed and burned (USDA Forest Service 1966).

In 1975, Armantrout and Shula surveyed Lookout Creek. By this time, Lookout Creek was closed to fishing, providing the researchers at H.J. Andrews Experimental Forest the opportunity to study aquatic ecosystems over the long term without having to consider the resident fish harvest variable. Rainbow and cutthroat trout were observed utilizing the creek. Like Kivett, these surveyors also noted the evidence of past erosion and alluvial material in the channel forming wide gravel bars and filling pools within the section below McRae Creek. Armantrout and Shula noted cutthroat and rainbow trout in Lookout Creek (USDA Forest Service 1975).

Lookout Creek has been studied extensively over the last couple decades by researchers at the H.J. Andrews Experimental Forest. Most recently Lookout Creek is 1 of 3 creeks in the Blue River watershed included in the Pool Complexity Project, a cooperative project between Oregon State University and the Blue River Ranger District and Cascade Center for Ecosystem Management. Various amounts of large wood has been placed in replicate pools to study the response of aquatic vertebrates to various degrees of complexity through effectiveness monitoring. The Forest Service has placed the wood and Oregon State University Aquatic Ecologists Randy Wildman and Jack Burgess with Stan Gregory will monitor the project during the summers of 1995 and 1996 and produce a report.

In Mack Creek, a major tributary of Lookout Creek, researchers have been inventorying cutthroat trout populations in clearcut and old growth sections of the stream since 1973. This is considered the longest running trout population study in the west. Above Forest Service Road 360, Mack Creek is unmanaged, allowing a great opportunity to compare the amount of large wood per mile in this section of the creek with other similar creeks in the watershed. In this watershed analysis, the comparison was made with similar order and size creeks where recent large wood per mile data exists.

Fish distribution in Lookout Creek has been intensively studied recently. Cutthroat trout occur throughout the Lookout Creek drainage. The range of sculpin also extends well into tributaries. Paiute sculpin have been documented in McRae Creek. Mottled and torrent sculpins have also been observed in Lookout Creek. Wild rainbow trout range well up Lookout Creek and their extent probably stops just upstream of Mack Creek, where the valley bottom narrows and the channel gradient increases. Hatchery rainbow trout probably utilize lower Lookout Creek when the partial barrier near the Forest Service Road 15 Bridge is passable. Their range would extend upstream 1.5 mile to the series of 2 bedrock falls. Prior to the construction of Blue River Reservoir, wild chinook salmon used Lookout Creek for spawning and early rearing, although they were likely never very numerous. A 70 degrees bedrock chute between North Fork Quartz and Scout Creek in Blue River may have been a partial barrier to upstream migration during low flow. Salmon arriving at the base of the chute in the summer may not have passed upstream during dry summers and falls. Salmon that did pass and enter Lookout Creek may be able to navigate the series of two bedrock falls 1.4 mile upstream from the mouth of the creek when conditions are right. I suggest salmon habitat, although probably never used to a great extent, extends well up Lookout Creek to the upstream end of the wide valley, near Mack Creek. Known longnose dace range extends from the mouth of the creek to its confluence with McRae Creek. Known speckled dace range extends 1.4 mile from the mouth of the creek (K. Dodge, BLM Fisheries Biologist, personal communication). Largescale sucker have also been observed in lower Lookout Creek (R. Wildman, OSU, personal communication).

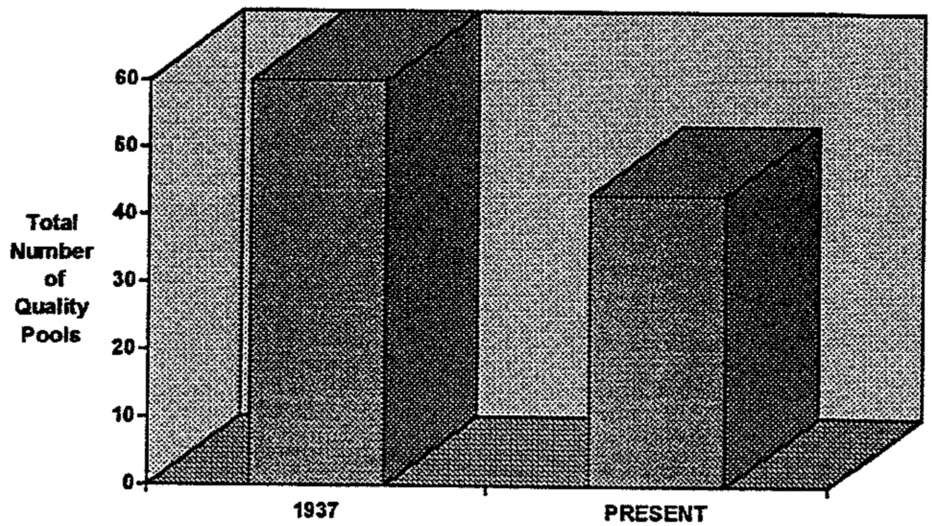
Pacific giant salamander, tailed frog, and Cascade torrent salamander have also been documented within the Lookout Creek watershed (R. Wildman, OSU, personal communication).

Extensive invertebrate research has been conducted on H.J. Andrews Experimental Forest. Oligophlebodes mostbento, a caddisfly on the Regional Forester's Sensitive Species list, has been documented on the forest (Parsons et al. 1989). This larvae of the species make portable tube-cases enabling them to be mobile. The larvae have special mandibles without teeth which they use to scrape for diatoms and fine organic particles. Their habitat is described as lotic-erosional.

The most recent extensive physical stream survey of Lookout Creek was conducted by Gordon Grant in 1986 and 1987 (G. E. Grant unpublished data). The number of pools from this survey, combined with an estimate of the number of pools from the downstream end of this survey to the mouth of the creek, provides an estimate of the number of pools in Lookout Creek in the present day. The number of pools within the first 2.3 miles of the creek today can be used in comparison with the number of pools within the same 2.3 mile reach of the 1937 survey. Because pools are an important component to quality fish habitat, this comparison can be used as an index of the condition of fish habitat today, as compared with 1937. In 1937, 60 pools existed in the lower 2.3 miles of Lookout Creek. Today, 43 pools exist in the lower 2.3 miles of Lookout Creek. Please refer to the graph below. The decrease may be due to the effects of road building and timber harvest and active removal of instream large wood(Chart 19: Lookout Creek Lower 2.3 Miles Total Number of Pools).

Chart 19

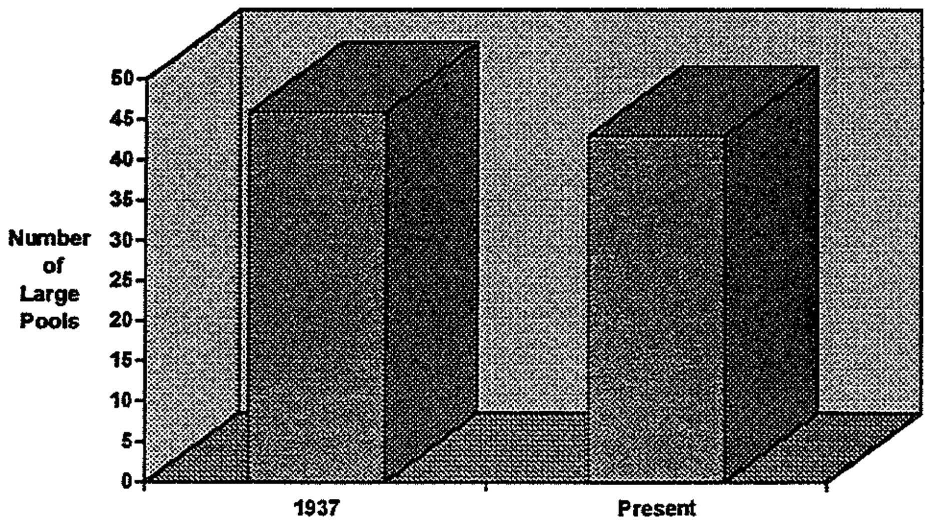
Lookout Creek
Lower 2.3 Miles
Total Number of Pools
1937 vs. Present



McIntosh (Oregon State University, personal communication), an Oregon State University Research Associate, has documented similar decreases in large pools in many other rivers and streams throughout Oregon. He uses a more conservative approach in the utilization of the 1937 pool data. Instead of total pools, he uses large pools in comparisons between 1937 and today. Before comparisons with present counts of pools, he extracts pools less than 3 feet deep from the 1937 survey data to minimize observer error/bias and to account for small differences in water elevation during the past and present survey. Using this technique, there were 46 large pools in the first 2.3 miles of Lookout Creek in 1937 compared to 43 large pools today. Fourteen pools that were between 2 and 3 feet deep and 25 to 50 square yards in surface area were dropped from the 1937 survey data. It is likely that all of the pools counted in the present survey are more that 3 feet deep (G. Grant, USDA Forest Service, personal communication). The shallow, small pools observed in the 1937 survey of Lookout Creek may have filled (Chart 20: Lookout Creek Lower 2.3 Miles Number of Large Pools).

Chart 20

Lookout Creek
Lower 2.3 Miles
Number of Large Pools
1937 vs. Present



Riparian Areas

Relative to the other three blocks within the Blue River watershed, the Lookout Landform Block riparian areas are in a less managed condition. Total harvest within riparian areas ranges close to the percentages in the Cook/Quentin Block at 28% (Cook/Quentin is 26%). However, there is slightly more roading in the Lookout Landform Block than in Cook/Quentin. Harvest within riparian areas of the Lookout block has occurred mainly in those areas adjacent to Class IV and Class II streams. (Figure 37: Landform Block 4 - Road and Harvest Activities Within Riparian Areas) However, a significant portion of riparian areas along Class II streams and approximately 50% along Class IV streams has remained unmanaged.

Splitting the Landform Block into the Lookout and McRae smaller drainages, one can see that harvest of riparian areas are distributed nearly equally between the drainages, with Lookout and McRae harvest percentages of 31% and 29%, respectively.

Roads within riparian areas account for 3% and 2% for each Lookout and McRae, respectively.

Figure 37: Landform Block 4 - Road and Harvest Activities Within Riparian Areas

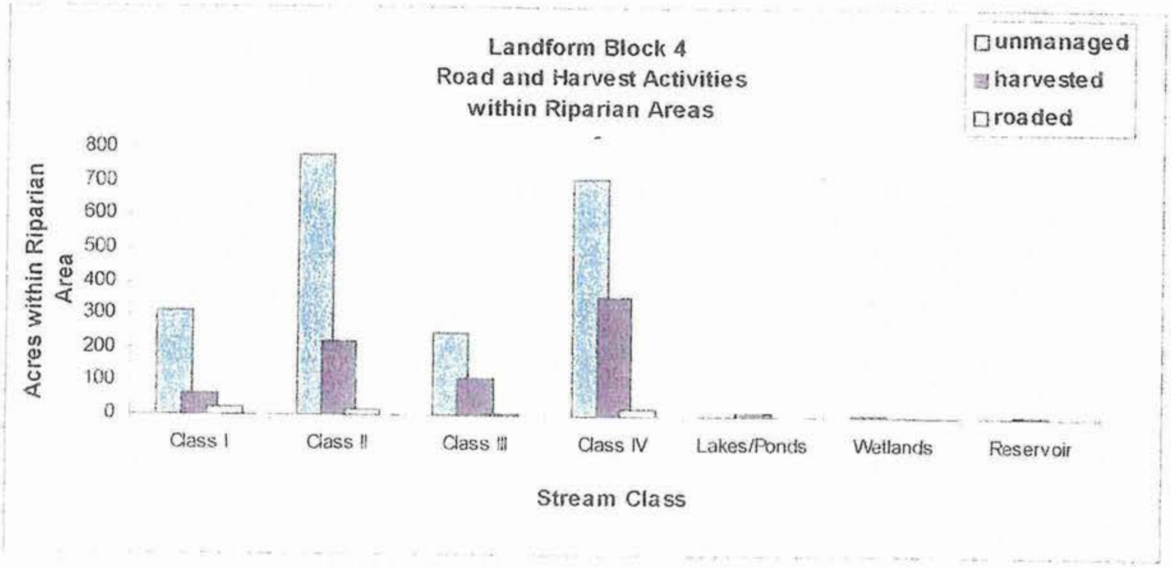
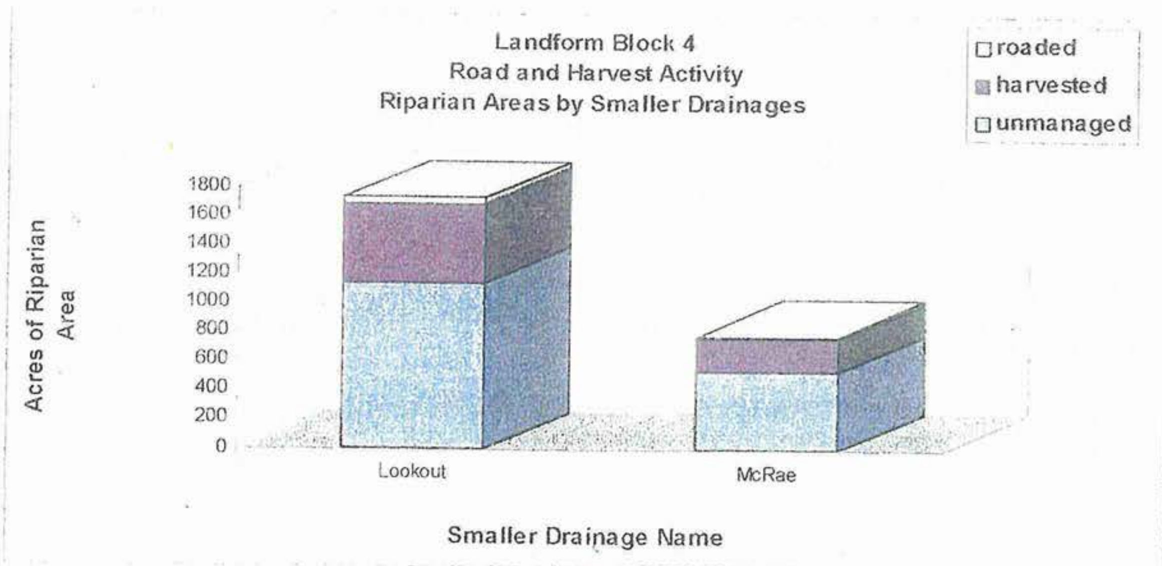


Figure 38: Landform Block 4 - Road and Harvest Activities Within Riparian Areas by Smaller Drainages



Biological

Vegetation

Two snapshots in time are presented to display conditions of the vegetation within the watershed. The current landscape displays the effects of 60 years of fairly intensive human disturbance through road building, timber harvest and dam building. The 1900 landscape only represents one point prior to large scale timber harvest and road building. The landscape in 1900 includes human disturbance, mainly as a result of people using fire. Ecosystems are dynamic and the vegetation is always changing. These two landscapes are useful in comparing the patterns, intensity and diversity of a landscape resulting from timber harvest and one resulting primarily from wildfire.

Seral Stage Distribution/Landscape Pattern

Reference Conditions

The reference conditions are depicted in the year 1900. This year was chosen to display a comparison for one landscape point prior to road building and timber harvest. This landscape does include effects of settlement and exploration since gold was first discovered in the 1860s and the valley was being settled around the same time. The primary disturbance to affect the vegetation was fire, some "natural" some perhaps human caused. The resulting pattern is displayed in (Map 16)and the seral stage percentages are shown in (Table16). This pattern displays large areas of both old and young forest. These large patches imply that there was little edge within the watershed and that there was quite a large amount of interior forest What is not captured in either the map or in the percentages is much of the diversity that in fact existed. This map is a gross representation of the landscape and was not mapped to the intensity and detail of the 1995 landscape simply due to the lack of adequate photography and detailed mapping from that time.

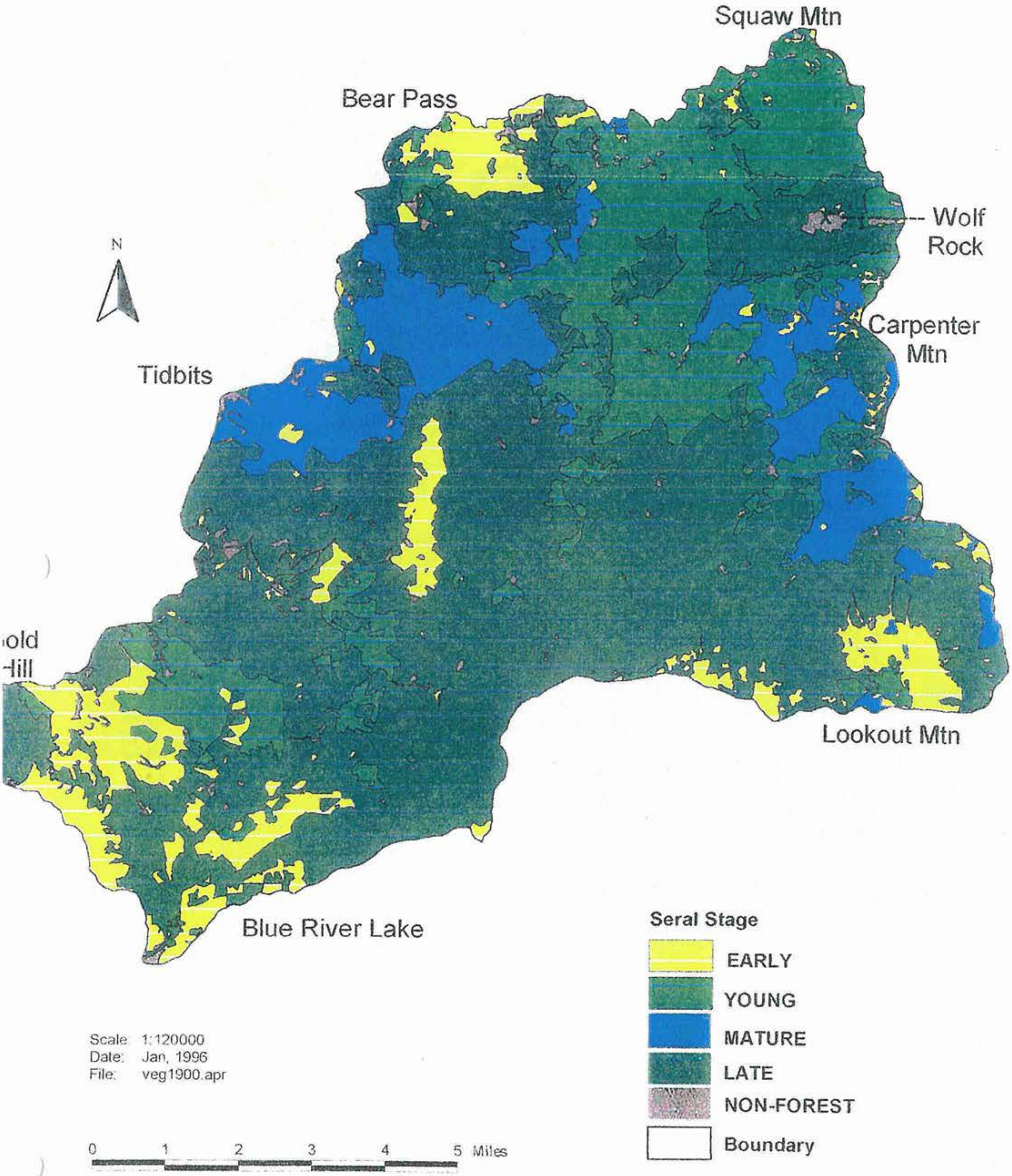
The intensity with which the fires burned varied considerably and resulted in quite different structural elements and age and size classes within the watershed. The Simmonds Creek area burned in a similar time frame as Quartz Creek but resulted in a much more diverse forest. There are quite a few larger older trees within the area although the dominant age of the stand dates from the 1870's or so. The Quartz Creek area has very little residuals and is a much more consistent young forest with little structural diversity.

The area labeled as young in the northern end of the watershed stretching from Quentin Creek to Mann Creek contains much diversity resulting from repeated fires, some of which replaced small patches of forest and some of which underburned other areas.

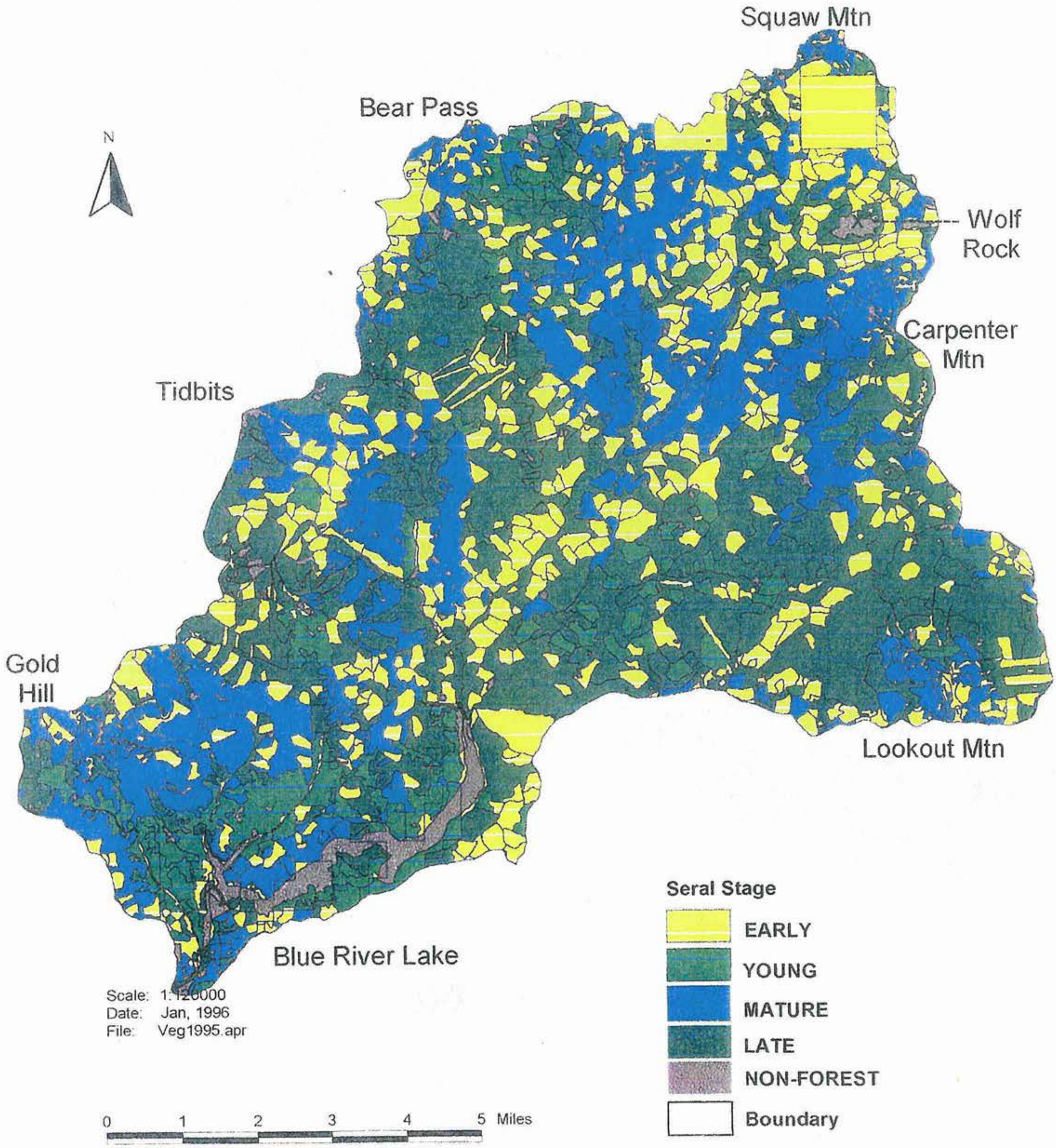
Most of the old forests in Cook Creek, Quentin Creek, along Blue River itself and in Lookout Creek are in fact a result of many underburns throughout the years. The defining line between mature forest and old growth is not quite as straightforward as depicted on the map. There are many patches of younger age forest scattered thought the old forest that were not mapped out. The areas defined as old forest are in fact a very diverse forest made up of many ages of trees resulting from repeated fires. The dominant age within each area is what is represented on the map.

The areas of meadows and rock gardens depicted were in fact larger in 1900. (Map 16) Once again due to lack of photography it is hard to tell how much larger they would have been. Based on a review of the 1959 photographs it appears that the areas would be at least one to two times as large. Along the ridge system to the west and north it is speculated that much of the area was much more open than currently due to the use of the area by sheepherders and native Americans. Much of the area was most likely maintained in an open condition to foster forage for grazing.

Map 16: Seral Stages 1900



Map 17: Seral Stages Current



Current Conditions

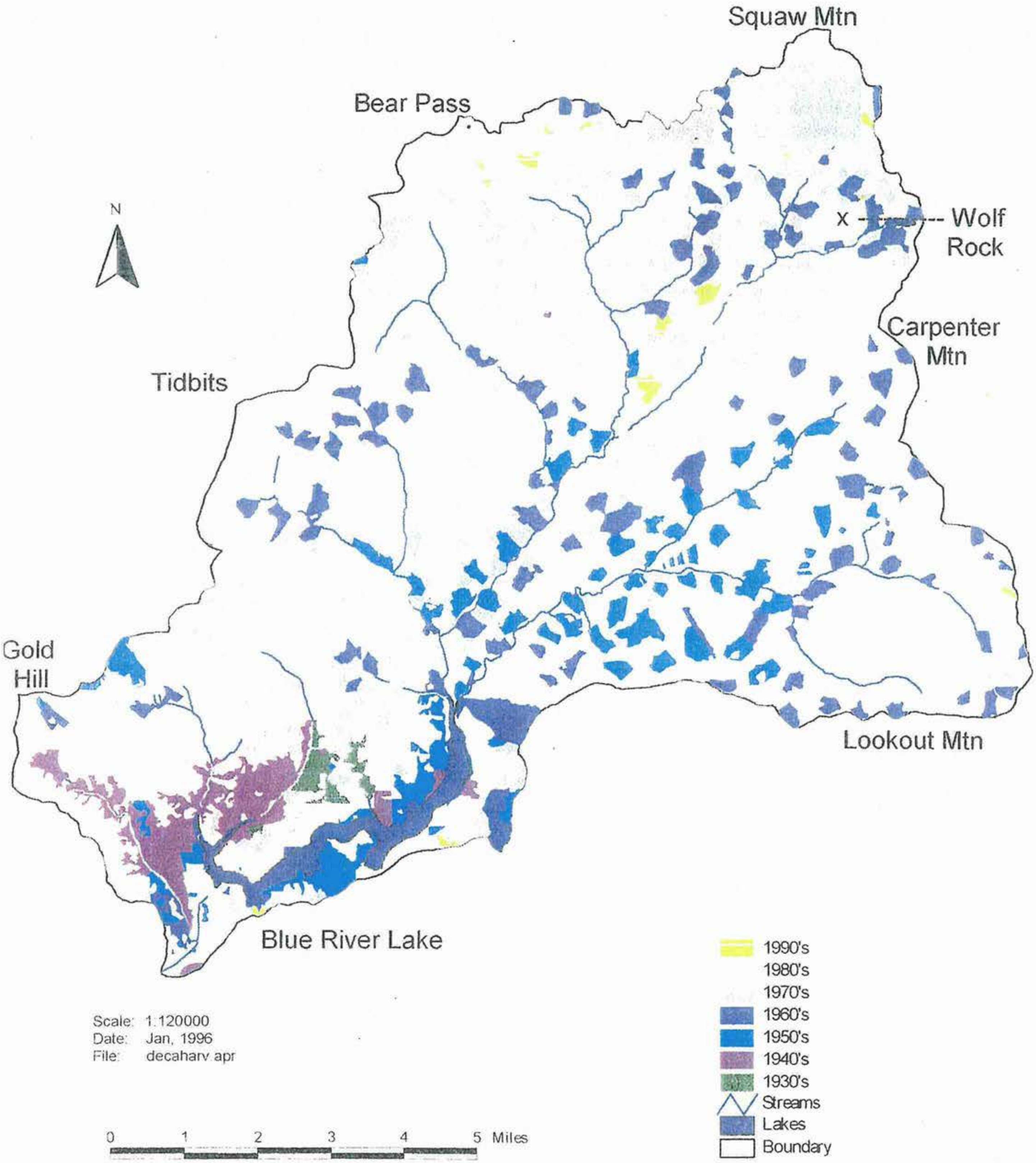
The current landscape is largely a result of timber harvest and fire suppression although there were a few fires that occurred in the teens, twenties and thirties. Most of the early and young seral stage are a result of timber harvest. (Map 17: Seral Stages Current) The harvest during the 30s and 40s was mainly on private land and occurred in large patches leaving many young small residual trees. The clearcuts of the 60s through the 80s occurred mainly on Forest Service managed land. The pattern was to limit the size and disperse the units thought the landscape. This has resulted in the fragmentation of the forest.

The current seral stages are compared to two sets of reference conditions in the table below, the seral pecentages occurring in 1900 and those occuring between 1600-1850. In 1993 the Pacific Northwest Region undertook an assessment of the historic range of variability for a number of key ecosystem elements; elements believed to be crucial to ecosystem health and sustaniability. This analysis was completed at the subbasin scale and is referred to as REAP (Regional Ecological Assessment Project, USDA, 1993). The assessmeent was designed to gain a "first approximation" or "coarse filer" analysis of ecological sustainability of North est Forests. Many assumptions and limitations are inherent in the assessment. However, the apparent patterns and trends are valuable in establishing baseline information to land maagers. The percentages occurring in the McKenzie Subbasin for the western hemlock series are displayed in the table.

Table 16: Seral Stages

Seral Stage	1900		1995		REAP
	Acres	Percent	Acres	Percent	Percent
Stand Initiation *(0-30 years)* *Early*	6,443	11	16,071	28	1-35
Stem Exclusion *(30-80 years)* *Young*	12,129	21	4,973	9	
Understory Reinitiation *(80-200 years)* *Mature*	6,466	11	14,999	26	
Old Growth *(200 years plus)* *Late*	33,187	57	21,177	37	35-90

Map 18: Timber Harvest by Decade



Overall Diversity of Vegetation

Reference Conditions

Species

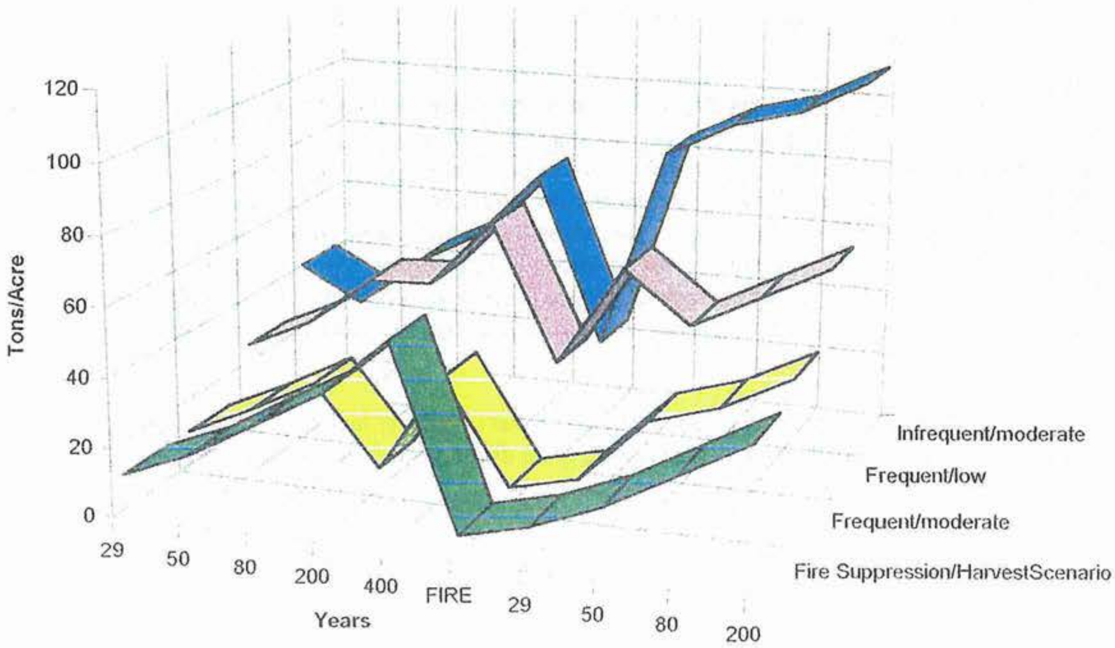
The plant communities occurring in the watershed as a result of natural disturbance would have been similar to what we see today. The size and distribution would have been different but the species composition would have included communities in the four plant series present in 1995. Periodic wildfire, especially along the ridge systems, would have maintained meadows and rock gardens in the watershed in an open condition for long periods of time.

Structure

During the natural cycle of stand development in western forests, accumulation of natural residues often exceeds rates of decay in young stands where normal mortality is high, and low crown heights allow rapid drying of the forest floor. Conversely, stands in the mature stage, with high, dense crowns, may produce a microclimate in which residue decays faster than it accumulates. Heavy fine fuel (0-3") loading is to be expected in open stands where grasses and other forbs, brush and young tree needle-cast continue to form this layer. Late-successional and old-growth areas can be expected to have a high fuel loading in the 9 inch and greater size classes as the stand continues to evolve. An equilibrium fuel profile, where fuel accumulated equals fuel decayed, is attained in the younger, vigorous growing stem exclusion and understory re-initiation stages.

A number of possible fire frequency and severity scenarios can affect fuel profile evolution. As seen in the graph below, a wide range of variability can result from different fire intensities at different return intervals.

Figure 39 . Fuels Evolution Graph



Current Conditions

Species

Plant communities within four forest series occur within the watershed. Forest series are vegetation zones which define areas based on which tree species is dominant in the climax community. The Blue River watershed includes acres within the warm and dry Douglas-fir series, the warm moist western hemlock series, and two cold high elevation series, mountain hemlock and silver fir. The most common forest series is the western hemlock (Map 19: Vegetation Zones). Thisvegetation zone covers most of the watershed below 3500' elevation. Some Douglas-fir series occur within the lowere elevation zones. This zone occurs mainly in the southwest section of the watershed in Quartz, N.Fork Quartz, Tidbits and along the Reservoir. Mountain hemlock zone occurs only within a very narrow band at about 3500' between the western hemlock and the silver fir zones. These two high elevation zones rim the watershed along the ridge systems.

As early as 1966 suitable plant species were sought out for revegetation of the drawndown zones of the reservoir. Revegetation of the reservoir was to improve wildlife and fish habitat, sediment erosion control, and improve scenic conditions. Experimental plantings of the drawndown zones occurred throughout the 1970s. An aggressive revegetation program began in the 1980's. Willamette National Forest worked in cooperation with the Soil Conservation Service, US Army Corps of Engineers, and the State Fish and Wildlife department. Areas for revegetation were identified and prioritized based on accessibility, wildlife needs, visual, and recreational priorities. Revegetation mainly occurred within the upper fifty feet with the upper five feet identified as top priority. A variety of species were used including many ornamental horticultural varieties as well as native plants that are non local.

The first recorded revegetation used seed and transplant plugs from two sedge species (*Carex aperta* and *C. rostrata*) that grow at Fish Lake, McKenzie Ranger District. In the early 1990s the empahsis was changed from planting a variety of exotic and native species to using a few specific locally native species. The main focus today is the continual planting of Columbia sedge, (*Carex aperta)* and native willow species for fish habitat and erosion control

<u>Structure</u>

The structural diversity within the watershed varies depending upon when it was harvested. The earlier harvesting during the 1930s, 40s and 50s more than likely contain quite a bit of down wood. These clearcuts contained no residual trees and during the 1970s no residual down wood. Units cut in the late 80s and early 90s contain some green trees, snags and down wood.

Fuels profiles in the Blue River watershed are affected by three elements: silvicultural treatments, catastrophic events and time. All three have played a role in the present fuels profile associated with the watershed. Silvicultural treatments (i.e. harvest, thinning and planting) occurred on about 18,450 acres or 31% of the watershed. Catastrophic events since 1900 (Carpenter, Lucky Boy and other undocumented fires) occurred at least 3,000 acres.

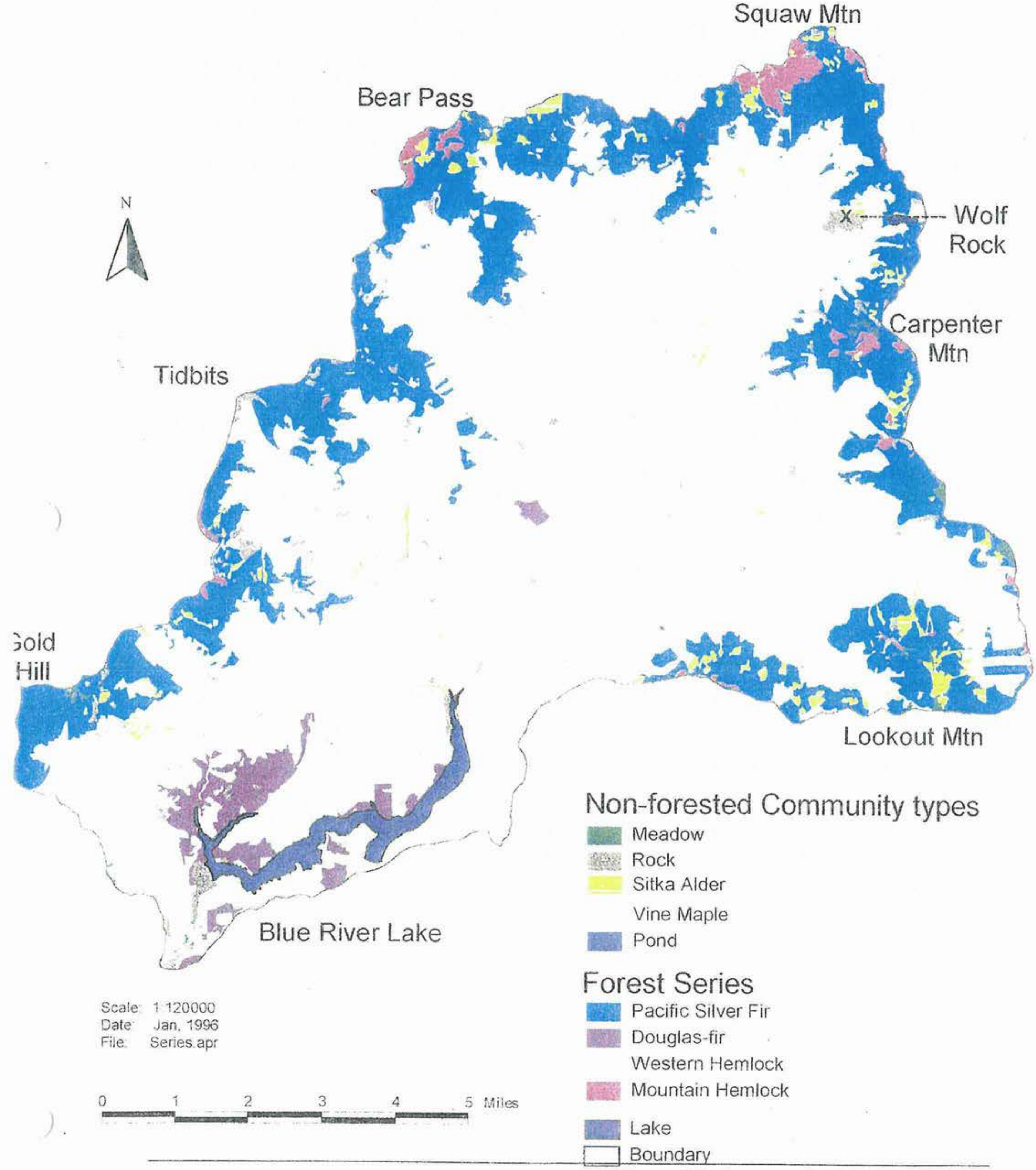
Fuel loading by size class was determined for seral stages by GIS analysis(Table 17: Fuel Loading). General Technical Report PNW-105 (Photo Series for Quantifying Residues in Common Vegetation Types of the Pacific Northwest) and field visits using GTR-PNW-105 and 258 (Stereo Photo Series for Quantifying Forest Residues in the Douglas-Fir -- Hemlock Type of the Willamette National Forest) were used in assigning a fuels profile for each seral stage.

Table 17: Fuel Loading (amount of fuel by size expressed in tons per acre)

	Size Class			Current Conditions	Reference Conditions
	0-3 inches Tons/Acre	3-9 inches Tons/Acre	9-20 inches Tons/Acre	Total Acres % of Area	Total Acres % of Area
Non Forested Meadows	2.0			1834 acres 3% of Area	
Early: 0-29 yrs	10.1	12.6	11.6	4973 acres 9% of Area	7176 acres 12% of Area
Young: 30-80 yrs	6.6	6.7	11.7	16071 acres 27% of Area	12640 acres 21% of Area
Mature: 81-200 yrs	3.8	5.0	18.5	14999 acres 25% of Area	6324 acres 11% of Area
Late: 200+ yrs	3.9	4.5	30.0	21199 acres 36% of Area	32936 acres 56% of Area

Disturbances interrupt the natural fuel profile progression by reducing the existing debris and/or creating new dead material. Intensity and frequency of disturbances determine the amount of snags and LWD present. In general, where fire frequencies are low, snag and LWD levels are normally high due to the incidence of insect and disease mortality. High fire frequencies and low intensities often result in higher snag levels and lower large wood. High fire frequencies in combination with high intensity usually result in low levels of snags and large wood.

Map 19: Vegetation Zones



The lack of requirements for leaving snags or LWD in past harvest units in conjunction with yarding and burning of unmerchantable material and then broadcast burning left little LWD and few snags in harvested units between 1975 and 1986. Moderate levels have been left since 1986 with new retention requirements in the forest plan standards and guidelines. Prior to 1975, harvest units had large amounts of cull material, including large diameter logs, left on the units but no snags were left.

Comparison of reference stand conditions to present conditions would suggest that management activities have decreased the total amount and changed the distribution pattern of snags in the watershed. As in changes to fuel profiles, the direction towards more young or old stands without the presence of the full range of stand conditions, lower levels of snags and LWD result. Recent efforts to create snags around harvest units have helped somewhat but most harvest activity that occurred here was before new snag retention standards and guidelines were implemented.

Disturbance

Fire

Reference Conditions

Fire has been an important disturbance process in the western Cascade Mountain landscape (Burke 1979, Teensma 1987, Morrison and Swanson 1990, Agee 1993). Fire suppression has been occurring in the Blue River watershed since the early 1900's or earlier in the mining area. With fire suppression, fire size is kept to a minimum and wildfire is virtually eliminated as a major shaper of vegetational landscape patterns and processes. Teensma (1987) found natural fire rotations to be around 87 years "pre-fire suppression" and about 587 years after fire suppression. This change in fire rotation has had a number of vegetational effects across the landscape. Forest structures may have become more complex in some areas and the distribution of age classes across the watershed may be less diverse.

Current Conditions

The Carpenter Fire in 1912 and the Lucky Boy Fire in 1952 are the only large fires with Forest Service fire reports in the area this century. Other large fire episodes are mapped by Teensma (1987) and Morrison and Swanson (1990) with very large areas burned in 1893 and other large areas burned in 1902, 1918, 1930 and 1935. Maps from both of these studies show the entire areas burned within the last 500 years. Other evidence of stand replacement fires exists with large areas of even aged stands in the Tidbits and Cook and Quentin Creek areas. Older records often did not include fires remote to residences or transportation routes. Fire Report records from 1970 to 1994 show an average of 4 fires per year were suppressed in the Blue River watershed. Effective fire suppression, coupled with timber harvest patterns has led to a reduction in the size of early seral patches, as well as a change in the pattern of distribution, compared to conditions expected under the natural disturbance regime.

The Blue River watershed fire regime, as described by Heinselmann (1978), is long return interval (100-300 yr) crown fires with some short return interval (25-100 yr) crown fires. Kilgore (1981) describes a variable regime of frequent low intensity surface fires and long return interval, stand replacing fires. This variable regime better describes the Blue River Watershed. Some differences in fire regime are observed across the watershed and are demonstrated in fire history studies within the watershed to vary by aspect, elevation, location and plant series. Most conditions will remain equal across the watershed for these factors with major differences showing only in exposure to wind events associated with large fire. In this area the Lookout Creek drainage is situated to be protected from East wind and strong Southwest wind events by ridges on it's South and East edges. The North and West portions of the watershed are more open to East winds through the low pass near Wolf Rock and Southwest winds up the Northeast / Southwest oriented Blue River drainage. (Map 20: Wind Event Map)

A study in progress (Weisberg, pers. comm.) is working to associate fire occurrence and pattern with landforms defined by aspect, slope, slope length, and elevation. These studies will increase the resolution of fire regimes and will be applicable to future detailed landscape and project analysis in the watershed.

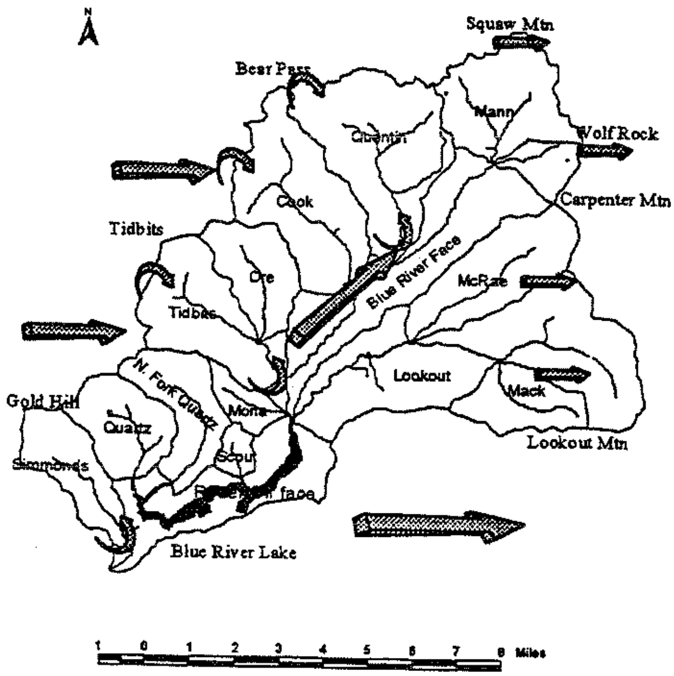
Description of fire regime is based on the areas mean fire return interval (MFRI). MFRI is the average number of years between consecutive fires. The MFRI for all fires in the area studied by Teensma (1987) is 114 years and varies by physiographic areas from 239 to 96 years. In the South Lookout area, MFRI is 160 years and in the Cook-Quentin area MFRI is 96 years. Extrapolating from this data we assign these intervals to the two defined fire regimes (Map xx). In both areas, both researchers believe the occurrence of understory fires is underestimated. Low intensity fires do not always leave fire scars that can be analyzed in fire history studies to show their frequency or extent. Study data from Teensma shows an average of 3.8 fire scars per site and indicates the contribution of fire to the layered structure of older stands. (Map 21: Fire Regime)

Preliminary results from Weisberg (unpublished 2/96) show similar physiographic fire regimes with a separation of a third regime from the northern regime mapped here. Weisbergs fire regimes are described by frequency and severity with patch characteristics. The Lookout Creek area is described as mixed frequency, moderately patchy severity Type 4, with average MFRI of 140 years. The Quartz/Tidbits/Cook/Quentin Creeks area is described as mixed frequency, finely patchy severity Type 2 with average MFRI of 175 years. A third regime (Type 1) is described for the Wolf Rock/Squaw Mtn./Mann Creek/Bear Pass area as low frequency, homogenous severity with an average MFRI of 200 years

In Weisberg's description of fire regimes, he discusses the issue of scale. The Blue River watershed area fine scale variability seems to exceed the large scale variability of fire regimes. This means that descriptions of fire patchiness seem better than descriptions by average fire regime characteristics. At the scale of the watershed, general approximations of effects on management are listed for each regime . For the Type 1 regime activities might be contiguous over larger areas and less concerned with creating fine scale variation in landscape pattern. Also these activities might occur over longer time periods. In fire regime Type 2 management activities would occur over smaller areas and considerable attention would be paid to topographic controls on the patchiness of disturbance severity. In Type 4 the patchiness and degree of topgraphinc control would be intermediate between the first two types.

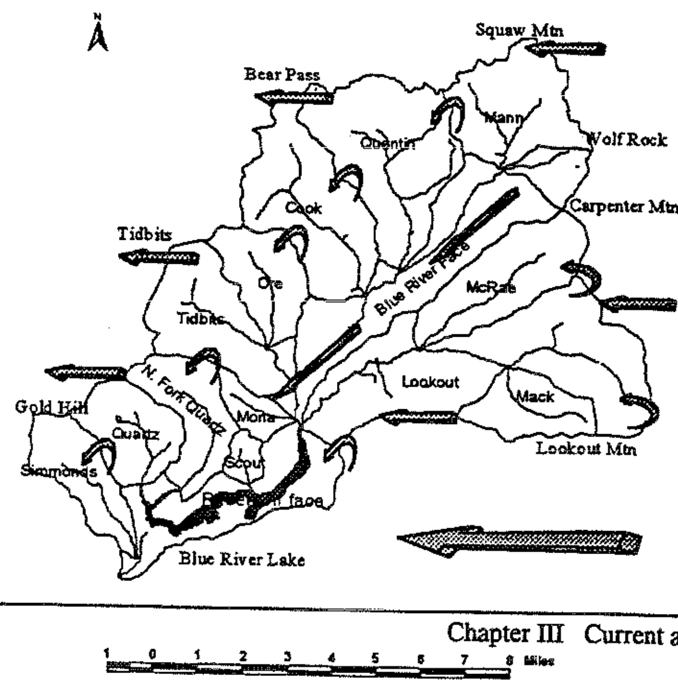
Blue River Watershed

Normal Westerly Wind

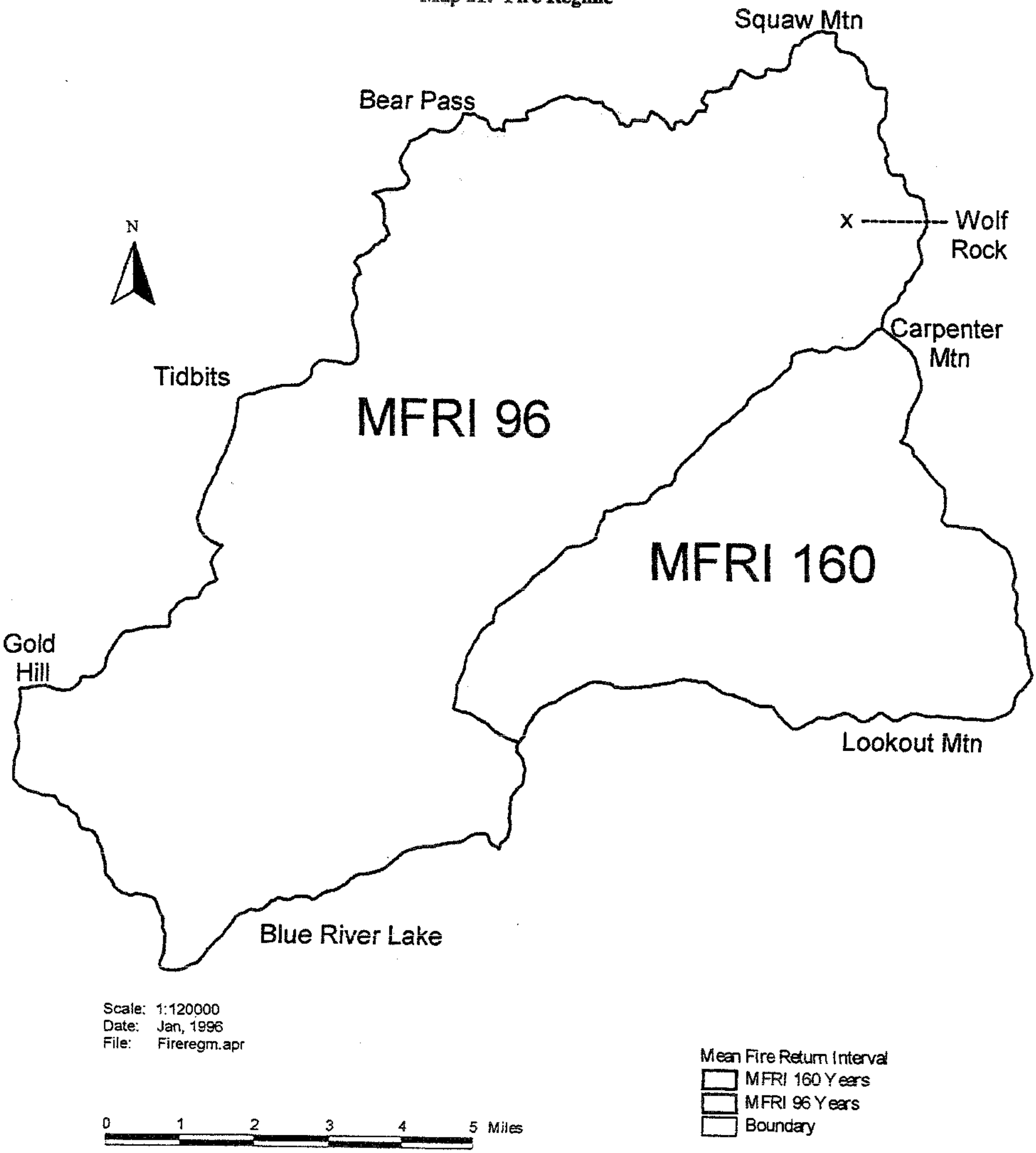


Blue River Watershed

An East Wind Event



Map 21: Fire Regime



Risk Assessment

Large fire events occurred in the watershed when a combination of weather and fuel factors were at an optimum for intensity and spread. In all probability wind, such as that associated with cold fronts, was the major spread event. Relative continuity of the fuel model carrying fire maintained spread and intensity until weather and fuel conditions changed. Usually fires would last for long periods and end only with season ending changes.

Currently the fragmented landscape will support various burning intensities as fuel models change. Significant fire runs may occur in the stand initiation and stem exclusion phase areas with catastrophic effects (Fuel Model One and Five), while lower intensity fires would occur in the understory reinitiation and old-growth stands (Fuel Models Eight and Ten). The combination of drought cycle and other weather events, such as lightning or strong east winds could cause an intense burn in all fuel models. The distribution of areas in different fuels profile evolution stages is currently biased toward either end of the possible spectrum. Higher fuel loadings exist with fire suppression in natural stands and lower fuel loadings exist in areas treated with harvest and prescribed burning.

Insects, Disease and Windthrow

Reference and Current Conditions

Insects, disease and windthrow are all disturbance agents that are endemic to the watershed. These agents of change are on a smaller scale than catastrophic fire but are occuring throughout the landscape on a small but regular basis.

Windthrow seems to have occured within the watershed on a small scale basis. Although no records exist prior to active management in the 1950s evidence of large scale blowdown is not apparent. A wind event occured in the area during January 1990 and the result was scattered blowdown along edges of clearcuts and along road systems as well as some small pockets within forested areas. Blowdown probably occured around openings in the past after fire events and or landslides on a small but somewhat regular basis.

The primary insect within the area is the Douglas-fir beetle (*Dendorctonus pseudotsugae*) which attacks Douglas-fir trees. Beetle populations increase soon after fresh blowdown occurs and result in a fringe effect of dead trees around pockets of down trees. Evidence of recent population increases could be seen one year after the 1990 blowdown event. The result of this increase was scattered pockets of dead trees throughout the landscape.

Disease primarily exists in the form of root rots. *Phellinus weirii* and *Armillaria mellea* are endemic and play a continuing role in the creation of diversity within older stands. Root rots are very site specific and pass from one tree to another via the root systems. The tendency is for the area of infection to spread outward as long as host trees are available. A variety of species invade the opening created by trees falling over and add diversty to the stands. Root rots have not played a large role in creating landscape patterns in terms of scale but probably play a signicant role in creating diversity within the landscape.

Non forested Habitat

Reference Conditions

The occurrence of non-forested communities and their distribution across the landscape was probably greater in the past than today. Historically, natural fire played an important role in maintaining species and ecological diversity within the watershed. Other natural disturbances such as windstorms, disease and insect outbreaks, floods and land movement influenced the landscape. Early seral plant communities most likely occurred for longer periods of time. Reoccurring fires maintained many of these habitat types and reduced conifer encroachment of open meadows. It is also possible that more openings existed around the rock outcrops in the watershed.

Native American populations used fire to create or perpetuate meadows for their use. Fire was typically used to increase the vigor and productivity of meadow forbs and grasses and huckleberry production. In the 1800s, large expanses of open, early seral habitats were maintained in that condition by sheepgrazing, primarily in the northern portion of the watershed.

Current Conditions

Special habitats located in the watershed were photo interpreted with some field verification during fall of 1995. (Table 18: Non-forested Habitats Map 19). The dominant types of special habitats identified are rock outcrops, talus slopes and vine maple (*Acer circinatum*), rocky soil or talus, and Sitka alder (*Alnus sinuata*) communities. Rock outcrops are found along the ridgetops of the old Cascade mountains and are abundant in the western section of the watershed, particularly along the district border. The distribution of Sitka alder communities are concentrated in the higher elevations of the watershed. Sitka alder is often one of the first shrub species to appear following a fire, landslide, and other natural or artificial disturbances. Huckleberry (*Vaccium membranacean*), and beargrass (*Xerophyllum tenax*) communities are found at the higher elevation Pacific silver fir zone. Rock outcrops and dry meadows are found on the southeast facing slopes of Carpenter and Lookout Mountains.

Aquatic habitats such as lakes, ponds, bogs, and wet meadows are relatively uncommon in the watershed. The majority of small ponds that are found are located in harvested timber stands on Forest Service land and private lands. These ponds have been affected by the removal of the forested canopy that once surrounded the ponds and the subsequent alterations in the hydrology and species composition. The only lake in the watershed is Wolf Lake. This lake was created by beavers constructing a dam across the west end of the lake. It was designated a botanical Special Interest Area in 1981.

Table 18: Non-forested Habitats

Habitat Feature	No. of occurrences	Total acres
dry meadows	13	100
mesic meadow	1	2
wet meadow	1	2
rock cliff	2	7
rock garden	1	2
rock outcrops	158	738
rock talus	26	137
Sitka alder communities	106	884
vine maple communities	22	72
vine maple/talus communities	9	55
ponds	4	25

Rare Plant Species and Rare Forest Plant Associations

Reference Conditions

There are no known historic documentation of rare plant sightings in the watershed before the 1980s. Rare plant surveys for management activities began in the 1980s. Cascade daisy (*Erigeron cascadens*) is found on high elevation rocky outcrops on Lookout Mountain. This species was listed on the Willamette National Forest Sensitive Plant List in 1981. In a rare plant survey report at that time Andrew Moldenke stated "the species is so very rare and narrowly distributed that every possible piece of information available will be needed for its efficient preservation." In 1985 the Cascade daisy was removed from the sensitive list and placed on the Forest Watch List. The species Hall's goldenweed (*Haplopappus hallii*) is also found growing on Lookout Mountain, and was sighted in the same report as having its center of distribution on the Willamette National Forest. The plant was a State candidate species proposed to be listed as Threatened in 1975. It was deleted from the Oregon Rare and Endangered Plant Species Task Force List in 1979. The achlorophyllous gnome plant (*Hemitmes congestum*) found in the watershed was listed on the State Review List until 1993 when the species was removed. In the last ten years a sighting of the sensitive species tall bugbane (*Cimicifuga elata*) was documented at the Lookout Creek guard station. There is no current information on this earlier sighting

Considering the present landscape it is assumed that habitat for plant species considered sensitive and rare was historically present. An exception may be the habitat for Thompson's mistmaiden (*Romanzoffia thompsonii*). Habitat for this species is specific to seepy areas on rocky, south-facing slopes that was most likely not common historically in the watershed.

Current Conditions

The purpose of the Region 6 Sensitive Plant Program is to protect rare species and their habitats before there is a need to list species as threatened or endangered under the Endangered Species Act. Plant species listed may have a very limited geographic range or highly specific habitat characteristics. Sensitive species are vulnerable due to low population levels or significant threats to habitat (USForest Service, R-6 Forest ServiceM). Species on the Region 6 Sensitive Plant List are protected to avoid population losses due to the effects of management activities. Sensitive plant surveys have occurred in areas of proposed timber sales and other ground disturbance activities. No surveys for rare plants have been done on private lands in the watershed. Two populations of Thompson's mist maiden, (*Romanzoffia thompsonii*), listed on the Region 6 Sensitive Plant List for the Willamette National Forest are located within the watershed (Table 19: Sensitive and Rare Species Present). These populations were found in 1990 during a sensitive plant survey for a proposed timber sale. *Romanzoffia thompsonii* is a small annual plant found only within a narrow geographic range on the west side of the Cascades and is considered rare throughout its range.

In addition to species listed on the Forest Sensitive List there is one plant on the Forest Watch List. The Watch List contains species of concern that are not currently threatened or endangered. The plant Cascade daisy (*Erigeron cascadensis*) is found on Lookout Mountain.

Table 19: Sensitive and Rare Species Present

Species	Common Name	No. of Populations	Status	Landblock
Romanzoffia thompsonii	Thompson's mistmaiden	2	sensitive	1
Erigeron cascadensis	Cascade daisy	2	watch	4
Cimicifuga elate	tall bugbane	historical sighting	sensitive	4

Rare forested plant associations contribute to the biodiversity of the watershed. These community types may reflect unusual environmental conditions or be at the northern or southern extent of their range (Dimling and McCain, 1992). Plant associations are ranked for frequency of occurrence by district. Plant associations identified from five or fewer stands on a district are considered rare. Plant associations identified from 6 to 11 stands on a district are uncommon. Stands identified as rare or uncommon are to be managed as special habitats (Special Habitats Management Guide 1992).

One hundred and twenty forested ecoplots distributed throughout the watershed were used to identify rare or uncommon forested plant associations. From this information there are no rare plant associations in the watershed. Several uncommon plant associations in the Pacific silver fir and the Douglas-fir series were identified (Table 20: Uncommon Plant Associations). The Pacific silver fir/devil's club plant association indicates a wet habitat and is protected by wetland and/or riparian buffers. The Douglas-fir series should be evaluated during landscape analysis and design.

Table 20: Uncommon Plant Associations

Series	Plant Association	Rating	No. of ecoplots
Pacific silver fir	ABAM-ABGR/SMST	U	1
Pacific silver fir	ABAM/OPHO	U	2
Pacific silver fir	ABAM/VAAL/COCA	U	3
Douglas-fir	PSME-TSHE/BENE	U	1
Douglas-fir	PSME/HODI-BENE	U	1
Western hemlock	TSHE/OXOR	C-U	2

Survey and Manage Species

Reference Conditions

Wildfire, windstorms, and insect outbreaks of varying size, frequency, and intensity have been replaced by short-rotation timber harvest and prescribed burning-disturbances that are more frequent and less variable in size and intensity (Halpern and Spies 1995). Harvest of mature and late-successional forests have been replaced with even-aged, structurally uniform stands. Old-growth's mix of large and small trees, snags, and coarse woody debris creates structural complexity and spatial heterogeneity supports a higher level of biodiversity than younger closed canopy forests (Franklin, 1992; Hansen et al. 1991). Botanical species associated with late-successional and old-growth forests include fungi, lichens, and bryophytes.

Current Conditions

The Northwest Forest Plan contains a list of species generally associated with late-successional forests and riparian habitat. Botanical species on the survey and manage list include fungi, lichens, bryophytes, and vascular plants. There are four survey strategies:

- Survey strategy 1: manage known sites, activities implemented in 1995 and later must include provisions for known sites;
- Survey strategy 2: survey prior to activities and manage sites, activities implemented in 1999 or later must have completed surveys;
- Survey strategy 3: conduct extensive surveys and manage sites starting in 1996;
- Survey strategy 4: conduct general regional surveys starting in 1996.

38 species are known to occur within the watershed at this time (Table 21). These species of fungi, lichens, bryophytes and vascular plants associated with late-successional forests and riparian habitat are valued as indicators of biological, and functional diversity of ecological stable old-growth forests. Species diversity for the majority of these species appears highest in late-successional forests because of the diversity of habitat structures, host species, and large amounts of duff and down material. Many of the lichen and bryophyte species are epiphytes. Of the 237 species of fungi listed, the majority are thought to be ectomycorrhizal fungi.

The 38 known species have been identified from herbarium and research collections, research literature, and from incidental sightings. The extensive amount of scientific research in the old-growth ecosystems in the H. J. Andrews Experimental Forest has provided much of the current information for many of the epiphytic species dependent on old-growth habitat conditions.

The old-growth stands in the H. J. Andrews, with some trees older than 500 years, provide habitat for some very rare species of fungi and lichens. In particular, the rare oceanic influenced lichen *Hypogymnia oceanica* is found in an old-growth Douglas-fir stand, approximately 90 miles inland from its coastal range. The old-growth forest canopy provides an extensive and structurally diverse habitat and microclimate that mimics the habitat for this species found on the coast (Holthausen et al. 1993). Other interesting species are the rare nitrogen-fixing lichens *Nephroma occultum* and *Pseudocyphellaria rainerensis*. These species appear to be restricted to old-growth forests (Neitlich, 1993). A total of eighteen nitrogen-fixing lichen species have been identified in old growth tree canopies in the H. J. Andrews.

Two aquatic lichens *Leptogium rivale* and *Hydrothyria venosa* are found on rocks in cool streams in the H. J. Andrews. The only other documented population of *Leptogium rivale* occurs in Montana. Both of these species are aquatic and will die if desiccated (Holthausen et al. 1994).

In the northern section of the watershed, a rare nitrogen-fixing lichen *Lobaria linita* was recently found on a rock cliff face. Prior to this sighting, the lichen was only known to occur on the bark of conifers older than 200 years.

The vascular plant *Allotropa virgata*, candystick, has been identified in four locations in the watershed. *Allotropa virgata* is usually found in dry soils, with a duff layer and coarse woody debris. Although it occurs more frequently in late-successional forests, one population is located in a second growth stand. The plant is a achlorophyllous, and mycotrophic obtaining its nutrients from its association with mycorrhizal fungi and a broad range of photosynthetic host species. The life cycle of this complex plant allows it to remain dormant underground for several years until specific environmental conditions exist. It typically occurs in stands that have had a fire history. Two vascular plants, *Botrychium minganense* and *Botrychium montanum* are on the survey and manage list and the Willamette National Forest Sensitive Plant List. These two species like *Allotropa virgata* require a mycorrhizal association with a fungus for establishment and survival. Both species are included in project level botanical surveys.

Table 21: Survey and Manage Species Present

Species	Category	Survey Strategy	Geographic Area
Ptilidium californicum	Bryophyte-liverwort	1 & 2	Lookout Creek, Mack Creek, & McRae Creek, H.J.Andrews
Allotropa virgata	Vascular achlorphyllous plant	1 & 2	Ecoplot # 6700, 8292, 964 & T14S R5E Sec36
Lobaria linita	Rare nitrogen-fixing lichen	1, 2 & 3	T14S R5E Sec26
Pseudocyphellaria rainierensis	Rare nitrogen-fixing lichen	1, 2 & 3	H.J.Andrews
Hydrothyria venosa	Aquatic lichen	1 & 3	H.J.Andrews
Leptogium rivale	Aquatic lichen	1 & 3	Tributary to Lookout Creek, Lookout Creek at Gypsy Camp, H.J.Andrews
Destuntzia fusca	Rare false truffle/ mycorrhizal fungi	1 & 3	H.J.Andrews
Leucogaster microsporus	Rare false truffle/ mycorrhizal fungi	1 & 3	H.J.Andrews
Nephroma occultum	Rare nitrogen-fixing lichen	1 & 3	H.J.Andrews
Hypogymnia oceanica	Rare oceanic influenced lichen	1 & 3	H.J.Andrews
Boletus piperatus	Bolete, low elevation/ mycorrhizal fungi	3	H.J.Andrews
Sparassis crispa	Cauliflower/ saprophytic fungi	3	Lookout Creek trail, H.J.Andrews
Gomphus clavatus	Chanterelle - Gomphus/ mycorrhizal fungi	3	Lookout Creek trail, H.J.Andrews
Gomphus floccosus	Chanterelle - Gomphus/ mycorrhizal fungi	3	H.J.Andrews
Rhizopogon truncatus	False truffle/ mycorrhizal fungi	3	H.J.Andrews
Hydnum repandum	Tooth fungi/ mycorrhizal fungi	3	H.J.Andrews
Cantharellus cibarius	Chanterelle/ mycorrhizal fungi	3 & 4	Conifer stands at low elevations
Cantharellus subalbidus	Chanterelle/ mycorrhizal fungi	3 & 4	T14S R4E Sec21
Clavariadelphus ligula	Club coral fungi/ saprophytic	3 & 4	H.J.Andrews
Douinia ovata	Bryophyte-liverwort	4	Lookout Creek, Mack Creek, & McRae Creek, H.J.Andrews
Antitrichia curtipendula	Bryophyte-moss	4	H.J.Andrews

Table 21: Survey and Manage Species Present cont.

Species	Category	Survey Strategy	Geographic Area
Lobaria oregana	Nitrogen-fixing lichen	4	H.J.Andrews
Lobaria pulmonaria	Nitrogen-fixing lichen	4	H.J.Andrews
Lobaria scrobiculata	Nitrogen-fixing lichen	4	H.J.Andrews
Nephroma bellum	Nitrogen-fixing lichen	4	H.J.Andrews
Nephroma helveticum	Nitrogen-fixing lichen	4	H.J.Andrews
Nephroma laevigatum	Nitrogen-fixing lichen	4	H.J.Andrews
Nephroma parile	Nitrogen-fixing lichen	4	H.J.Andrews
Nephroma resupinatum	Nitrogen-fixing lichen	4	H.J.Andrews
Peltigera collina	Nitrogen-fixing lichen	4	H.J.Andrews
Pseudocyphellaria anomala	Nitrogen-fixing lichen	4	H.J.Andrews
Pseudocyphellaria anthraspis	Nitrogen-fixing lichen	4	H.J.Andrews
Pseudocyphellaria crocata	Nitrogen-fixing lichen	4	H.J.Andrews
Sticta beauvisii	Nitrogen-fixing lichen	4	H.J.Andrews
Sticta fuliginosa	Nitrogen-fixing lichen	4	H.J.Andrews
Sticta limbata	Nitrogen-fixing lichen	4	H.J.Andrews
Calicium viride	Pin lichen	4	H.J.Andrews
Stenocybe major	Pin lichen	4	H.J.Andrews

Noxious Weeds and Invasive Non-native Plants

Reference Conditions

The majority of the nonnative weed species in the Pacific Northwest are native to Europe and Asia. Many of the most troublesome weeds now present in the United States were introduced into this country from Europe during the colonization and early settlement of North America, such weeds include thistles, (*Cirsium* spp.), and St. John 's wort, (*Hypericum perforatum*), (Anderson 1977). Weeds were introduced intentionally as garden ornamentals or as in case of Scotch broom used for erosion control in the State in the 1920's (Miller 1995). Nonnative weed seed is spread by contaminated seed, and accidental transport of seeds and plants.

Current Conditions

The term noxious weed is a legal definition designated by the Oregon State Weed Board for any "non-native plant species that is injurious to public health, agriculture, recreation, wildlife, or any public or private property" (ODA 1995). A criteria that is used in this definition is "a plant species that is or has the potential of endangering native flora and fauna by its encroachment in forest and conservation areas" (ODA 1995).

The Willamette National Forest recognized the need for an active weed program and established an integrated weed management program in 1993 after the completion of a Forest-wide environmental assessment document (USDA 1993). This program coordinates survey and control actives with the Oregon Department of Agriculture (ODA).

Control strategies for noxious weeds are stated in the Forest EA. Species classified as new invaders have the highest priority for control. Weed population sites identified are analyzed for the most effective control method as outlined in the Forest E.A. Control methods currently used in the watershed are manual removal and the release of beneficial insects that feed on the seeds and roots of selected noxious weed species. The ODA has supplied the beneficial insects.

A survey for five noxious weed species in the watershed was done by the ODA in 1989. A less intensive survey for the same five noxious weeds and the invasive weed Himalayan blackberry (*Rubus procerus*) was completed in the fall of 1995. An intensive nonnative weed survey was completed on the H. J. Andrews Experimental Forest during 1993-1994 (Parendes 1994). The surveys indicate the majority of the weed populations found in the watershed are located along roadsides, landings, in early seral regeneration units, and along trails. Scotch broom (*Cytisus scoparius*) is widely distributed along roads, landings, and in the campgrounds at Blue River reservoir; St. John's wort (*Hypericum perforatum*), tansy ragwort (*Scenecio jacobaea*) and thistle species (*Cirsium* spp.) are widespread along most of the Forest Service roads and spotted knapweed (*Centaurea maculosa*) is well established growing adjacent to Forest Service Road 15. Spotted knapweed is the only noxious weed in the watershed designated as a new invader species. (Table 22: Noxious Weeds)

Thirty-two weedy species have been identified growing in the watershed. Aggressive nonnative species include giant knotweed (*Polygonum sachalinense*), Himalayan blackberry (*Rubus procerus*), everlasting peavine (*Lathyrus latifolius*) and canarygrass (*Phalaris arundinacea*). (Table 23: Nonnative Plants)

Table 22: Noxious Weeds

Common Name	Species	Distribution	Biological Control
spotted knapweed	*Cenaurea maculosa*	Patchy	Yes
Canada thistle	*Cirsium arvense*	Widespread	Yes
bull thistle	*Cirsium vulgare*	Widespread	Yes
Scotch-broom	*Cytisus scoparius*	Widespread	Yes
St. John's-wort	*Hypericum perforatum*	Widespread	Yes
tansy ragwort	*Scencio jacobaea*	Widespread	Yes

Table 23: Nonnative Plants

Common Name	Species	Distribution
bentgrass	*Agrostis alba*	patchy
oxeye dasiy	*Chrysanthemum leucanthemum*	widespread
lamb's quarters	*Chenopodium album*	patchy
orchard grass	*Dactylis glomerta*	widespread
Queen Anne's-lace	*Daucus carota*	patchy
cut-leaved geranium	*Geranium dissectum*	patchy
foxglove	*Digitalis purpurea*	patchy
velvet grass	*Holcus lanatus*	patchy
false dandelion	*Hypochaeis radicata*	widespread
wall lettuce	*Lactuca muralis*	widespread
annual rye	*Lolium perenne*	widespread
everlasting peavine	*Lathyrus latifolius*	patchy
bird's foot trefoil	*Lotus corniculatus*	patchy
reed canary grass	*Phalaris arundinacea*	isolated
common Timothy	*Pheum pratense*	patchy
common plantain	*Plantago major*	widespread
Kentucky bluegrass	*Poa pratensis*	patchy
common smartweed	*Polgonum persicaria*	patchy
giant knotweed	*Polgonum sachalinense*	isolated
sealheal	*Prunella vulgaris var. vulgaris*	patchy
Himalayan blackerry	*Rubus procerus*	patchy
evergreen blackberry	*Rubus laciniatus*	patchy
red sorrel	*Rumex acetosella*	widespread
woodland groundsel	*Senecio sylvaticus*	patchy
common groundsel	*Senecio vulgaris*	patchy
blue field-madder	*Sherardia arvense*	patchy
common chickweed	*Stellaria media*	patchy
common dandelion	*Taraxacum officinale*	widespread
alsike clover	*Trifolium hybridum*	patchy
red clover	*Triflolium pratense*	patchy
white clover	*Trifolium repens*	patchy
commom mullen	*Verbascum thapsus*	isolated

Species and Habitats

Overview of Wildlife Habitat

Forest Habitat Structure (Snags and Large Woody Material)

Snag and log structural components are important for numerous wildlife species that use both early and mid seral habitat as well as for species that use mid and late seral habitat. The following discussion describes the conditions within the watershed for each of these structural components. For a list of species which use snags as primary habitat, as well as those which use downed logs refer to Appendices 18-20 in Brown (1985).

Current Conditions

Snag and large woody material levels vary substantially within the watershed. Harvest, salvage and firewood collection has decreased snag and log levels within approximately 100 feet of most roads in the watershed.

<u>Snags</u>
A snag model currently in use on the Willamette National Forest was used to determine snag levels. This model uses a spreadsheet program developed by Matt Hunter (1990) which determines subdrainage snag densities based on current snag levels in both managed and natural stands. Potential snag deficiencies were identified in the following subdrainages: Mona Scout (10C), Lower Blue River (10E), Upper Blue River (10H), South Blue Lake (10J), and Mann Creek (10K).

Logging prior to about 1985 has resulted in a lack of snag habitat in current early and mid seral habitat. . Between 1986 and 1990, it is estimated that about one snag or green tree per acre, or 20% snag levels were left in logged units. Since 1990, units have retained an average of about twice that, or 40% snag levels or green trees. From these trees snags have been or are planned to be created artificially. Snag creation began in this watershed in 1987 and since then, additional snag creation activities have been accomplished or are planned by topping, girdling, and inoculation with heartrot. In general, it is thought that about one third of all snags created should be inoculated so they will develop soft inner cores which may be more suitable for nesting by some cavity excavators. Creation of snags by two or three methods is believed to provide a wider variety of snag habitat for the benefit of all snag dependent species.

<u>Down Wood</u>
Down woody material levels have not been calculated or tracked to the same extent as snags. Provision of adequate snag levels will eventually lead to adequate levels of down woody material, however, this may not always be the case if areas are logged before the snags fall and become useable log habitat. Currently, log levels are being prescribed to meet the ROD standards and guidelines (240 linear feet per acre), with site-specific modifications. For example, existing adjacent log habitat in riparian areas, northern spotted owl Critical Habitat units, marten or pileated woodpecker habitat areas, or riparian reserve enhancement recommendations may lead to modification of the 240 foot guideline.

Stands which were logged prior to the 1960s generally have fairly high levels of large logs. As a result of this, many stands which are now mid seral habitat contain abundant levels of old-growth logs. These can be expected to last for several more decades. Yarding of unmerchantable material within timber sale units occurred until the mid 1980s and resulted in very little down log structural habitat. Since the mid to late 1980s, standards and guidelines have been in place that prescribe retention of down wood. Down wood levels are also augmented by blowdown of retention trees left in timber sale units.

Reference Conditions

Historic snag and log levels would have varied throughout the watershed and would have been dependent on the fire regime (Map 21). Both the frequency and intensity of fire played a role in the amount and distribution of snag and log habitat. Low to moderate intensity fires would have left snags, green trees and logs in patchy distribution. In areas that returned the snags and logs would have had a likelihood of being removed. Higher intensity and larger sized fires may have burned existing snags and logs, or reduced their sizes and habitat values. Diseases such as heartiest also would have played a role in the creation of snags and eventually down wood structure.

Early seral species such as black-chinned hummingbird, great horned owl, or mountain beaver depend on large, intense fires to clear away the forest and allow grasslands, forbs, and shrubs to develop. Small and moderate, lower intensity fires clear out the forest understory and benefit certain species such as large mammals by facilitating on-the-ground travel. These types of fires may also improve flight paths for birds, especially some of the medium and larger-sized raptors such as northern goshawk, Cooper's hawk, and northern pygmy owl while they may decrease habitat quality for their small mammal prefabs by temporarily reducing ground cover. Lower intensity fires benefit snag and log dependent species because they accelerate the creation of snags and logs.

Wildlife Associated with Special Habitats

Current Condition

Non-forested or special habitat distribution is discussed within the vegetation section earlier in this Chapter (Map 19 and Table 18). Many wildlife species are associated with these areas. Overall, non-forested habitat is fairly uncommon in the watershed. For a list of wildlife species which use special habitats such as meadows, cliffs, ponds, or talus, refer to Appendix 8 in Brown (1985) as well as the Appendix in this document which shows wildlife guilds and their species, including those which use special habitats.

The meadow complex in the Lookout Mountain area consists of alder thickets in the lower elevation areas, with a transition to beargrass at the higher elevations and a very small proportion (~5%) of grasses. These meadows are currently undergoing a minor amount of encroachment by true firs due to fire suppression since the 1940s, resulting in a very gradual loss of open habitat in that area. At the same time, insects have caused mortality to the young conifers which fringe the meadows which may be slowing the conifer encroachment (A.McKee, pers. comm.). See the Appendix for a list of those species which are in the early seral guilds.

Amphibian surveys during the summer of 1995 identified some unique areas in the Blue River watershed, including some waterfall areas which contained torrent salamanders, as well as a small pond on the HJ Andrews Experimental Forest that contained tens of thousands of Pacific tree frogs (Matt Hunter, personal communication). It is speculated that elk wallowing may help keep some of the few ponds open and prevent aquatic vegetation from taking over. It is interesting that the southeast side of Wolf Lake contained numerous amphibians, while they were scarce on the northeast side. Rough-skinned newts are found around Blue River Reservoir in very high concentrations, and are found on the district primarily in stream tributaries that are in fairly close proximity to the reservoir.

Reference Condition

The likely reference conditions of the non-forested habitat in the watershed is discussed earlier in this Chapter within the vegetation section. Wildlife using this type of habitat in the past was most likely similar to the use today and can be found in Appendix 8 in Brown (1985) and in the Appendix showing wildlife guilds and their species.

Wildlife Guilding/Habscapes Analysis

The Willamette National Forest has been using a process developed by Mellen et al. (1994) to identify and map habitat for wildlife guilds at a landscape scale (Habscapes). Guilds are groups of vertebrate species, excluding fish, which generally require similar habitat seral stages for all or portions of their life histories. Currently, an estimated 250 species use the Blue River watershed for a portion or all of the year. The Appendix contains a table of all wildlife species, by guild which are documented and suspected to occur in the watershed, either seasonally or year-round.

The following characteristics were used to assign a species to a guild:

- *Home range size* — **small** = < 60 acres, **medium** = 60-1,000 acres, **large** = >1,000 acres
- *Seral stage* — **open**, **small tree** = <21 inches dbh, **large tree** = >21 inches dbh

Patch configuration category: **patch** = species use single habitat patches, **mosaic**= aggregate patches, **contrast species** =use of two different seral stages in close proximity or, edge species, **generalists** = use all seral conditions

Guild maps were reviewed for the Blue River Ranger District, Sweet Home Ranger District to the north, and the McKenzie subbasin to the east and west (Maps available in District Files). Each of the guilds within the watershed are listed in Table 24 along with the associated characteristics of the guild, the amount of habitat available both on the Forest and within the watershed and an identification of the guilds that are of most concern. There is also an indicator of whether the habitat is of high, medium or low quality.

Following the table there is a discussion of each guild. In general, habitat in the Blue River watershed is similar to other watersheds in the western Cascades. There is a higher proportion of late seral habitat within the watershed than there is on land to the west of the watershed within the McKenzie Basin. in and elsewhere.

The following are the assumptions used in this analysis and some concerns of the guilding process:

1. The results are generalizations for species combined into guilds. Species within these guilds might have differences in specific habitat requirements or home range sizes.
2. The model assesses the watershed condition to provide habitat for wildlife guilds, however, it does not address species viability.
3. The guild model as used did not include an elevational stratification for low and high elevation species.
4. One of the assumptions of the model is that habitat outside the analysis boundary mirrors habitat patterns inside the boundary. Habitat outside the analysis area boundary was not coded separately for this analysis. Since the watershed borders a few sections of private lands which are entirely in the early stage, the results of the guild analysis in these two areas (north end of watershed and just west of Elk Mountain) are slightly biased, based on the mirror assumption. Less suitable early seral habitat appears than actually exists and less large tree habitat exists than is represented.
5. The model did not consider riparian and special habitat species, and does a poor job with this. The pixel size used in the model is larger than small areas of riparian and other special habitats, and many of these species do not require very large patches of these types of habitat. In addition, the level of mapping detail, much of which was based on aerial photo analysis, did not include every small special habitat patch to be mapped.

Table 24: Wildlife Guilds

Guild	Sample Species Present (Number of Species) in Watershed	Suitable % on Willamette National Forest	Suitable % of Watershed &Suitable Acres in Watershed	High	Med.	Low	Trend *	Concern
I. Early seral species								
A. TSPE *Small home range* *Open seral stage* *Patch species*	Wrentit Dusky Flycatcher Western Bluebird California Ground Squirrel (26)	NA	26%	NA	NA	NA	↑	
B. TLME *Large home range* *Open seral stage* *Mosaic species.*	Red Fox Rough-legged Hawk Swainson's Hawk (3)	7%	3% 1470	57	0	1413	↑	X
C. TMME Medium home range Open seral stage Mosaic Species.	Merlin Badger (2)	9%	6% 3164	1023	0	2142	↑	X
D. TSME *Small home range* *Open seral stage* *Mosaic species*	Scrub Jay Mountain Quail American Goldfinch Western Fence Lizard (15)	15%	15% 8862	8692	0	170	↑	
II. Late Seral Species								
A. TLML *Large home range* *Large tree seral stage* *Mosaic species*	Northern Goshawk Pileated Woodpecker Marten Fisher Northern Spotted Owl Barred Owl (6)	30%	36% 20810	1274 5	1123 ≅	6941	↓	
B. TSPL *Small home range* *Large tree seral stage* *Patch species*	Red Tree Vole Brown Creeper Shrew-mole Trowbridges's Shrew (6)	NA	NA	NA	NA	NA	↓	X

Guild	Sample Species Present	Suitable % on Willamette National Forest	Suitable % in Watershed/ Suitable Acres	Trends*	Concern
		III. Contrast Species			
A. TLC *Large home range.* *Contrast species*	Red-tailed Hawk Great Horned Owl Roosevelt Elk Great Gray Owl (7)	17%	20% 11481	↓	X
B. TMC *Medium home range* *Contrast species*	Big Brown Bat American Kestrel Little Brown Myotis (5)	18%	21% 12019	↓	X
C. TSC *Small home range* *Contrast species*	Olive Sided Flycatcher Lewis' Woodpecker Cassins' Finch (4)	11%	13% 7333	↓	
		IV. Generalist Species			
A. TSGEM *Small home range* *Small and Medium tree seral stage* *Generalist*	Fox sparrow Willow flycatcher House wren (5)	51%	50% 26667	no change	
B. TSGML *Small home range* *Medium and Large tree seral stage* *Generalist*	Hermit warbler Western red-backed vole Williamson's sapsucker (11)	71%	19% 11006	no change	
C. TMGG *Medium home range* *Generalist*	Long-legged myotis Long-eared owl Cooper's hawk (21)	NA	NA	no change	
D. TLGG *Large home range* *Generalist*	Wolverine Coyote Black bear (10)	NA	NA	no change	

*Trend is defined in the above table as being the difference in habitat quality for a particular guild between the historic condition and the current condition. It should be noted that future trends will depend entirely on future management of the area:

↓ = declining conditions ↑ = improving conditions

I. Early Seral Species

Currently, 26% of the watershed consists of early seral habitat. Four guilds exist for early seral depending on size of home range, and whether they use habitat in single habitat patches or a mosaic pattern. species (Table 24: Suitable Habitat Acres Available by Wildlife Guild)

Throughout the Pacific Northwest and in the Blue River watershed, early seral habitat has been created almost entirely by logging during the past several decades, which is projected to decline in the future with management under the Northwest Forest Plan. It is unknown how much habitat is needed within a given area to maintain viability of these species. The percentages given for early seral habitat guilds could be skewed because many of these species are dependent on the standing and dead wood structural components lacking in many early seral, managed stands. There is a concern that in the past, early seral habitat was maintained in that stage for a longer time period than is presently the case with reforestation and silvicultural manipulation.

Much of the early seral habitat in this watershed and across the Willamette National Forest currently lacks structural snags and down woody material critical for successful reproduction of all species in the early seral stage guilds, which may reduce species richness and overall population levels. It will take several years of leaving amounts of structural components on the high end of the range of natural variability to obtain the landscape and associated population levels which existed prior to logging activities.

A. TSPE Guild: Small home range, open, patch species.
No habitat maps were created for this guild because their habitat needs are represented by the total amount of early seral habitat, which comprises 26% of the Blue River watershed. Open habitat for this guild appears to be well-represented, however, needed structural components are lacking in many of the managed stands.

B. TLME Guild: Large home range, open, mosaic.
The overall proportion of this habitat type in the Blue River watershed is only 3% compared to 7% for the entire Willamette National Forest. Only 4% of the suitable area within the watershed is highly suitable, and all of this habitat is concentrated around the higher elevational edges. The McKenzie subbasin shows suitable habitat for this guild to be highly concentrated in some areas and larger areas of non-habitat, including the south end of the Blue River watershed and a large area east of Cougar Reservoir to the Cascade Crest.

C. TMME Guild: Medium home range, open, mosaic.
Habitat for this guild is also rare in the Blue River watershed. Only 6% is suitable and 32% of that is highly suitable, with 9% suitable on the Willamette National Forest. The Sweet Home Ranger District appears to have a higher proportion of suitable habitat for this guild, most of which is scattered along the eastern district boundary. The McKenzie subbasin map for this guild shows that very little suitable, almost no moderately suitable, and no highly suitable habitat for this guild occurs west of the Blue River watershed. In the McKenzie subbasin, this guild is mostly dependent on habitat provided by the Willamette National Forest.

D. TSME Guild: Small home range, open, mosaic.
15% of the Blue River watershed is suitable for this guild which is the same proportion of habitat provided on the entire Willamette National Forest. Habitat for this guild appears to be quite well distributed on the Blue River and Sweet Home Ranger Districts, as well as throughout the McKenzie subbasin. There is a fairly large area along the Cascade crest and within the wilderness to the west where this habitat type is sparse.

II. Late Seral Species

Late seral habitat currently makes up 36% of the watershed. At the present time, 76% of the late seral habitat is greater than 350 years old (Table 25: 1995 Late Seral Habitat (>200 years). Based on the analysis provided in Option 9 (FEMAT, 1994), the viability of large home range, mobile, mosaic species is moderate to high. There are however concerns for the low mobility patch species, which indicates the need to manage the landscape to provide connectivity between suitable habitat for these species.

Table 25: 1995 Late Seral Habitat (>200 years)

Year of Origin	Age in 1995	Late Seral Habitat Acres	% of Late Seral Habitat	% of Watershed Acres
1495 and earlier	>500 years	4546	21%	7%
1496-1545	450-499 years	2381	11%	4%
1546-1595	400-449 years	4164	20%	7%
1596-1645	350-399 years	4989	24%	9%
1646-1695	300-349 years	2320	11%	4%
1696-1745	250-299	1495	7%	3%
1746-1795	200-249	1305	6%	2%
Total acres		21200	100%	37%

Table 26: 1995 Mature Habitat (81-200 years)

Year of Origin	Age in 1995	Mature Habitat Acres	% of Mature Habitat	% of Watershed Acres
1796-1845	150-199 years	4201	28%	7%
1846-1895	100-149 years	7693	51%	13%
1896-1945	50-99 years	3106	21%	5%
Total acres		15000	100%	25%

A. TLML Guild: Large home range, large tree, mosaic.
This guild is represented on the Blue River watershed at 36%, compared to 30% representation on the Willamette National Forest. 61% of the habitat in the Blue River watershed is highly suitable, and the guild map shows it to be concentrated on the HJ Andrews Experimental Forest, Cook Creek subdrainage, Tidbits Mountain ridge and Simmonds Creek areas. Field surveys for northern spotted owls have identified these same areas as being of high value. The moderate and low suitable habitat is fairly well distributed throughout the rest of the watershed with the exception of the Wolf and Mann subdrainages. The McKenzie subbasin map for this guild shows no suitable habitat in the Blue River watershed which is due to the use of a different and less accurate vegetation layer.

B. TMML Guild: Medium home range, large tree, mosaic.
There is somewhat more habitat for this guild compared to the TLML guild due to the smaller home range size, with 40% habitat suitability in the Blue River watershed and73% of this being highly suitable. Habitat for this guild is well-connected throughout the watershed, and there are highly suitable stepping stones to the north to larger habitat blocks.

C. TSPL Guild: Small home range, large tree, patch species.
These species will pick up additional habitat beyond that in the TMML guild, and there is no concern for a lack of habitat. For this reason, guild maps were not created and percentages are not available. There is a concern about dispersal for these species.

III. Contrast Species

Contrast species documented or suspected to occur in the watershed use edge habitat between early seral and other older forests as primary habitat for breeding and/or foraging. This guild was divided into large, medium, and small home ranges.

A. TLC Guild: Large home range, contrast species.
20% of this watershed contains suitable habitat which is fairly well-distirbuted in clumps except in the HJ Andrews Experimental Forest. Suitable habitat for this guild is very sparse west of the Willamette National Forest, and in most of the wilderness in the McKenzie subbasin.

B. TMC Guild: Medium home range, contrast species.
Like the large home range, contrast species, this guild has adequate suitable habitat consisting of about 21% of the watershed compared to 18% for the entire Willamette National Forest.

C. TSC Guild: Small home range, contrast species.
In contrast to the TMC and TLC guilds, habitat for the smaller home range guild is well-scattered west of the Willamette National Forest in the McKenzie Basin. This guild has 13% suitable habitat in the Blue River watershed compared to 11% on the Willamette National Forest. Habitat in the Blue River watershed is fairly concentrated with gaps in the Simmonds and Cook Creek drainages, near Squaw Mountain/Wolf Rock and on the HJ Andrews Experimental Forest.

IV. Generalist Species

These species can use several different seral stages as primary habitat for breeding and/or foraging. There are few concerns for the viability of these sxpeices within the watershed now or in the future. Because a very high proportion of these species use snags for breeding and benefit from down woody material, retention of these structural elements would provide excellent habitat for these species over time.

A. TSGEM Guild: Small home range, generalist, small and medium tree.
Habitat for this guild is very abundant with 50% of the watershed being suitable. There is no concern for quantity or distribution now or in the future for this guild throughout the entire McKenzie subbasin.

B. TSGML Guild: Small home range, generalist, medium and large tree.
Habitat for this guild is fairly abundant, although it is not represented as well in the Blue River watershed as on Willamette Nationl Forest. There is no concern about habitat for this guild.

C. TMGG Guild: Medium home range, generalist and TLGG Guild: Large home range, generalist.
Habitat modelling was not completed for these guilds because habitat is very abundant and there is no concern. Although there is concern for wolverines (see Wildlife Species of Interest Discussion), the proportion of early, mid and late seral habitat is not a factor which is related to their rare occurrence.

Special Habitat Species are represented on the Special Habitat Map on page...These are species which are highly associated with habitats such as caves, meadows, lakes, talus, or cliffs. Because of the scarcity of these habitat types across the entire forest, a Special Habitat Guide was written to be used as reference in management in and surrounding these areas. Other than slight meadow encroachment by conifers, it is not expected that these habitats have undergone much change between 1900 and 1995.

Marten/Pileated Woodpecker Analysis

On Page C-3 of the Northwest Forest Plan for Amendments to the Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, Item Two states: "Administratively withdrawn areas that are specified in current plans and draft plan preferred alternatives to benefit American marten, pileated woodpecker, and other late-successional species are returned to the matrix unless local knowledge indicates that other allocations and these standards and guidelines will not meet the objectives for these species."

Under the 1990 WNF LRMP there are eleven complete areas and three partial areas designated for martens within the Blue River watershed, and seven complete areas and one partial area designated for the pileated woodpecker. Current habitat conditions are fairly good and mostly in the late seral stage. Over time, those acres currently in mature habitat will grow into late seral habitat. Objectives for these species will be incorporated in the overall design of the landscape.

Connectivity, Dispersal and Interior Habitat Conditions

Current and Reference Conditions

The concept of dispersal habitat and need for fairly contiguous habitat has been a topic of debate among biologists. There is no data which shows how much of a given habitat type is needed on a landscape to provide good dispersal habitat conditions for species which depend on certain seral stages. At the turn of the century, dispersal habitat conditions in the Blue River watershed were different than they are today. The vegetation at that time was similar in terms of proportion of different habitat types (Maps 13 and 14). Dispersal via mature and late seral habitat:

In the past, there has generally been a greater concern for dispersal of mature and late seral dependent species than those that depend on the early and young seral stages. Biologists have interpreted dispersal habitat needs to be met if a certain level of canopy cover and tree diameter has been met over a given area. For the northern spotted owl, the usual measurement to evaluate dispersal conditions has been to determine the percentage of forest stands that average at least 11 inches DBH and have at least 40% canopy closure. Guidelines from the U.S. Fish & Wildlife Service in the past have been to maintain at least 50% of each quarter township in this condition. Only one quarter township in the Blue River watershed does not exceed the 50% guideline: T.15S., R.4E, SW in the Rialto Mine area. This quarter township has 48% of stands in the suitable condition.

Other methods can be used to determine suitable dispersal conditions. For example, a review of the 1995 Seral Stage map (Map 17) shows that mature and late-successional forest habitat connects fairly well throughout the Blue River watershed except in the Wolf and Mann Creek areas where it is somewhat limited due to two sections of private land which are in early seral conditions.

Since many wildlife species which use primarily late seral habitat can most likely disperse through mature habitat, it seems valid to combine these two habitats for an evaluation of dispersal conditions. The combined percentage of mature and late seral habitat was projected to be 67% in 1900, compared to 61% in 1995. Since the historical seral stage projection does not include all the very small patches which were created by fire, disease, or windthrow, it is possible that the overall composition of both seral stages combined was very similar. It is however important to consider that only two points in time are being compared, and there were most likely fairly wide fluctuations in habitat conditions at other times. The main difference in dispersal conditions between the past and now is that the remaining mature and late seral stands have a patchier distribution, and thus while there may be more routes now of habitat which appears to be suitable, these routes are narrower and have more edge effects. This can lead to increased predation on some species. It has been speculated that great horned owls may prey on juvenile northern spotted owls in these edge areas.

In the past, many of the forest stands were more contiguous, supplying large amounts of interior habitat for species such as the spotted owl, marten, goshawk, Cooper's hawk, pileated woodpecker, fisher, Vaux's swift, olive-sided flycatcher, Hammond's flycatcher, Townsend's warbler, band-tailed pigeon, and numerous amphibian species. Before the European American settlement and influence, the landscape was continually in a state of change, and it is suspected that the range of wildlife species throughout the Pacific Northwest were able to adapt to these changing conditions. The projected 1900 landscape, and other past landscapes did contain some fairly major habitat barriers for species which use specific seral stages. For example, in 1900 the northeast portion of the watershed contained very little mature and late seral habitat (Map 16: Seral Stages 1900). There were a few islands of late seral habitat which could have been used for dispersal to the north. Some species with smaller home ranges may have been temporarily confined to these islands until the surrounding habitat developed more suitability for them. Certain individuals of these species may have attempted dispersal taking a fairly high risk of not reaching optimally suitable habitat. The rest of the watershed seems to have been fairly well connected based on the 1900 condition.

Dispersal via early and young habitat:
The 1900 map does not show good habitat connections for these seral stages consistently throughout the watershed (Map 16: Seral Stages 1900). There are some major habitat gaps especially in the Lookout, Tidbits, and Quartz Creek drainages.

Wildlife Species of Interest (Threatened, Endangered, Sensitive, C-3, Appendix J2, and Big Game

The following are threatened, endangered and sensitive species known or suspected to occur within the Blue River watershed. Species recently included as Category 2 species (USFWS, Animal Candidate Review, Nov. 1995) are also listed. The discussion of each species includes current information on status and survey history, and future potential occurrence based on vegetation trends and land allocations in the Northwest Forest Plan. Also included are species of interest or concern which are documented or suspected to occur in the watershed.

AMPHIBIANS

Red-legged Frog (Rana aurora)

Status:	Federal:	Candidate Category 2
	State:	Sensitive
	R-6:	Sensitive

Current Conditions

The red-legged frog is a pond frog which inhabits reservoirs, lakes and the slow-moving water of streams, most commonly in wooded areas. Breeding waters used by these frogs vary considerably, but generally are permanent or temporary waters with little or no flow, but which must last long enough for metamorphosis to occur, and with sturdy underwater stems for egg attachment (Nussbaum, *et. al.*, 1983). During the non-breeding season, red-legged frogs have been found in moist forest situations 600-900 feet or more from any standing water (Nussbaum, *et. al.*, 1983). Red-legged frogs are usually found below 3000 feet in elevation, however, they have been documented above 5600 feet elevation on the Rigdon Ranger District of the Willamette National Forest.

In spite of a spring, summer and some fall amphibian fieldwork, only one red-legged frog breeding location has been documented in the Blue River watershed at a pond on the HJ Andrews at approximately 3000 feet in elevation. Several thousand tadpoles of this species were foung at this pond in early summer 1995 (M.Hunter, pers.comm.). Other breeding sites may occur, but very few potential sites have been found below 3000 feet in elevation. A few other dispersing individuals have been found in the watershed. However, it appears that red-legged frogs are not very common. The most likely locations to find additional red-legged frogs in the watershet are in the least constricted creek channels: Lookout, Mann and Tidbits Creek as well as Blue River.

Reference Conditions

There is no information available about historic population levels of red-legged frogs. However, they are judged to have been slightly greater than currently exists. Past higher populations of beaver may have created more slow moving side channel habitat used by red-legged frogs. Some of the past beaver dam sites may have been lost during construction of Blue River Reservoir. Trapping of beavers may have also reduced their populations. Many historic natural fires in the Blue River watershed probably burned through Class III and IV riparian areas, whereas these fires probably did not burn through and impact Class I and II riparian areas. Increased sedimentation from burning through Class III and IV areas affected habitat quality in the lower class I and II streams used by red-legged frogs. In an area the size of the Blue River watershed red-legged frog populations were probably stable. Past logging practices impacted riparian areas to a greater extent than the historic fires, so populations may have dropped slightly due to impacts to creeks and adjacent riparian areas.

Northwestern Pond Turtle (Clemmys marmorata marmorata)

Status: Federal: Candidate Category 2
State: Sensitive
R-6: Sensitive

Current Conditions

Northwestern pond turtles inhabit ponds, marshes, sloughs, and slow-moving portions of creeks and rivers, preferring those with rocky or muddy bottoms and aquatic vegetation (watercress, cattails, etc.). These turtles feed on aquatic plants, carrion, and insects. In 1995, a western pond turtle was found on road 15 about one mile from the confluence of Lookout Creek and Blue River Reservoir, but due to the turtle's condition it was suspected to have been dropped off by someone who had captured it elsewhere. The annual drawdown of Blue River Reservoir would not allow turtles to survive in the Lookout cove area.

Reference Conditions

There is no information about historic levels of pond turtles in the Blue River watershed, and no anecdotal information about turtle sightings. A review of old aerial photos does not appear to show side channel habitat in the Blue River area where the reservoir now exists, and there does not appear to have been suitable pond turtle habitat.

Tailed Frog (Ascaphus truei) (J2)

Status: Federal: Candidate Category 2
State: Protected, Sensitive\vulnerable

Current Conditions

The tailed frog is a riparian associated late seral species normally found in permanent, fast-flowing, rocky, cold-water streams and headwaters in coniferous forests. Although tailed frogs are normally found in or near streams during rainy weather, they have been known to forage 25 or more meters away from water (Nussbaum, *et. al.*, 1983). In the Oregon Western Cascades, tailed frogs have a one to three year larval period, possibly longer depending on climatic conditions, thus contributing to their relatively low reproductive ability.

1995 amphibian surveys in the Blue River watershed indicate presence of tailed frogs and larvae in many streams at all elevations. Other district records indicate presence in Mack Creek, where a study has marked over 100 individuals, the mainstem and North Fork of Quartz Creek, and Lookout Creek. Water testing in the North Fork of Quartz Creek shows levels of lead and zinc above the usual western Cascades background levels, which could be impacting amphibian populations. It is unknown if these metals are naturally occurring in an ore vein, or whether this is the result of previous mining activities or other heavy equipment left in the area. Mercury has also recently been found in a tributary to the North Fork of Quartz Creek and could also be impacting amphibian health in the local area.

It is likely that the construction of Blue River Reservoir has resulted in somewhat of a barrier to amphibian movement for species such as the tailed frog which depend on clear, cool water conditions and do not disperse over land. This may be affecting genetic diversity.

Reference Conditions

There is no information available about historic population levels of tailed frogs. Before the advent of fire suppression, natural fires which historically occurred in the Blue River watershed probably burned through riparian areas if they were very large and intense. Smaller scale fire events probably did not burn through Class I and II riparian areas but more frequently through Class III and IV streams (see also Reference Conditions, Riparian Areas). Historic populationsof tailed frogs may have been stable. Historic logging practices impacted riparian areas to a greater extent than historic fires in Landform Blocks 1 and 4 (Table 16: Seral Stages), so populations in these areas may have dropped slightly due to impacts to creeks and adjacent riparian areas.

Clouded Salamander *(Aneides ferreus)* (J2)

Status: State: Sensitive/undetermined status

Current Conditions

Clouded salamanders are normally found in large woody material, preferably Douglas-fir, and stumps of varying decay previously inhabited by ants, termites, and other invertebrates (Leonard, *et. al.*, 1993). They require permanent dampness, rotten logs necessary for their invertebrate prey base, and rocky or woody debris for cover, such as large Class III and IV Douglas-fir logs with sloughing bark. Once a large log has decayed to the point of moisture loss, clouded salamanders abandon it. These salamanders depend on a continuous supply of suitable large, rotten logs or snags. Throughout the Pacific Northwest, clouded salamanders have frequently been found either under the bark of logs or in seeps in recently burned clearcuts if the fire was not too intense (Joe Beatty, personal communication).

During the 1995 Blue River Watershed amphibian survey (Hunter, 1995), this species was documented in many habitat types and substrates. Although most often found under the bark of logs, clouded salamanders were also found in a rock quarry in the Cook Creek area. Due to their preference for Douglas-fir logs, their upper elevational limit may be identical to the upper elevational limit for this tree species.

Reference Conditions

There is no information available about historic population levels of clouded slamanders. Historic fires may have had both negative and positive effects on the habitat of this species. Intense, large fires may have reduced or eliminated suitable habitat locally by burning and drying out of down woody material. On the other hand, tree mortality resulting from fires creates a supply of new logs if the trees were not entirely charred. The earliest logging practices between 1890 and approximately 1960 left abundant down woody material for species such as the clouded salamander, however, these practices gradually changed with the thinking that recently logged units should be required to be "cleaned up", and all unmerchantable material was yarded to the landings. Units logged between 1960 and the 1980s are oftentimes devoid of down woody material and the resulting habitat for clouded salamanders. By 1990, the importance of leaving down woody material was recognized for many reasons, and scattered logs were required to be left in logged units. Observations indicate that clouded salamanders can make use of log habitat in open stands (Joe Beatty, personal communication).

Oregon Slender Salamander (Batrachoseps wrighti) (J2).

Status: State Sensitive/undetermined status

Current Conditions

Oregon slender salamanders are most commonly found in mature Douglas-fir forests on the western slopes of the Oregon Cascades (Nussbaum, *et. al.*, 1983). An endemic species to Oregon, this salamander inhabits moss-covered logs, rotting stumps and is also found under rocks or pieces of bark near spring seeps. In late spring and early summer they retreat vertically for a subterranean existence to maintain suitable moisture regimes. This salamander lives a primarily subterranean existence, and is not extremely effective in terrestrial movement. Some natural barriers may prevent dispersal. 1995 amphibian surveys frequently discovered this salamander in old forests, including relatively small patches where ground duff and litter was abundant, but especially in bark piles around snags (Matt Hunter, personal communication). It was found from low elevations to the lower elevations of the true fir zone, and primarily on north-facing slopes. Other incidental district sightings have documented this salamander in the Tidbits and Ore Creek drainages as well as just outside the Blue River district office.

Reference Conditions

There is no information available about historic population levels of Oregon slender slamanders. Historic fires may have had both negative and positive effects on the habitat of this species. Intense, large fires may have reduced or eliminated suitable habitat locally by burning and drying out of down woody material. On the other hand, tree mortality resulting from fires creates a supply of new logs if the trees were not entirely charred. The earliest logging practices between 1890 and approximately 1960 left abundant down woody material for species such as the Oregon slender salamander, however, these practices gradually changed with the thinking that recently logged units should be required to be "cleaned up", and all unmerchantable material was yarded to the landings. Units logged between 1960 and the 1980s are oftentimes devoid of down woody material and the resulting habitat. By 1990, the importance of leaving down woody material was recognized for many reasons, and scattered logs were required to be left in logged units.

Southern torrent salamander *(Rhyacotriton variegatus)* (J2) and Cascade torrent salamander *(Rhyacotriton cascade)* (J2).

Status: Federal: Candidate Category 2

State: Protected, Sensitive/vulnerable

Current Conditions

The recent revision by Good and Wake of the family and genus of Torrent Salamanders in 1992 split the "Olympic Salamander" into four distinct species not fully accepted by all authorities (Leonard, *et. al.*, 1993). Two of the species which may occur in this watershed are the Southern and Cascade torrent (seep) salamanders. The two species can be separated by range, subtle morphological characteristics, and slight differences in life history. *Rhyacotriton* spp. normally occur in or near permanent, cold streams and seeps in association with talus, small rocks, and gravel, often in streams with moss capped rock rubble in late seral forests. Torrent salamanders are mostly aquatic and their habitat appears to be restricted to riparian zones including small cliffy, seepy areas that may be Class IV creeks.. These species are sensitive to activities impacting headwater areas and seeps, such as logging and road building activities, which increase sedimentation and/or water temperatures in their coarse substrate habitat areas.

1995 amphibian surveys in the Blue River watershed documented sightings of Cascade torrent salamanders in stream channel substrates, as well as cliffy seeps up to 4000 feet elevation (Matt Hunter, personal communication). They appeared to be fairly common in the right habitat at the right time. It is interesting that these salamanders were found only in the western half of the watershed in steeper ground and where rocky crevices, shallower soils, and more extensive earthflow terrain occurs. Torrent salamanders are probably also excluded from the eastern portion of the watershed where Pacific giant salamanders which prey on them can survive due to the shallower stream systems. Only smaller Pacific giant salamander larvae were found in the eastern portion of the watershed.

In stream channels the larvae were most often found in the smallest headwaters that could be found during summer low flows. They were also found downstream, but less frequently. The gravel, pebble, and cobble substrate was usually relatively clean of fine material, and had many interstitial spaces. What was especially noted during these surveys was the high amout of discontinuous surface flow in the creeks, especially in the upper reaches.

Reference Conditions

There is no information available about historic population levels of Cascade torrent salamanders. Large and intense historic fires may have negatively impacted habitat of this species by shortening the timeframe that small headwater creeks contained water during dry weather periods in late summer and fall. Until more recently in the late 1980s and 1990s, small class IV headwater areas did not receive riparian habitat protection on the Willamette National Forest, which probably resulted in the same effects as large scale, intense fires. An analysis of the current and reference condition seral stage distribution in riparian areas shows that Landform Blocks 1 and 4 now contain higher proportions of early and young seral stages than in 1900.

BIRDS

American Peregrine Falcon (Falcon peregrinus anatum)

Status: Federal: Endangered
State: Endangered
Indicator species for endangered species habitat.

Current Conditions

During the summer of 1996, one active pergrine falcon site was discovered in the watershed. Although an eyrie was not discovered, there is a strong likelihood that one exists. There is a concern about recreational rock climbing on this cliff. The climbing activities will need to be restricted during the critical nesting period until the situation can be better assessed.

Suitable habitat for peregrine falcons exists in other locations within the watershed as well, however general surveys have been very limited .

The peregrine falcon feeds almost exclusively on birds, many of which are associated with riparian zones and large bodies of water such as Blue River Reservoir. Currently there is less mature and late seral habitat within riparian areas than there was in 1900 (Maps 13 and 14). Because of this change in habitat, there are also less snags and nesting habitat for some prey species of peregrines. However, peregrines feed on a wide variety of prey items so it is unknown to what extent the drop in snags and other nesting habitat for mature and late seral species may have impacted prey availability.

Although there are 738 acres of rock outcrops in the watershed, not all are suitable nesting habitat. In the Pacific states, preferred peregrine falcon nesting sites are sheer cliffs 150 feet or greater in height (Willamette National Forest DEIS, 1987). In 1981, 1991, and 1992 aerial reconnaissance of cliffs on the Willamette National Forest was conducted in conjuction with the Oregon Department of Fish & Wildlife and the Regional Peregrine Falcon Specialist, but no high potential nest sites were identified in the Blue River watershed at that time. It must however be noted that peregrines have been heard, and eyries have subsequently been located at cliff sites originally ranked as low or moderate potential, which indicates the need for additional ground surveys. There are several substantial cliff sites in the Blue River watershed A limited one day field review in September 1995 showed some of the cliffs in the Quentin and Upper Cook drainages to have possible nest site suitability.

Reference Conditions

Historic nesting habitat conditions for peregrines in the watershed have probably not changed significantly. Habitat conditions for peregrine prey may have reduced in quality over historic conditions due to the reduction in snag habitat.

Northern Bald Eagle (Haliaeetus leucocephalus)

Status: Federal: Threatened

State: Threatened

Indicator species for endangered species habitat.

Current Conditions

One nest site was discovered during the summer of 1996 at Blue River Reservoir. Although the Reservoir is usually drawn down near the end of summer, fish availability between spirng and mid-summer appears to be adequate to support a nesting pair. The eagles were not seen in late summer but monitoring was limited.

In April 1994, Blue River Reservoir was aerially surveyed as part of a cooperative Challenge Cost Share with the Eugene Audubon Society and the McKenzie Ranger District. Ground surveys for eagles have been very limited around Blue River Reservoir, but there have been several sightings in recent years.

Reference Conditions

The construction of Blue River Reservoir enhanced foraging conditions for bald eagles. Blue River itself does not seem large enough to allow efficient eagle foraging. Historically, eagles probably did not occur in this area.

Northern Spotted Owl (Strix occidentalis caurina)

Status: Federal: Threatened
State: Threatened
R-6: Sensitive

Current Conditions

There are 35 known spotted owl activity centers within the watershed. All currently known activity centers, except one which was established in 1995, have designated 100 acre cores surrounding them. The overall condition of the watershed in terms of spotted owl habitat is fairly healthy. This is evidenced by only three of the activity centers being below levels used by the U.S. Fish & Wildlife Service to assign take levels. Take occurs when there is less than 1182 acres of suitable habitat available within a 1.2 mile radius of an activity center. This corresponds to studies which have shown that spotted owls are still frequently capable of successfully reproducing when 40% of their average home range acres are available.

Some of the original northern spotted owl research was conducted in the Blue River watershed in the 1970s. In 1987 a spotted owl density study was initiated by the Oregon Cooperative Research Unit. This study is the longest ongoing spotted owl study in the western Cascades and is contributing to information about long-term population trends throughout the owl's range. It annually covers the entire watershed with the exception of the area west of the North Fork of Quartz Creek. As a result of these studies, the Blue River watershed has excellent long-term information about spotted owl presence and movements. Each activity center in the study area is visited annually and a minimum of three visits comparable to the Regional owl protocol is completed.

The area west of the North Fork of Quartz Creek, which accounts for about 10% of the watershed, has not been well surveyed. The Gold Hill area was surveyed to protocol in 1992 and 1993, but the rest of this area has not been well surveyed.

The owl density study has identified the Cook, Mack, Lookout Mountain, Upper Lookout, Watershed 2, and North Carpenter pairs as those with the highest reproductive rates. Researchers from the Cooperative Unit have identified eight largely contiguous areas of mature and old-growth habitat which seem to contribute to a high level of northern spotted owl reproduction in the area.

Table 27: Contiguous Mature and Late-Successional Habitat Areas

Name of Block	Acres	Percent Late Successional Habitat	Non-suitable Habitat
North Carpenter	600	90	Managed stands and natural openings
Upper Quentin	850	75	Young fire regenerated stands, managed stands and natural openings
Quentin Creek	675	80	Some young fire regenerated stands
Cook Creek	1000	90	Managed stands
South Cook Creek	500	85	Managed stands
Ore Creek	700	95	Managed stands and young fire regenrated stands
Tidbuck	725	90	Natural openings, managed stands and fire regenerated stands
North Fork Quartz	625	95	Managed stands
Total acres	5675		

Note: Acres and % late-successional habitat were based on visual estimates and are approximate.

Late Successional Reserve and Dispersal Habitat Analysis

The Northwest Forest Plan designated large Late-Successional Reserves (LSRs), 100-acre LSRs, and the Central Cascades Adaptive Management Area (CCAMA) within and adjacent to the Blue River Watershed. Prior to that, the U.S. Fish & Wildlife Service had designated Critical Habitat Units (CHUs) across the range of the northern spotted owl, one of which overlaps the entire Blue River watershed. CHUs are still official units, having been designated in the Federal Register, and the U.S. Fish & Wildlife Service will be closely evaluating the effects of proposed activities within CHUs which may affect the northern spotted owl.

Suitable northern spotted owl habitat acres and numbers of activity centers were compared within the Critical Habitat Area (OR-16), the Adaptive Management Area, and within the two Late Successional Reserves which are partially within or directly adjacent to Blue River watershed (LSRs 0215 and 0217). These areas were compared to assess the difference and value between them and to determine baseline levels for 1995. The analysis follows U.S. Fish & Wildlife Service's recommendations to compare these areas.

The analysis shows that currently the AMA and the two LSRs contain 93 pairs of spotted owls, compared to 60 pairs within just the Critical Habitat Unit. There are 18 pairs within the two large LSRs, and this number is expected to be fairly stable over time. Over decades and in the long-term, this number may increase slightly when habitat conditions in LSR 0215 improve.

No guidelines have been established for the take threshold within specific Critical Habitat Units at this time. It is expected that with future timber management activities, the number of spotted owl pairs within CHU OR-16 and the AMA would decrease. It is also possible that the packing phenomenon may occur in the large LSRs. This phenomenon occurs when numbers of spotted owls increase in the short-term due to habitat exclusion elsewhere. In the long-term, numbers drop back down to former levels because the habitat can only support a given number of individuals. This analysis will provide a baseline for future comparisons and changes to spotted owl populations.

Table 28: Northern Spotted Owl Pairs and Habitat Within the AMA, LSRs 217 and 215, and CHU OR-16

	AMA		LSR 0217		LSR 0215		AMA & LSRs		CHU OR-16	
	Number of pairs	Number in a Take Situation *	Number of pairs	Number in a Take Situation *	Number of pairs	Number in a Take Situation *	Number of pairs	Number in a Take Situation *	Number of pairs	Number in a Take Situation *
BR	45	11	4				49	10	46	10
SH	13	3			14	1	27	4	11	1
MK	10	2					10	2	3	
BLM	7	6					7	6		
TOTAL	75	22	4		14	1	93	22	60	11

Table 29: Acres of Suitable Northern Spotted Owl Habitat within Critical Habitat Unit OR-16, the Central Cascades Adaptive Management Area, and Late Successional Reserves 215 and 217.

	CHU OR-16	LSR 0215	LSR 0217	AMA
Total Acres	98,628	26,767	9,163	140,246
Suitable Habitat Acres				
Nesting	25,777	5,663	942	31,110
Foraging	34,772	14,530	7,441	49,085
Total	60,549	20,193	8,383	80,195
Percent Suitable	61	74	92	57

Reference Conditions

See the discussion about Vegetation, Reference and Current Conditions for an overview of historically projected mature and old-growth habitat which was suitable for the northern spotted owl.

Harlequin Duck (Histrionicus histrionicus)

Status: Federal: Candidate Category 2
State: Sensitive
R-6: Sensitive

Current Conditions

Rivers, streams, and creeks are primary feeding and breeding habitat for harlequin ducks during the breeding season. Birds winter on the coast where they feed on a wide variety of sea life and then move into fresh water river and stream systems in the spring to breed and rear young. They are known to prefer stream reaches typically ten meters across from bank to bank, with rocks, logs and an adequate food supply of benthic invertebrates.

Surveys for harlequin ducks were conducted in 1992 and 1993 in the lower reaches of Lookout Creek and Blue River where several sightings have occurred. Harlequin ducks have nested in Lookout Creek. The currently rather low amounts of large woody material in Blue River due to historic practices of salvaging from the river and logging the adjacent riparian area have made this habitat less optimal for harlequin ducks, but the recently completed aquatic enhancement projects in Blue River and Lookout Creek have improved habitat conditions. A direct correlation exists between stream restoration activity and increased macroinvertebrate abundance in those areas. The stream fertilization project may also be benefitting harlequin ducks by increasing macroinvertebrate levels and providing seclusion that would not otherwise be present.

Reference Conditions

Before construction of Blue River Reservoir, channel conditions in Blue River are judged to have been somewhat confined, but the wide riparian area was probably suitable for harlequin ducks in selected areas. Blue River is judged to have had more pool habitat historically than what is present now, which provided more brood rearing habitat.

Common merganser *(Mergus merganser)* (J2).

Status: None

Current Conditions

The common merganser is associated with larger moderate-gradient streams, primarily at lower elevations. A small percentage of these ducks are found on federal land. Common merganser's primary prey items are fish; and they are cavity nesters. These birds use Blue River Reservoir and would also be expected to use some of the larger rivers and creeks in the watershed, such as Lookout Creek and Blue River. Common mergansers may nest at Wolf Lake where nestboxes have been erected to enhance the currently low number of suitable snags with large cavities. As long as thousands of smaller-sized fish continue to be stocked in the reservoir annually, foraging conditions for common mergansers will be enhanced. Suitable large nesting snags are less abundant now than before logging began in riparian areas along creeks that are large enough for common mergansers such as Lookout Creek and Blue River (see Reference/Current Conditions, Riparian Areas).

Reference Conditions

Common mergansers probably used the lower reaches of Blue River before construction of the reservoir. Historically, large snags adjacent to riparian areas were more numerous, so suitable nesting habitat was more widely available (see Reference/Current Conditions, Riparian Areas).

Great gray owl (Strix nebulosa nebulosa) (J2).

Status: USForest Service species of concern

Current Conditions

The Great Gray Owl is primarily a northern arboreal forest owl and is relatively uncommon west of the Cascades. Great grays inhabit densely forested edge habitat where exposure to direct sunlight and predators is minimized. West of the Cascades, great grey owls are believed to inhabit stands similar to those used by Northern Spotted Owls. This owl is associated with natural meadows, meadow complexes and recently harvested stands where small ground dwelling mammals, primarily voles and pocket gophers, are abundant. Few studies have been completed in the western Cascades and habitat requirements are still in question.

There is only one incidental documented sighting of a great grey owl in the Blue River watershed in the Lookout Creek area in 1980. No surveys specifically for great grey owls have been conducted. The most suitable great grey owl habitat is located in the uppermost open slopes of the watershed. The meadow complex near Lookout Mountain and the adjacent forested stands are suitable habitat, as well as recent clearcuts adjacent to late seral stage forested stands.

Reference Conditions

There is very little historical information about the occurrence of great grey owls in the western Cascades. The 1900 reference condition was estimated to have only half the early seral habitat compared to today. However, it should be recognized that managed early seral habitat is only suitable for great grey owl foraging for about five years, or possibly more in higher elevation, lower site quality areas. Unmanaged early seral habitat may have been suitable foraging habitat for twice that timeframe or longer, if the patches were large and the historic fires burned surrounding seed trees. Natural fires maintained small and large patches of early seral foraging habitat adjacent to late seral foraging habitat. The measurement of total forested edge between early and late seral habitats can give a comparison of suitable habitat in the past compared to the current amount (Maps 13 and 14).

Goshawk (Accipiter gentilis)

Status: Federal: Candidate Category 2

Current Conditions

Goshawks inhabit forested areas throughout the northern hemisphere and in the Pacific Northwest, where they use mountainous coniferous forests. Goshawks are very aggressive hunters, generally foraging within the forest canopy for small mammals and birds. There is growing concern that timber harvest and related activities are causing the decline of goshawk populations, although there is little research and monitoring information that adequately addresses this issue in the Northwest. Mature and old-growth forests with closed canopies are often selected for nesting, although a nest site in a 35 year-old managed stand has been located on the Lowell Ranger District of the Willamette National Forest.

There is high potential that goshawks exist and nest within the watershed since much of it consists of suitable habitat. Between 1987 and 1989 there were six goshawk sightings or roost locations found in the watershed, but no nests were discovered.

Reference Conditions

In 1900, there was less edge and more interior habitat than exists today (Maps 13 and 14). Since the literature shows that goshawks require or prefer interior forests, the forest in 1900 contained more optimum goshawk habitat.

MAMMALS

Pacific Western Big-eared Bat (Plecotus townsendii townsendii)

(also known as Townsend's Big-Eared Bat (Plecotus townsendii)

Status:	Federal:	Candidate Category 2
	State:	Sensitive
	R-6:	Sensitive

Current Conditions

Caves and cave-like structures are critical habitat for these bats as hibernacula in winter and as roosts for summer nursery colonies (Perkins, 1987). Pacific Western Big-eared Bats are also known to roost in the bark crevices of large snags. This species of bat has been located at five locations in the Blue River watershed. Four of these locations were at bridges across and snags near Blue River, and one was in a cave in the Ore Creek drainage, where only one bat was discovered. For the past several years, a fairly extensive bat survey and monitoring project has been conducted in this watershed and some adjacent areas as a cooperative effort between the Springfield School District and the Willamette National Forest. During the summer months, students have worked with a teacher and biologist to mistnet bats, as well as survey bridges and use bat detectors to determine presence in snags (Perlmeter, 1995).. In spite of this work, bat surveys have been fairly limited to the annual monitoring at several bridges and mistnetting on Lookout Creek, and many areas of the watershed remain unsurveyed.

Reference Conditions

In the past, snag habitat across the landscape is believed to have been more abundant than is currently the case, providing additional bat roosting habitat.

Other Bats:

Fringed Myotis *(Myotis thysanodes)*

Silver-haired Bat *(Lasionycteris noctivagans)*

Long-eared Myotis *(Myotis evotis)*

Long-legged Myotis *(Myotis volans)*

Pallid Bat (Antrozous pallidus)

Status: J2

Current Conditions

Of the above five species of bats which are mentioned in Appendix J2 of the Forest ServiceEIS, all of them are present within the watershed, many were discovered at four different bridges on Lookout and Tidbits Creek, and Blue River. Pat Ormsbee, a graduate student has conducted a study of the long-legged myotis, also resulting in additional information about presence and habitat use of other species of bats (Ornsbee, 1995). Long-legged myotis were radiotracked to determine day roost characteristics. Snags made up 88% of all roosts and were an average of 42.5"dbh and 150 feet tall. In spite of the ongoing cooperative research, survey efforts have been limited to only a few locations within the watershed, and the other four species are suspected to be present. The silver-haired bat is a migratory species that has been found during the summer months. It is assumed to be associated with large snags as roost sites and late-successional old-growth forests when roosting and foraging. The fringed, long-eared and long-legged myotis species tend to use large trees and snags for roosting habitat. These three species also use caves, old mines and rock crevices as winter hibernacula sites which are present in the watershed. Mining in the Gold Hill area of the watershed may have enhanced bat and other cave-dwelling wildlife habitat.

Reference Conditions

In the past, snag habitat across the landscape is believed to have been more abundant than is currently the case, providing additional bat roosting habitat.

California Wolverine (Gulo gulo luteus)

Status:	Federal:	Candidate Category 2
	State:	Sensitive
	R-6:	Sensitive

Current Conditions

At the present time, no wolverine studies have been conducted in the Cascades. The most recent and comprehensive wolverine study was conducted in northwestern Montana (Hornocker and Hash, 1981) during 1972-1977. Wolverines appear to be extremely wide-ranging, and unaffected by geographic barriers such as mountain ranges, rivers, reservoirs, highways or valleys. For these reasons, it was concluded that wolverine populations should be treated as regional rather than local.

Wolverines may have always been rare in the Cascades, and past instances of trapping and hunting may have depleted their already low populations to a current level which is barely viable. Wilderness or remote country where human activity is limited appears essential to the maintenance of viable wolverine populations. High elevation wilderness areas appear to be preferred in summer, which tends to effectively separate wolverines and humans. Wolverine populations on the edge of extirpation usually have been reduced to areas of habitat which have not been developed, extensively modified or accessed by humans through roads and trails. The perception of the wolverine as a high elevation species usually coincides with areas of increased human disturbance and loss of habitat, restricting them to wilderness and inaccessible areas. In winter, wolverines move to lower elevation areas which are snowbound with very limited human activity. Wolverines make little use of young, thick timber and clearcuts (Hornocker and Hash, 1981).

There has only been only possible wolverine sighting in the watershed which occurred during the summer of 1995 on road 320 between road 1506 and road 325. Questioning of the observers indicates that it may have been a wolverine or possibly a badger.

Reference Conditions

The absence of roads and less disturbance historically indicates that habitat conditions for wolverines were more optimal than they are presently.

White-footed Vole (Phenacomys albipes / Arborimus albipes)

Status: Federal: Candidate Category 2
State: Sensitive
R-6: Sensitive

Current Conditions

Very little is known about the natural history of the white-footed Vole. Phenacomys is thought to be one of the most primitive of living microtines and unable to withstand much competition. Preferred habitat seems to be moist areas near small streams in mature timber or pole-sized regeneration stands (Maser, 1966). Specific studies of the white-footed Vole have not been accomplished, and all trappings of this vole have been accidental. It is suspected if such studies were undertaken, this vole might be more prevalent than is currently believed (Verts, personal communication).

Two specimens of the white-footed Vole have been collected on or near the Willamette N.F. One was found near Vida; the other on the Blue River Ranger District, but not in the Blue River watershed. It is thought that these locations represent the easternmost extent of their range (Maser, 1966). Most of the known specimens of P. albipes in Oregon have been found to the west and north, primarily near the Pacific Coast. White-footed voles feed on alders in riparian habitat, although they have also been found in a variety of other forest conditions including logged areas. Due to the comparatively rapid recovery rate of alders in logged riparian areas, it is suspected that habitat conditions for white-footed voles have not changed considerably.

Reference Conditions

Before the construction of Blue River Reservoir, white-footed vole habitat may have been more extensive in the lower reaches of Blue River.

Pacific fisher (Martes pennanti pacifica) (J2)

Status: Federal: Candidate- Category 2

Current Conditions

There have been no fisher surveys in the watershed and no survey efforts, however, it may occur within the watershed. Fishers prefer a closed canopy with a diverse stand structure, including large diameter snags and tree cavities for use as denning sites. They are associated with low and mid-elevation forests of the western hemlock zone. Fishers have been impacted by past logging and forest fragmentation, along with increased human access and disturbance patterns in western forests.

Reference Conditions

The absence of roads and less disturbance historically indicates that habitat conditions for fishers were more optimal than they are presently.

American marten *(Martes americana)* (J2)

Current Conditions

The marten is another carnivore with the potential to occur within the watershed, although it has not been documented. Martens show a strong preference for large patches of late-successional forest which include adequate amounts of larger coarse woody debris in various decay classes. No survey work has been completed for the species but suitable habitat does exist.

Reference Conditions

Although formerly the combined total percentage of the watershed in the mature and late-successional stage is very similar to the current total (67% versus 61%, see also Table 18), the current condition contains a higher proportion of edge and less interior habitat, making much of it less optimal for martens (see Seral Stage Distribution/Landscape Pattern).

Oregon red tree vole *(Phenacomys longicaudus)* (C-3 & J2)

Current Conditions and Reference Conditions

The red tree vole is the smallest and least studied of the arboreal rodents of Douglas-fir forests in the Pacific Northwest. Red tree voles find optimum habitat in wet and mesic old-growth forests (Corn and Bury, 1988). They are presumed to be almost entirely arboreal and feed exclusively on conifer needles. Logging and loss of late-successional habitat has had an effect on vole populations in the Pacific Northwest due to fragmentation and habitat loss. A comparison of the total percentage of late seral forest in the Blue River watershed between 1900 and 1995 (Maps 13 and 14) shows the overall proportion has dropped from 56% to 36%, indicating less suitable habitat now than formerly. In addition, the currently suitable habitat is more fragmented (see Fragstats Analysis in Reference/Current Condition, Seral Stage Distribution/Landscape Pattern). The vole's main predator is the spotted owl. Spotted owl pellet analysis in the H.J. Andrews Experimental Forest has indicated that the red tree vole comprises 13% of the spotted owl diet. Bury and Corn (1988) captured red tree voles at seven sites within the Blue River watershed.

Arthropods

No arthropods, as listed on Table C-3 of the Northwest Forest Plan, are suspected to occur in the Blue River watershed.

Mollusks

Current Conditions

Of the mollusks listed in Table C-3 of the Northwest Forest Plan and Appendix J2, only two species may occur in the Blue River watershed. Prophysaon coeruleum is a land slug which could occur in coniferous forests from low to mid-elevations. The southern Willamette valley is the southernmost extent its' range, and all historic locations have been absorbed by urban development. There are no known sightings on the Willamette National Forest. Prophysaon dubium is another land slug associated with riparian areas and rock slides. Rock source development could have an effect on this species.

Reference Conditions

Unknown.

Big Game

Reference Conditions

An historical perspective for Roosevelt elk population levels in western Oregon (Oregon Department of Fish and Wildlife, 1992) indicates that the species was numerous and widely distributed in western Oregon prior to the arrival of European settlers. During the late 1800s, market hunting for elk and human encroachment on elk range substantially affected elk population levels which were reduced to a few small herds along the coast and in the Cascades by 1900. In 1909, the Oregon State Legislature closed elk hunting in the state. This closure continued until 1938, when hunting was reopened on a limited basis. During the closure period, elk populations recovered substantially due to some transplanting efforts but mainly due to an increase and expansion of remnant elk populations. Population trends continued to rise into the 1960s with a dip in numbers occurring in the 1980s. Overall trends have been on the rise in western Oregon up to the present.

Rolen Silen, who was a former forester of the H.J. Andrews Experimental Forest in the late 1940s and 1950s, stated in an interview in December 1992, that there were no elk there that he remembers or even heard about. The Oregon Cooperative Wildlife Research Unit conducted a survey in the early 1940s and found five deer per square mile. When Rolen first began working on the forest in 1948, deer were seldom seen, but that changed as the logging started. It opened up areas, and "all the populations got heavy."

The Blue River watershed contains about 85% winter range with the remainder being summer range. The summer/winter range line was delineated using the 3000 feet elevation line as a base and then adjusting this line based on aspect, slope, topography, and general knowledge of big game use.

The big game model was not run on the 1900 reference conditions but a review of the projected Blue River watershed seral condition map for 1990 shows habitat conditions for big game at that time (Maps 13 and 14). In 1900, the early seral stage only made up approximately 12% of the watershed compared to 26% in 1995, however, it must be considered that this seral stage includes stands up to 30 years of age, and big game forage generally only last for 15 years after a disturbance. The highest quality areas for big game in 1900 were in the upper Cook Creek drainage on the northern ridge, the areas around lower Blue River (near today's reservoir), and the upper Lookout Creek drainages where open forage was adjacent to optimal thermal cover. Since there was less of the early seral stage historically, open forage conditions for big game have now improved.

In contrast, the cover condition historically was better than it is currently since approximately twice the acres were projected to be in a late seral condition in 1900 than currently. The size and spacing of suitable forage and cover habitat was not as well distributed as is currently the case, because there were fairly large expanses of forage, and big game are known to use the edges of suitable forage adjacent to cover in higher proportion than forage which is further away from suitable cover habitat. Roads did not exist in 1990, which would have increased the overall big game rating for the emphasis areas considerably.

Map 22: Big Game Emphasis Areas

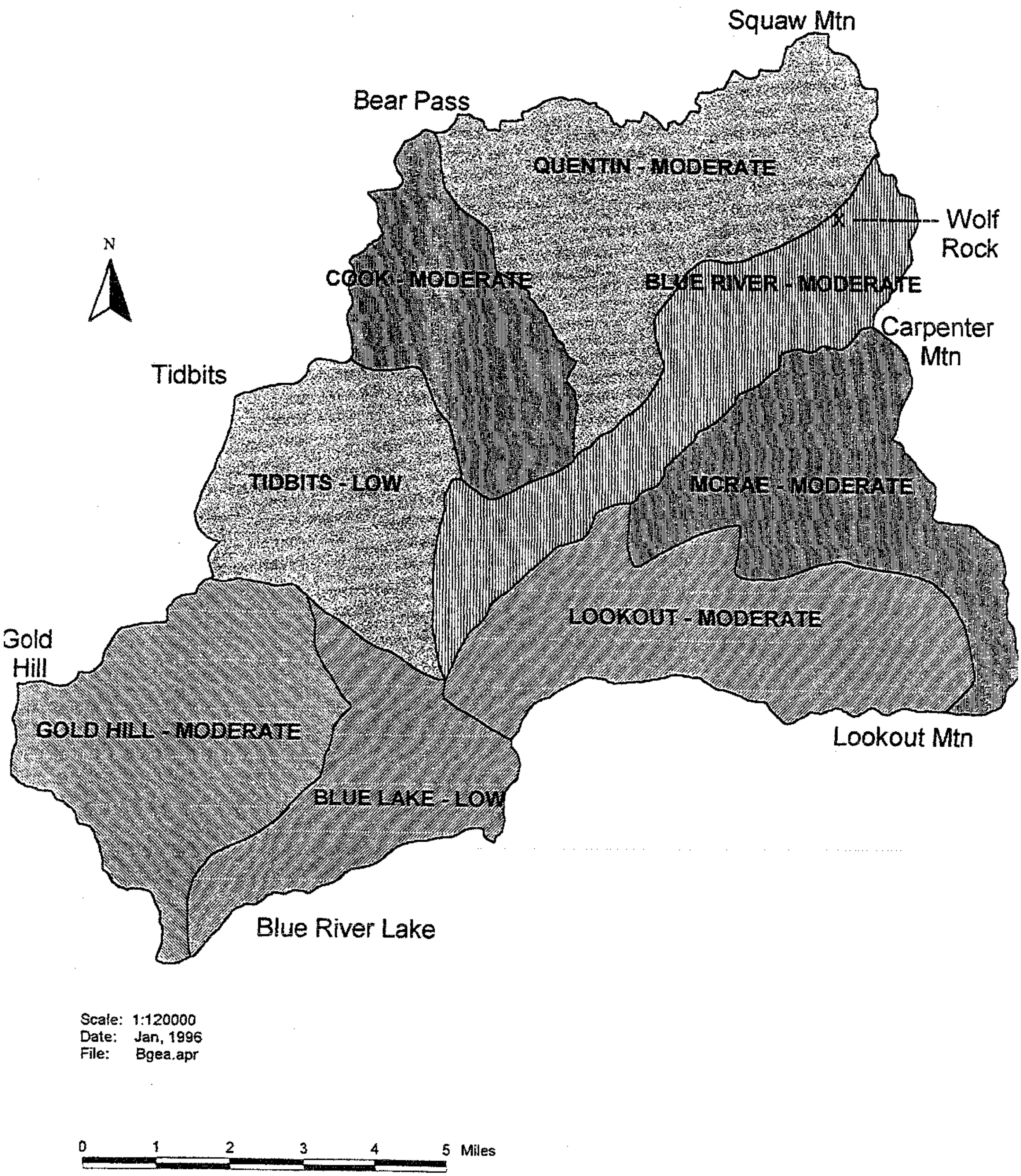


TABLE 30. Big Game Habitat Effectiveness Values for Current Vegetation Conditions

HABITAT CONDITION:	Forage Quality *	Cover Quality *	Road Density *	Size and Spacing*	HEI *	Forest S&Gs HEI*		Open Road Miles*	Comments
						Each variable	Overall		
Blue Lake (L)	.25	.66	.31	.78	.54	NA	>0.2	27.0	*This area supports elk calving and small year-round elk herd, and contains areas which are fairly good habitat.*
Blue River (M)	.32	.69	.27	.87	.48	>0.4	>0.5	46.1	*High road miles due to the presence of Road 15 in this area.*
Gold Hill (M)	.35	.58	.49	.68	.51	>0.4	>0.5	25.2	
Cook (M)	.34	.90	.39	.84	.56	>0.4	>0.5	25.2	
McRae (M)	.28	.90	.43	.86	.55	>0.4	>0.5	29.0	
Lookout (M)	.25	.92	.43	.81	.53	>0.4	>0.5	33.6	
Tidbits (L)	.27	.76	.43	.81	.52	NA	>0.2	27.3	
Quentin (M)	.32	.61	.32	.88	.48	>0.4	>0.5	58.5	

NA= not applicable

**Shaded areas show variables which do not currently meet the desired Forest Plan standards and guidelines.*

Current Conditions

As shown in the table above, the overall desired HEI value is met in all but two of the emphasis areas, Blue River and Quentin. Forage quality is somewhat low in four areas, and very low in two areas. There has been very little recent forage creation by logging due to the designation of the watershed as a Habitat Conservation Area for northern spotted owls and then with Critical Habitat designation. No fires other than small lightening strikes have recently occurred.

Open road densities are excessive in three areas, Blue River, Cook, and Quentin. Although this model was designed specifically for big game, many other species of wildlife are sensitive to high open road densities if the roads are frequently used. For amphibians and other small, less mobile animals, for example the rare forest slug Prophysaon dubium, a road may represent a non-passable barrier. Many of the rough-skinned newts which concentrate around Blue River Reservoir do not survive the traffic on Road 15. Depending on the amount of traffic, roads may impact wildlife by creating disturbance. This may increase energy needs when an animal hides, or may even eliminate an area as functional habitat if the disturbance is too great. This probably occurs during the implementation timeframe of large scale projects such as timber sales for individual species which are more sensitive to noise disturbance, for example fishers and wolverines.

Social

Heritage Resources

Reference Conditions

Prior to the turn of the century, before the first wagon roads were constructed in the Blue River Watershed, the condition of prehistoric heritage resources must've been different since there was little if any human-caused direct soil disturbance. Conversely, indirect disturbance may have been caused by erosion following human-set fires, a well-documented pattern of landscape alteration by Native Americans elsewhere in North America. Similarly, natural fires prior to the modern era weren't suppressed, and they would've had the same effect. Indeed, at one of the larger archeological sites in the watershed, there is evidence that a stand-replacement fire took place, leaving deep, burned root channels in the ground into which artifacts fell and then were reburied as the location eroded. The main difference between past and current conditions was that direct artifact and feature-containing soil displacement, a prominent aspect of logging and road construction, was not a factor. We have anecdotal evidence that after the period of intense road construction began that artifact collecting took place at a number of locations in the watershed, mostly in the lower elevations. Because no archeological sites were recorded or monitored before the early 1970's, however, our assumptions about past conditions of prehistoric heritage resources are only assumptions.

Before the discovery of gold in the Blue River area in the 1860's, use was limited to hunting and fishing parties and the search for an easy route over the Cascade mountains. Earliest records show that Mr. Sewell Smith and John Davis had homestead claims in Blue River in the 1860's or 70's (no date given). In 1895 The Sparks family purchased two adjoining homesteads consisting of 320 acres which included the present site of the community of Blue River and the McKenzie High School. In 1900 when mining was booming the Sparks family built a sawmill, hotel, and a livery stable, and by 1911, Mr. Sparks had the town site of Blue River City layed out and plotted.

In 1893 the Cascade Range Forest Reserve was established to set aside or protect the forested area along the Cascade Range. In 1907 the Cascade Range Forest Reserve was renamed to the Cascade Forest Reserve and in 1908 renamed to the Cascade National Forest with the McKenzie Ranger District being established. In 1955 the Blue River Ranger District was formed, by the year 2000 the district will merge back with the McKenzie Ranger District to create the McKenzie National Forest.

From the time the Cascade National Forest was established, lookouts were constructed to provide warnings of fires. Lookout Mountain was used in the ear 1900's before permanent structures were build. Tidbit and Carpenter Mtn. in 1915, Frissell Point in 1928, Buck Mtn. in 1934 and Gold Hill in 1935. During WW II Gold Hill Lookout was used as an aircraft observers lookout. All of the lookouts have been removed except Carpenter Mountain, which was reactivated in 1995.

Guard Stations were built at Wolf Rock (Buckhaven) in 1912, Blue River in 1934, Lookout Creek in 1935. During the 1934's a CCC forest camp was located at Bear Pass.
During the late 1800's to the mid 1900's sheep herds grazed in the Cascade meadows and in the upper areas of the Blue River drainage's.

A Boy Scout Camp and a few homesteads were located along Blue River before 1963, when the Corp. of Engineers started the construction of the Blue River Dam.

Current Conditions

Currently, there are 33 confirmed prehistoric archeological sites (as defined by the Oregon State Historic Preservation Office) within the Blue River Watershed. The majority of these locations on the landscape are characterized by the presence of deposits of chipped stone tools and toolmaking debris, and by a limited amount of simple, minimally formed grinding tools; such sites indicate resource processing tasks related to Native American hunting or plant gathering , or basecamp activities in support of hunting and gathering. Several of the documented sites in the watershed are rock carins thought to represent vision quest activities by prehistoric or early historic period Native Americans. Most archeological sites have been discovered in the course of routine heritage resource inventory of USForest Service project areas. Some have been brought to our attention by local citizens, and some were fortuitous discoveries.

Only three of the designated sites have been formally evaluated against National Register criteria and each was found to be significant . Of those evaluated sites, most are interpreted as the basecamps or work locations of prehistoric Native American hunters and gatherers.

Because of the depth and density of ground cover plants and forest duff layers within the watershed, most archeological deposits are visible only in disturbed areas such as road cutbanks, unsurfaced turnouts, trailheads, eroded areas or tree rootwads. Many of these prehistoric cultural deposits have also been "mixed" by biotubation processes, such as tree windthrow, root growth and penetration, and by stand replacement fires.

Mixing by such natural processes and the recent historic period disturbances, combined with the damp environment of deposit, has limited both the detection and the preservation of organic cultural materials, such as campfire remains, wooden and bone artifacts, and structures.

In general, it has been the lack of organic artifacts and discernible cultural structures (ie, cooking fires, storage pits, housepits, living floors, and "kitchen middens") which has hampered the science of archeology in the Blue River drainage. It is seen as a difficult place to do meaningful cultural interpretations, and thus, it hasn't received the research attention as has the Willamette Valley or desert Great Basin. This also means that preservation of what is in the archeological record is doubly important, since it is all we have and there'll probably be future analytical techniques which may prove more useful than those currently available. Monitoring of the known sites indicates that erosion is a major factor in site condition. In addition, one of the larger sites was subject to recent intense disturbance by road permit holders.

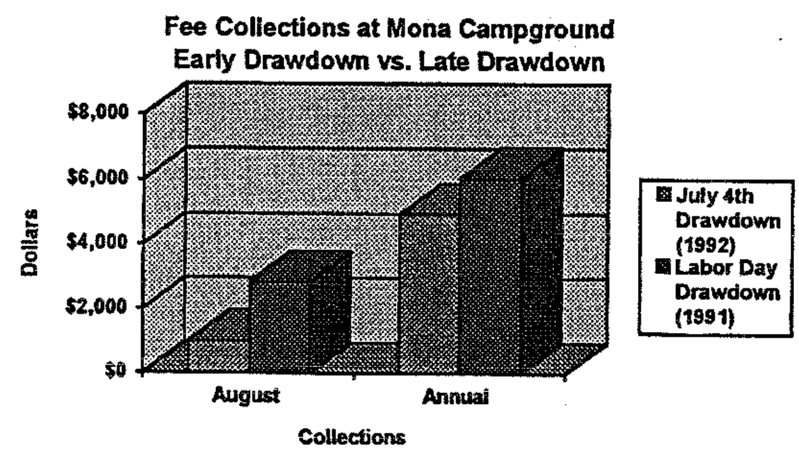
Recreation

Current Conditions

The Blue River Watershed supports a variety of recreation activities such as hiking, boating, camping, swimming, hunting, berry picking, fishing and others. Typically, most activities happen between April and September with people staying one day or for the weekend. Most recreationists are from the local community or the Eugene/Springfield area. This watershed sees less people than other places along the McKenzie River Corridor, mostly because it is not as developed. Its uniqueness therefore is outlined by the short stay of , and relatively lower number of visitors.

Most recreational activities occur in the area around Blue River Reservoir and H.J Andrews Experimental Forest. This reservoir is usually the first in the system to begin letting water out at the end of the summer. There are years when the reservoir is not drawn down early and recreational use continues through Labor Day. There are two developed campgrounds as well as dispersed camping adjacent to the reservoir. The steep sides of the reservoir and the location of the roads around it, limit the amount of camping next to it. Boating, fishing, camping, and swimming occur from when the reservoir is filled around the opening day of fishing season in April, until the reservoir becomes to low to launch a boat in August or September. When the reservoir is drawn down early (July 4) use of Mona Campground decreases. Data for two years, one with an early drawdown and one with a later drawdown are shown in Chart 21. This data corresponds with annual observations. The duration of use in this area is directly dependent on how long the water stays in the reservoir. The duration of campers is also directly dependent on how long water stays in the reservoir. During the fall of 1995 the Lookout Boatsite was developed to prolong the boating season. It may also disperse campers that have historically camped there to other areas because the number of camping spots has decreased, and a fee will now be collected.

Chart 21



Carpenter Mountain, Wolf Rock, and Gold Hill are three Special Interest Areas. Carpenter Mountain and Wolf Rock are designated because of their geological attributes. Gold Hill is designated a special area because of its cultural significance.

Carpenter Mountain Lookout was staffed during the 1995 fire season for the first time since the mid-sixties. The lookout received 300-400 visitors during the summer. Its expected with continued staffing, the number of visitors will increase in the short term.

Wolf Rock is the result of volcanic activity millions of years ago and is the largest Monolith in Oregon. It is about 1,000 feet tall. This is a difficult climb, and there is evidence that local climbers are using this rock more than they have in the past.

The Gold Hill area use to support the Blue River Mining District (see mining). Today it attracts gold panners, curiosity seekers, and people looking for crystals. Berry picking in the fall is popular here.

There are four hiking trails in this area. These trails are one mile to three and a half miles in length, so are attractive to day users. Though these trails are short in distance, two of them lead to high points with spectacular views. Another winds through old-growth Douglas fir on the H.J. Experimental Forest.

Other recreational activities include some white water kayaking on Bluer River when the volume of water gets high enough. Road 15 can be used as a through route to Santiam Pass Highway 20

A survey to determine how many kayakers use the reach of Blue River between the mouth of Quentin Creek and Blue River Reservoir was distributed through a Eugene-based kayakers' homepage mailing list on the internet. The home page called WHITE-WATER, is a mail list that had 170 subscribers at the time of the survey. Two weeks were allowed for responses and 3 were received: one person kayaked this stretch once, ten years ago; one person knew of three people kayaking the stretch twice last year; and one person does the river at least annually. This person also know of 2 others who have kayaked it in the past. Overall it does not appear to have high use. According to some of the kayakers they prefer to kayak the rivers in as natural a state as possible. If a channel is blocked by a log, they portage around it.

Blue River and McKenzie Ranger District Free Fishing Day Derby occurs at Blue River Reservoir the first Saturday of every June. This is a cooperative effort between Districts and the Big Brothers/Sisters Organization of Eugene, the Emerald Empire Northwest Steelheaders, and local merchants. The event is geared toward kids and there is usually about 50 children that participate annually. The Lookout Boat Ramp Area has been the derby location for 4 of the last 5 events because of its proximity to Eugene and the little potential of affecting wild fish populations at this location.

Mining

Reference Conditions

Gold was discovered in Blue River and in the Gold Hill area around the 1860s along the crest of the divide between the McKenzie, South Santiam, and Calapooia River drainage's. The Blue River Mining District (established in the 1870s) saw most of the mining activity concentrated in the headwaters of Quartz Creek drainage and the Lucky Boy mine, although other mines were located in the North Fork Quartz and Simmonds Creek and on the north side in the Calapooia drainage.

Within the active years of 1897 to 1924 about 18 patented claims were issued averaging from 0.5 acres to 25 acres each and over 300 mining claims filed. Around the 1900s mining had developed into a booming industry in the Blue River area with many of the patent claims having well established camps consisting of saw mills, offices, equipment sheds, boarding houses, bunkhouses, kitchens, blacksmith shops, hotels, stamp mills, processing mills, and a post office. Each claim tunnel (some with multi levels) was excavated from 10 to 1000 feet or more. Many trenches were excavated to expose gold bearing ore. Beside gold; silver, copper, and zinc were also recovered from ore taken from the mines in the Blue River Mining District. Production for the Blue River Mining area between 1896 and 1924 was estimated at about 77,514 tons of crud ore, 7,727.89 oz of gold, 17,162 oz of silver, and 257 oz of copper (these figures vary depending on which reference you read).

The extensive activity in mining between 1898 and 1912 had a significant impact on the growth and development of the Blue River community. At one time more than 250 men were employed or working in various capacities in the area.

The mining activity died out in the 1920's due to the increased cost of extracting the gold from the ore. Some minor activity in the Luck Boy mines continued into the 1960's. There are no major active operations working today.

There is no information on mining activity elsewhere in the Blue River Watershed area, but many areas were prospected for gold along Blue River and other subdrainages.

Current Conditions

The current mining activity has been minor in the Blue River Watershed area since the 1950's. Most of the mining activity has been on historic claims within the Quartz Creek, North Quartz Creek, and Simmonds Creek drainages. As of June 1994, 19 claims were registered with the Bureau of Land Management (who is responsible for minerals management). The Blue River Ranger District (responsible for the surface and environmental management) has 1 Plan of Operations, which covers improvements on the claim and 1 notice of intent, which covers future expansion of mining activities on file for the Gold Hill area. The claims consist of 12 lode (hard rock mining) and 7 placer claims (panning and suction dredging in creeks) which have minor activity or ground disturbance

In the Gold Hill area there is a quartz crystal claim, administered by the Sweet Home Ranger District, which has a considerable amount of activity with ground disturbance on both districts. During the year there are about 5-10 inquires on where to find crystals and these people are directed to this area.

It is not known at this time if a mineralogical study has been conducted for the area, there may be commercially recoverable quantities of gold, silver, copper, and other metals extending from Gold Hill to Tidbits Mountain, down Simmonds Creek, Quartz Creek, North Quartz Creek, and Tidbits Creek drainages. Digging for quartz crystals is a major draw to the Gold Hill area which is creating some ground impacts to a confined area. Recreational panning and suction dredging for gold has been on the increase the last couple of years, with interest expected to increase in the future.

Conflicts with research studies in the North Quartz Creek, environmental laws, State laws and the Mining Act of 1872 will need to be addressed and training should be a priority for anyone working with mining issues in order to work with the miners to mitigate for environmental issues.

The Ranger Station has about 10 -15 inquires on recreation panning and dredging for gold and most people are directed to the Tidbit Creek area. About 5 inquiries are received on where a person can prospect and possibility stack a claim are answered by the mineral specialist throughout the year.

Research

Reference Conditions

The 15,700 acre Lookout Creek watershed was designated as the Blue River Experimental Forest in 1948. The name was later changed to the H.J. Andrews Experimental Forest in memory of Regional Forester H. J. Andrews, who was killed in an auto accident.

The initial emphasis of research at the Andrews in the 1950s was to learn how to convert old forests to new forests in an efficient manner. Attention shifted in the 1960s to look at the effects of forest cutting, particularly on soil and water. The 1970s ushered in a new era of ecosystem science, focused initially on old-growth forests.

The emphasis and scope of the research program on the Andrews has changed and grown markedly over the years. The emphasis on ecosystem science continues today. The Andrews is managed for the purposes of research and education. Experimental watersheds, plots, monitoring stations and control areas cover virtually all of the Andrews. The vast majority of research conducted at the Andrews Forest are nonmanipulative, observational studies; however, studies requiring manipulation of experimental variables are essential to answer some questions and are part of the Andrews Forest research program. Physical facilities at the Forest have greatly expanded in the last 5 years. Currently there are three dormitories capable of housing approximately 60 individuals, a new office and laboratory building, and construction of a new conference room/classroom suitable for groups of up to 100 people is scheduled to begin in 1995.

Studies have been undertaken on the structure and composition of forest communities, the vertebrates and invertebrates that inhabit the forest, aquatic ecology, decomposition, nutrient cycles, long-term ecosystem productivity, disturbance patterns, fungi, lichen, and the relationships among these features of the ecosystem. A long-term measurements and permanent plot program provides critical baseline data for vegetation, fish, hydrology, climate, and erosion (Research and Learning Assessment, Cissel). At present there are over 100 studies in and around the Andrews Forest. The studies include basic science, long-term environmental measurements, the Long-term Ecological Research Program (LTER), management studies and development and demonstration projects.

The Andrews is administered under Memoranda of Understanding among the Pacific Northwest Research Station, Oregon State University, and the Willamette National Forest. These three institutions provide the personnel, organization, and resources to conduct the Andrews research program. A wide variety of cooperating organizations also contribute to the Andrews program. A Board of Directors composed of a member of each primary institution makes policy and administrative decisions for the Forest. Open meetings are held monthly where participants from all three institutions and cooperating organizations are invited to exchange information, review research proposals, and shape the direction of the program.

A number of interwoven programs provide the resources for the research program on the H.J. Andrews Experimental Forest. Major support comes from the LTER (Long Term Ecological Research) program of the National Science Foundation (NSF). The Andrews is a coniferous forest site in the LTER network of 18 sites located throughout the United States and Antarctica. The Pacific Northwest Research Station, Oregon State University, and the Willamette National Forest all provide baseline funding and salaries to support the Andrews program. Special programs, such as the Forest Service New Perspectives Program, support specific aspects of the overall program. Numerous project-specific grants come from a wide variety of agencies and organizations (e.g., NSF, NASA, EPA).

Cascade Center for Ecosystem Management

The Cascade Center for Ecosystem Management is a research and management partnership formed in 1991 as an evolutionary outgrowth of the Andrews program. The increasing importance of larger spatial scales, the expanded effort to rapidly incorporate research findings and concepts into management practices, and a growing communication and education program led to the recrafting of the Andrews program as the Cascade Center. Today the Cascade Center manages a program of ecosystem research, development, demonstration, and education throughout much of the Adaptive Management Area. Projects are aimed towards improving both our understanding of ecosystem function and our application of that knowledge through ecosystem management.

The production and dissemination of new information drives the Cascade Center program. The process begins with research, management or public questions. Projects are designed to answer questions, or to demonstrate results in an applied context. Depending upon the nature of the question and the resources available to address the question, projects take a variety of forms. Research projects are designed to answer science questions and produce scientifically credible results with a degree of statistical rigor. Management studies and monitoring projects use scientific methods to address questions concerning the effectiveness of management plans and actions. Demonstration projects incorporate new information and concepts into management practices. Demonstration projects test the operational feasibility of new practices, and serve a critical role as a forum to exchange information and promote dialogue. The primary product from Cascade Center projects is information. A variety of methods are used to exchange project results, including tours, workshops, presentations, publications, and interactions with the media. Information is used to adapt practices on a variety of scales and to produce a new generation of questions. New practices are monitored to judge their effectiveness.

The Adaptive Management Area is in many ways analogous to the H.J. Andrews Experimental Forest. Both are land allocations with management objectives oriented towards learning and adaptive management. However the mandates of the Adaptive Management Area are much broader, and include development of innovative approaches to solving social and administrative problems. In addition, the Adaptive Management Area is an order of magnitude larger than the Andrews Experimental Forest. While the Cascade Center conducts projects throughout the Adaptive Management Area, historically the focus has been on the Andrews and the Blue River Ranger District. The Cascade Center and the Andrews Forest can go a long way towards meeting some of the objectives for the Adaptive Management Area.

Chapter IV Interpretation

Erosion Processes

In Landform Blocks 1,2, and lower reaches of 3, the dominant mass wasting process is rapid debris avalanche/flow failure induced by high intensity storm events in conjunction with timber harvest and road building. These type of events input elevated levels of sediment into stream in "pulses" rather than "chronically", such as large earthflows in Landform Block 4, or marginal road surfacing.

Lamberti et.al. (91) concluded that in this instance {pulse related} "Disturbance size and timing thus favored rapid recoloniztion of the affected reaches. In general, this rapid recoloniztion may reflect some preadaptation to episodic disturbance imparted by adaption to physically similar but more regular and frequent disturbance such as floods.

Anderson, in his 1992 paper on the same {pulse related} event noted in regard to population recovery that " While the perturbation was due to clearcutting, even in pristine streams a similar effect could result from beaver activity, wildfire, or debris torrents" and that " The debris torrent at Quartz Creek denuded 300m of stream bed and the adjacent riparian strip but it was recolonized by a major component of the typical macroinvertebrate community within a few months. This level of disturbance appears to increase biodiversity by opening up habitat patches and adding to the complexity of the physical habitat as well as to the variety of autochtonous and allochthonous foods." The natural interval for these type of failures is about 50 years, however clearcutting and road construction can increase this return interval considerably, thereby making stream recovery difficult.

Mills, in his 1983 study of the Lookout Creek earthflow determined that it was moving at a rate of almost 5 inches per year over a two year period. A wood sample for 77 feet below the surface in an exploration bore hole was Carbon 14 age dated at >40,000 years. This indicates that this type of slope failure typical of this landform block is "chronic" producer of stream sediment rather than the "pulse" type typical of the debris avalanche failures in shallower soils of the other landform blocks.

Wallenstein (95) noted that "The H.J. Andrews Experimental Forest was cut heavily in the decades of the 1950's and 1960's. Consequently, it suffered numerous landslides in severe storms of this period, including 43 slides from a series of strong storm events in December 1964 and January 1965" and that "Forest cutting was minimal in the Upper Blue River through the 1950's but was heavy from about 1960 to 1990. This unit did not suffer as heavily in the strong storms in 1964, but produced more landslides during a 1986 storm event."

He did not conclude from this limited study what exactly were the other limiting parameters that could be used to predict landslide distribution and control but he said "The results indicate that physical controls on landslide occurrence may be more complex than was assumed for the purposes of this study. There may be other physical controls that play an important role, such as geomorphic setting, hydrological features, and geologic structure. It is likely that one or more of these factors is/are not randomly distributed with respect to slope."

Other properties that have a much more direct influence on landslide behavior are soil shear strength and ground water fluctuation along with slope geometry. Uncontrolled wildfire can be a direct controlling agent influencing the first two. Soil Transfer rates were calculated using the first two properties with the historical fire return interval and the probability of failure. The rates were calculated for reference conditions and then compared to those measured during high intensity road construction and logging during the period 1945-1979, Marion (81) and the most current conditions between 1990 and present. This comparison displayed that the natural range of variability for soils transfer rate to streams due to mass wasting is around 52 to 216 cubic meters/square kilometer/year for Landform Block 3, which is used as the quantitative index reference area. During the periods of high intensity logging and road construction, slope failures related to clearcutting was over ten times the estimated historical reference condition rate for medium intensity wildfire which has similar characteristics as clearcutting, and three times the rate for high intensity wildfire. During the past 5 years, the rate has dropped below the natural background rate due to elimination of road building, reduction in harvest, and fire suppression. This agrees with Wallenstein's projections for watershed recovery and land use effects on landslide hazard.

Clearcuts, road construction and high intensity wildfires on SRI 21 soils and complexes on slopes greater than 70% can significantly increase this rate.

Most road related slope failures are from side-cast construction on slopes greater than 70%.

There is a significantly smaller number of road-related acres or events of mass wasting compared to natural events, however, sediment delivery volumes from road surfaces is unknown.

Rock aggregate fro road surfacing has generally been of high quality in the watershed, which has kept road surface sediment contributions to a minimum, however, in the Tidbits and Cook-Quentin Creek drainages continual ravel from road cutslopes require yearly ditch cleaning.

36% of the slope failures that resulted from the storm damage of the 1986 event were caused by plugged culverts. Another 41% was a result of saturated road fills.

The probability of a large subduction earthquake off the Oregon coast with a magnitude 8.0 or greater is high, but the distance from the probable focus to the watershed will provide attenuation which will reduce damage. Blue River Dam has been inspected and designed to withstand any probable earthquake loads, however, local crustal generated earthquakes can be a hazard and can cause landslide and debris avalanche dams.

Vegetation

The current vegetation pattern and distribution within the watershed is a result of clearcut harvest and wildfire. Historically vegetation patterns were primarily created by wildfire both upslope and in the riparian. Fire has played a role in influencing riparian vegetation in all Landform Blocks except perhaps in Lookout. For Landform Blocks 1,2 and 3 fire played a significant role in returning many of the lower order stream channels to early seral stages. These stands would typically become established with conifer seedlings, with perhaps a fringe of hardwoods along the banks depending on the moistness of the site and the seed source. Under a natural regime the Tidbits drainage is the only drainage that would be dominated by hardwoods within the riparian areas of these lower order streams. This is due to the naturally high frequency of debris slides and debris flows which are triggered during periods of large storm events. The pattern and distribution of riparian vegetation was also influenced by floods.

The higher order stream channels within Landform Blocks 1,2 and 3 would remain too moist to carry a stand replacement fire. Thus, these riparian areas would generally maintain mature stands of conifers with gaps created by large floods, wind, disease, and insects.

Landform Block 4 (Lookout) would also have some part of the lower order streams in early seral condition, though probably less than in the rest of the watershed. This is due to the longer fire return interval and the low frequency of debris flows and debris slides. The exception is the vicinity of Lookout Mountain which is subject to debris slides. Some of the lower order streams may be dominated by hardwoods where associated with earthflows or landslides. Along the higher order streams, fire would be less likely to significantly influence middle or late seral stands. Depositional features dominated by hardwoods as a result of flood events would more likely occur in this geomorphic block due to the wide, unconstrained valley.

Overall the change in the vegetation pattern is from one of large patches with a high amount of diversity and variability to a fragmented landscape with many managed stands lacking some structural features. Most of the managed stands from the 1950's to the mid 1980's lack snags and a smaller percentage lack down wood. The percentage distribution is within the range of variability as defined by REAP.

The occurrence of non-forested areas was probably greater in the past when fire played a dominant role in shaping the vegetation. Conifer encroachment has been occuring in meadows and sitka alder communities although the extent is not known at this time. There has been harvest adjacent to many of the non-forested areas resulting in open conditions surrounding these areas. Roads have been built through some of the sitka alder communities. Where harvesting and roading has occurred it has resulted in a reduction in size of these plant communities and potentially a change in the microclimate. The alterration of microclimates through increased exposure to wind, sunlight, precipitation and temperature conditions can in turn alter species composition and distribution. There is no current data on change in plant communities and no specific historic data to compare it to.

Aquatic habitat is relatively uncommon in the watershed. There are a few small wetlands and ponds within harvest units. The change in seral stage from late to early successional has resulted in more open conditions surrounding these areas and a potential change in species composition. Data is not available on the condition and plant communities present prior to harvest. It is also unkown if the hydrology of the sites were changed through this change in vegetation. Much of the mature forest surrounding Wolf Lake has been harvested and is currently in an early seral condition. At the turn of the century about half of the lake was surrounded by old forest and half by young forest.

Habitat for 20 rare species, those species that have limited geographic range or highly specific habitat requirements, occur in the watershed. Current surveys are limited and historical data is non-existent for these plants.

Non-native weeds have increased in both number of species and distribution since the settlers in the early 1900's. Harvest operations, road construction, and livestock grazing all have contributed to the spread of weeds in the watershed. Most of the weed populations are located along road systems, landings, in early seral harvest units, along trails and in the campgrounds at Blue River Reservoir. Only one of the species is classified as a "new invader" and is the highest priority for control. This is spotted knapweed and it occurs adjacent to Forest Service road 15.

During the 1970s and 1980s there were many experimental plantings in the drawdown zone of the reservoir. A variety of native non-local species were planted as well as ornamental horticulture varieties of shrubs and trees. Many of the non-local species did not survive. Recently the emphasis has been on using native species. Seed and transplant plugs from two sedge species that grow at Fish Lake have been used as well as native willow. These species appear to be the most successful in terms of survival and also meet the native seed policy.

Survey and Manage Species: fungi, lichens, bryophytes and vascular plants

Harvest of old-growth and riparian forests and associated road building has reduced and fragmented the amount of habitat available for many of the survey and manage species. Past silviculture practices typically fragmented late-successional stands, reduced duff and large rotting logs on the forest floor and emphasized homogeneous conifer plantations. Early harvest of vegetation along many of the creeks have resulted in an increase of early seral red alder stands. A lack of hardwood and conifer diversity in riparian zones decreases species diversity, particularly epiphytic bryophyte and lichen species.

The Mann/Blue River/Wolf and the Cook/Quentin geomorphic blocks have the largest percentage of dispersed early seral units (65%) and fragmentation in the watershed. These units result in extensive older forests edges affected by an altered microclimate. Harvest increases stand edge fragmentation, this zone of edge influence can change light, air and soil temperatures, wind humidity, and tree mortality from 200 feet to more that 790 feet into the forested stand (Chen 1995). Many of these species are dependent to interior old-growth habitat.

The extremely slow growth rates and long periods required for certain late-successional and old-growth associated species to colonize younger stands emphasizes the importance of linkage to older stands. Unsuitable habitat in fragmented areas may prevent gene flow and colonization into younger stands. Neitlich's (1993) study in the H. J. Andrews, found in forty year old stands, conifers five meters from old growth trees had a greater lichen species richness and biomass then the interior of the young stands.

The majority of the mature conifer stands in the watershed average 150 years old. Neitlich's (1993) study in the H. J. Andrews found epiphyte lichen biomass to increase significantly in forest stands 140 years old. Nitrogen-fixing lichens are most abundant in old-growth forests and are virtually absent from young stands (Neitlich, 1993). Lobaria oregana accounts for over half of the total epiphyte biomass in old-growth Douglas fir forests (Pike et al., 1977) but it is much less abundant in younger forests (Neitlich, 1993). The biological and economical importance of lichens are of great significance. Nitrogen fixation levels by lichens in old-growth forests have been found to be approximately 145 times those of 40 year old stands and contribute approximately 16 pounds of nitrogen per acre per year to the forest ecosystem (Neitlich, 1993). Lobaria oregana and L. pulmonaria are found in mature and late-successional forest stands throughout the watershed. Eighteen of the twenty-six nitrogen-fixing lichen species in the survey and manage list are documented in the H. J. Andrews. Potential habitat for many of these species is present in older conifer stands in the watershed, however only the H. J. Andrews been extensively studied.

Hydrology

Drainages that had a high percentage of harvest units or mid-slope roads located within potentially high contributing areas to rain-on-snow, are considered to contribute to increased peak flows. Blue River Face and Quentin Drainages had both harvest units and mid-slope roads located within high contributing areas, likely resulting in increased peak flows. Tidbits drainage also had a large area of harvest units located with high contributing areas. Cook and Mann drainages had harvest units located within high contributing areas to a lesser degree than Blue River Face and Quentin, but probably still cause increased streamflows. Roads may increase peak flows independent from harvest units, and may be causing increased flows in Mann, Lookout, and McRae drainages.

ARP is a relative measure of the hydrologic recovery used by the WNF. This is the percent of the watershed considered to have large enough trees to intercept and hold snow within their canopies. A threshold value has been calculated that should be met in order to ensure that peak flows are not augmented and channel damage does not occur. Blue River Face is the only small drainage to have the most probability of experiencing peak flows. The ARP level is 78%. All other Landform Blocks and smaller drainages are above 80% and above the threshold value.

Water Quality

Historically summer stream temperatures would have been relatively cool during periods of high base flows and moderately warm summer air temperatures. Climatic conditions of low base flows coupled with unusually high air temperatures would have caused summer stream temperatures to be higher than average. Fires that consumed extensive riparian vegetation would have allowed for increased solar radiation input, thereby causing increased summer stream temperatures.

An analysis of the current situation used data for Lookout Creek. The results of the analysis displays that in all probability environmental factors, base flows and air temperature, and not management related activities, are driving summer stream temperatures to exceed the proposed state standards. Data from Blue River is to be analyzed as well but is not complete yet.

Stream Channel and Fish Habitat

Landform Block 1

44% of the riparian (as defined in the ROD) has been harvested and 2% roaded. Class II and IV streams, along with the area surrounding the reservoir have been the most heavily managed. Several of the smaller drainages have higher percentages harvested than the overall Block. These include Mona, Reservoir Face, North Fork Quartz, Scout and Simmonds. Simmonds and North Fork Quartz Creeks have been harvested along the main stream channels and have had roads built along the channels. This has resulted in a decreased ability of the riparian area to provide large wood, stability and shade to the channel. This is particularly true for the lower half of the North Fork Quartz stream length, which was heavily logged. The upper sections of the channel were left relatively intact, providing good amounts of wood to the upper channel. Wood in the channel has often been pulled out. Mining as well as harvest has played a role in this Landform Block. As trees within the riparian continue to grow improvements are being seen. Stream shading and temperatures are recovering. However there does not appear to marked recovery of the riparian areas and water quality in and near mine tailings in Quartz Creek.

Current sediment delivery to streams in this block is due to road related failures, particularly in Tidbits Creek. Full bench construction on steep slopes has resulted in chronic input of sediment. Unlike the debris slides and debris avalanches which historically pulsed various sized sediment and large wood into the streams, chronic input of sediment associated with roads in the Tidbits drainage are fines, gravels, and cobbles that dribble into the stream virtually continuously. This road related sediment may fill some pools in Tidbits Creek, however most sediment is probably flushed downstream into Blue River and Blue River Reservoir. Mass wasting has also resulted from harvesting in the Tidbits drainage, contributing large quantities of sediment to the stream channel. Old abandoned logging roads up the bottoms of Simmonds, Quartz and North Fork Quartz Creeks provided sediment to the channels especially during construction. Harvest of riparian vegetation and yarding down the channel bottoms of Simmonds, Quartz and North Fork Quartz caused extensive erosion of the floodplain and riparian areas. Riparian areas that were once dominated by conifers are now hardwood stands.

The quality of fish habitat has declined as a result of these management activities and fish abundance and diversity has decreased. Simmonds, Mona, Tidbits and Ore Creeks have decreased amounts of wood in the channel and there is a decreased potential for significant input of large wood in the near future. North Fork Quartz and Quartz Creek have the most in stream wood on average due to the intact older forest adjacent to the channel in some sections. As a result of the harvest of conifers adjacent to the creeks stream shading was decreased but it is currently recovering. Since most of the shade is being provided by deciduous trees, and they provide little protection from cold winter weather, winter stream temperatures may be colder than natural stream temperature variation.

Embeddedness is high in Quartz Creek and North Fork Quartz Creek due to roads, logging and naturally caused erosion. Since spawning gravels were relatively clean of fines, the fines are most likely limiting fish production by decreasing rearing habitat. In Tidbits Creek, cobble embeddedness is low. Fines are readily flushed from the creek due to the lack of in stream structure to slow the water.

The mining activities may have affected water quality and, in turn, the health of the aquatic ecosystem in Quartz Creek. A metallic liquid, potentially mercury, was seen in the creek
Fish population interactions have decreased due to the placement of impassable culverts at the mouths of Ore and Quartz Creeks. These culverts have isolated populations of cutthroat trout and excluded rainbow trout upstream migrations. The Barriers resulting from culverts in Ore and Quartz Creeks prevent migration of fish from Blue River and its tributaries. Blue River Dam blocks interaction of Simmonds Creek and McKenzie River populations with those in tributaries upriver. The Dam also intercepts downstream flow of large wood and bedload affecting down river habitat. The reservoir has severely change 6 miles of river habitat.

Landform Block 2

This area has the lowest percentage of managed riparian area of all four blocks, with 26% harvested and 1% roaded. The breakdown between the two drainages are nearly identical for management in riparian areas of all stream classes. However, the Class II riparian areas of Cook Creek have been more heavily harvested than Class II streams in Quentin.

When compared with other streams in the watershed the average large wood per mile in Cook and Quentin Creeks is moderate to low. This may be due to the low amount of slope failures. This area contains relatively fewer site specific slope failures than any of the other Landform Blocks. There have been few harvest and road related failures causing stream channel scour. This is due to the relatively low harvest rates, consideration of road placement, low road density, and the fact that much of the upper portions of these drainages were unmanaged during the 1964 flood. Road related slides triggered by the 1964 flood provided sediment that aggraded the channel bottoms of Cook and Quentin Creeks, with accumulation principally at the mouth of Cook Creek.

There is more large wood in Quentin than in Cook Creek. This may be due to impacts that logging activities have had upon Cook Creek or it may also be due to the addition of large wood resulting from a large, stream-side slide originating in forested terrain in Quesntin Creek.

Stream canopy shading appears to be naturally low in both Quentin and Cook Creeks due to clearing of riparian vegetation during high flows and also due to the southerly aspect of the drainage.

Landform Block 3

This block along with Block 1 has had the most management in the riparian areas. 44% of the riparian area has been harvested while 4% is in a roaded condition. All smaller drainages within this block have been heavily managed.

The area contain 28% of the total natural failures, 18% of the road failures and 36% of the post harvest failures in the watershed. .This block also contains 2 ancient landslides with over 400 acres, and 9 areas of unstable soils containing over 500 acres. Mass wasting of harvest units have generally occurred in the lower sections of Blue River, triggered by the 1964 flood. Most of the sediment generated by these slides was transported down into what is now Blue River Reservoir, with some local deposition within the river at small meander bends. A debris flow scoured Mann Creek to bedrock when a small earthen dam located on private ground failed in the mid 1980s.

There has been a significant decrease in pool habitat in Mann Creek between 1975 and 1991. This is likely due to pool filling from accelerated erosion and sedimentation and debris torrents. Mann Creek also has low amount of large wood due to the amount of management in riparian areas.

Forest Service Road 15 severely impacts the quality of aquatic habitat in lower Blue River by reducing potential large wood input, channel/floodplain interactions, and stream canopy shading. The proximity of the road to the river between the reservoir and Quentin Creek has also facilitated wood salvage efforts in the past, further decreasing the amount of in-stream wood. There has also been a significant decrease in pools within Blue River between 1937 and today due to the effects of natural and human accelerated erosion. The decrease of the amount of large wood in the river probably doesn't play a major role in the decrease in pools. Similar low pool per mile rates occur in similar river reaches with significantly different amounts of in-stream large wood.

The populations of wild trout within Blue River has likely declined since the introduction of hatchery rainbow trout. Hatchery fish out-compete and displace wild fish. Genetic interaction may be occuring. Fish populations within this landform block are genetically isolated from those in the McKenzie River by the Blue River Dam.

Although the release of Chinook salmon juveniles in the reservoir to supplement down-river fisheries restores the presence of that species with the watershed, the aquatic ecosystem would more directly benefit from the release of adult Chinook. Their spawned-out carcasses provide rich nutrients to the aquatic ecosystem.

<u>Landform Block 4</u>

Relative to the other 3 blocks within the watershed, the riparian areas in this block are in a less managed condition. Total harvest within riparian areas is about 28% which is similar to the amount in Landform Block 2. Harvest within riparian areas has occured mainly in those areas adjacent to Class IV and Class II streams and the harvesting is split nearly equally between Lookout and McRae smaller drainages There is a significant portion of each of these areas that has remained unmanaged. Roads within riparian areas account for 3% in Lookout Creek and 2% in McRae Creek.

Both road and harvest related mass wasting has contributed sediment to Lookout Creek. The amount of sediment delivery into the creek was high during the 1964 flood due to the relatively large number of harvest and road acres in existence prior to the 1964 flood, and the amount of unstable, earth flow terrain on which the roads and harvest were located. The large volume of sediment and debris provided ample material for devastating the riparian vegetation on the wide, unconstrained valley bottom, and creating new floodplains through deposition of sediment. With the upper, more constrained sections of Lookout Creek, erosional material moved downstream tot he lower gradient, wider valley bottom section, with local accumulation within the upper channel reaches.

Logging and road building have decreased the amount of large wood available to the stream. The result is less stream energy dissipation, habitat complexity, nutrient retention, spawning gravel collection, and pool scouring in Lookout Creek. Pools have decreased in quantity in the lower 2.3 miles of Lookout Creek between 1937 and today. This is due to the additions of sediment related to management activities. Because pools are important holding and rearing habitat for adult and sub-adult cold water fish species, their relative quantity can be used as an index to habitat quality.

Above Forest Service Road 360, Mack Creek is unmanaged and in-stream wood levels average 250 pieces per mile. The amount of large wood per mile in this section of the creek was used as a reference point in an attempt to characterize wood levels in other similar sized streams in the watershed as high, moderate or low. The lack of management adjacent to the Mack Creek, the long fire return intervals and the frequency of natural landslides acting as a wood delivery mechanism all contribute to the levels of wood in Mack Creek.

Species and Habitats

Snag and Log Habitat
Logging activities have reduced the levels of snags and logs in the watershed from historic conditions. This is especially true in the Mona Scout, Lower Blue River, Upper Blue River. South Blue Lake and Mann Creek subwatersheds.

Down logs densities vary considerably. It is uncertain exactly how much the current condition has changed from the past but logging did reduce down wood in harvested stands from about 1975-1986.

The following interpretations are based on the analysis using the habscapes model. The conditions described in Chapter III are generalizations based on guilds. There may be differences for some species which have specific habitat conditions not well represented by a guilding process.

Early Seral Habitat
The watershed currently contains 26% early seral habitat which is within the range of historic variability. This habitat has changed from being created by fire to being created by logging. Although structural elements were lacking in areas logged from 1950-1986, they are currently being prescribed for all harvest areas. The length of time areas remain in early seral has declined over the historic timeframe due to aggressive reforestation of logged and burned areas. At this point the trend is for a continuation of early seral with more structure. It will take several years of leaving amounts of structural components on the high end of the range of natural variability to obtain the landscape and associated population levels which existed prior to logging activities.

Late Seral Habitat
Currently late seral habitat occupies 37% of the watershed. This is within the range of historic variability, but on the low end. The viability of species associated with late seral in this watershed is moderate to high for large home range species. There are however concerns for the low mobility, small home range patch species. The concern is not with the total amount of habitat but for their dispersal capabilities in the Mann and Wolf drainages. There is also a concern about connectivity to the north. 61% of the watershed is highly suitable for large home range, mosaic species, which is concentrated in Lookout, Cook, Tidbits and Simmonds Creek areas.

Contrast Species
About 20% of the watershed is providing edge habitat for contrast species with large and medium home ranges. There is about 13% suitable habitat for the small home range species. Habitat for these species appears to be fairly concentrated with a few gaps across the watershed. There are only four species in this guild, two of which have been confirmed in the watershed. The others, flammulated owl and Lewis' woodpecker are generally found on the east side of the Cascades and their generally preferred habitat is not found in the watershed. There is no concern for adequate distribution and abundance of habitat for any of the contract species.

Generalists
There is no concern for habitat generalists. They can use the variety of seral stages that exist or will exist in the future. Structure is important since many use snags for breeding and benefit from down woody material.

Non-forested Habitat
The habitat is uncommon in the Blue River watershed. In some areas, it has been decreasing slightly due to fire suppression and resulting conifer encroachment in meadows. Meadows in the watershed are located mainly in the higher elevation ridgetops. If fire suppression continues, there is a concern that natural meadow communities that evolved with fire will change, which could impact wildlife species

which use this habitat. Meadows are a longer term early seral habitat than logged areas which are reforested, and reduction in their quantity may affect wildlife in the long term.

Dispersal Habitat

Between mature and late:

The main difference in dispersal conditions between the past and now is that the remaining mature and late seral stands have a patchier distribution. Thus while there may be more routes of habitat which appear to be suitable, these routes are narrower, have more edge effects and may be less effective

Between early and young:

More is provided currently than was present in 1900.

Chapter V Recommendations

The following chapter summarizes the answers to the key questions by describing key findings, causal mechanisms, and recommendations that are responsive to the key questions and findings.

Where appropriate the data is presented in chart form. For the issues related to the AMA the answers to the key questions are also the recommendations for future actions and they are presented in a list format.

Issue#1: AMA

QUESTION#1: What activities or projects are most likely to contribute to the goals of the AMA and involve researchers, managers and the community?

Landscape Design Process.

Site specific prescription development for forest management.

The reservoir revegetation program within the drawdown zone of the reservoir.

Riparian area management prescriptions including riparian silviculture as well as short term restoration projects.

Issue#1: AMA

QUESTION#2: What questions from the CCAMA research and learning assessment could be further developed and addressed within this watershed?

The following questions from the Research and Learning Assessment appear to be well suited to the Blue River Watershed. Opportunities exist within the watershed to address these questions:

Social Interactions, Human Uses and Community Goals

◊ What kinds of public involvement techniques will help ensure that all interested voices are heard up front and throughout the process?

◊ What is public understanding and acceptance of managing within the range of natural variability?

◊ Fire as an ecosystem process and concerns over smoke:
  * What level of smoke resulting from prescribed natural fire is socially acceptable?
  * Are people willing to accept relatively frequent occurrences of small amounts of smoke to avoid the larger amounts of smoke resulting from less frequent catastrophic fires?
  * What is an acceptable balance between allowing fire to play a more "natural" role in the ecosystem and smoke?

◊ What is a meaningful and useful definition of sustainability that includes both social and ecological objectives, and where in the Adaptive Management Area can it be implemented?

American Indian Relations

- ◊ What are effective ways of learning about and enhancing American Indian values? The name change process for Squaw Mt. Might provide an opportunity to learn and integrate some historical understanding.

- ◊ How can American Indian knowledge and values be integrated into research projects?

Economics

- ◊ How can we encourage local processing and value-added products from resources harvested from the forest?

Landscape Pattern

- ◊ What type, size, and location of corridors meet wildlife objectives? Are corridors effective?

- ◊ How do landscape patterns affect the quality of wildlife habitat? (e.g., corridors, fragmentation, etc.)

- ◊ What output levels are linked with alternative management strategies?

- ◊ What are measurable objectives of ecosystem management?

- ◊ How do we establish and link objectives at different spatial and temporal scales?

- ◊ What is the effectiveness of the default riparian reserves for dispersal/migration?

Disturbance Processes and Ecosystem Management

- ◊ What kinds of disturbance patterns, especially fire, historically occurred in riparian areas?

- ◊ What is the relationship of fire regimes to landforms, plant communities or other environmental gradients?

- ◊ What was the historic role of low-severity underburns on snag recruitment?

- ◊ What are efficient approaches to protecting Late Successional Reserves? What mix of fuel reduction and fire suppression meets Late Successional Reserve objectives in an efficient manner?

Biodiversity

- ◊ What is vertebrate response to disturbance during operations; e.g., tree cutting, planting, road building? e.g., bird nesting.

- ◊ What is the role of large woody debris in nutrient/water cycling; providing dispersal/connectivity for small mammals, fungi, bryophytes, etc? (question relates to salvaging in Late Successional Reserves)

- ◊ What affect does underburning stands of varying ages and structure have on wildlife?

Spotted Owls

◊ What is the influence of forest management on spotted owl movements and home range, survival and reproductive rates, population demography, and seasonal diets?

◊ How do changes in forest structure affect the abundance of fungi, small mammals, and spotted owl prey?

Riparian Management

◊ What is the effectiveness of designated riparian area widths (edge effects, microclimates, wildlife, plant populations, etc.)?

◊ What is the effectiveness of the default riparian reserves, and how can/ should their boundaries be adjusted to increase their effectiveness? What criteria should guide riparian reserve boundaries?

◊ What is the effect of reintroducing adult spring chinook in Blue River and the South Santiam River above the dams? Monitoring can include nutrient cycling and a comparison with the current practice of releasing juveniles above the dam.

◊ What would be the effect of additional over-wintering habitat upon trout populations

Stand Management

◊ How can we imitate natural stand dynamics?

◊ What silvicultural practices accelerate/enhance the development of late-successional characteristics?

◊ Is fire an effective tool to promote development of late-successional forest characteristics? Best opportunities may be found in mature (100-150 year old) stands.

◊ What are the benefits/detriments of scattered and/or aggregated green trees vs. intact patches?

◊ What is the effectiveness of underplanting/density control versus natural recovery after thinning, burning, salvaging of blowdown, etc. on stand development?

◊ What are the effects of the conversion of hardwoods to conifers in riparian systems (ie nutrient input, etc) and upslope (retention in harvest areas)?

Issue#1: AMA

QUESTION#3: What opportunities exist within the watershed for providing local forest based employment and for producing a variety of forest products?

Special Forest Products are available for commercial harvest throughout the watershed. These include beargrass, salal, and oregon grape.

Wood products in a variety of forms from firewood to small wood to sawtimber will be available. A landscape design will be developed based on the findings of this analysis and specific locations will be identified at that time. There is potential for any of these products to enhance local employment.

Electricity from the Blue River Dam.

Knowledge. The Blue River Watershed as part of the Central Cascades AMA has as a primary output sharing of knowledge gained from the partnership between research and management. This has great potential to be expanded within the public sector.

Restoration projects ranging from road rehabilitation or obliteration to placing wood structures in the streams.

Stand management activities from planting to thinning.

Eradication of noxious weeds could be a Jobs in the Woods activity or a YCC project.

Issue#1: AMA

QUESTION#5 What ecological processes or conditions are important to consider in landscape design?

ANSWER FINDINGS	CASUAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Disturbance regimes in riparian vs. riparian reserves as defined in the Northwest Forest Plan. Fire is an important disturbance resetting vegetation in riparian areas in Landform Blocks 1-3. Floods were important in resetting riparian vegetation in Block 4.				• Continue on the ground and photo interpretation work to better identify frequency, extent and intensity of disturbance in riparian areas.
Areas with potential to increase water yields.		Tidbits, Blue River Face, and Quentin		
Historical fire regimes and the past pattern for creating forest structure.		Throughout the watershed		
Presence of TES plant and animal species, as well as other sites of species of concern.		Most known TES locations are spotted owl activity centers, but a red-legged frog breeding pond is also present.	By definition TES species are rare and the trend is decreasing numbers.	• Protect all known sites and as much adequate habitat surrounding those sites as possible. Where possible avoid incidental take for spotted owls in the short-term, considering U.S. Fish & Wildlife Service guidelines.
Connective dispersal routes for small home range, less mobile TES and other species of concern such as red-legged frogs and red tree voles. Small populations could become isolated if lands within the watershed do not provide suitable dispersal habitat connections.	Logging activities have potential to interrupt contiguous dispersal routes, especially through riparian areas.	Throughout the watershed	↓	• Consider providing fairly contiguous riparian and upslope habitat areas wide enough to prevent blowdown and the invasion of edge predators.

STAKEHOLDER ANALYSIS				
Who should be contacted and contact information	**What is their interest?**	**How will they be affected by the project?**	**What, if any, specific methods might be needed to inform and engage this person/group**	**Who needs to make this contact?**
Bend Metro Parks and Recreation District Attn: Eric Denzler 799 SW Columbia St. Bend, OR 97702	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
Central Oregon Community College Attn: Konnie Handschuch 2600 NW College Way Bend, OR 97701-5998	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
Oregon Museum of Science and Industry Attn: Steve Tritz 1945 SE Water Ave. Portland, OR 97214	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
City of Eugene Riverhouse Program 310 N. Adam St. Eugene, OR 97402	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
Halligan Ranch Llama Adventures Attn: Sherry Halligan 9020 S. Hwy 97 Redmond, OR 97756	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
Outward Bound West Attn: Mike Armstrong	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation

70000 NW 83rd Redmond, OR 97756				
Portland Parks and Recreation Attn: Nancy Harger 2909 SW Second Ave. Portland, OR 97201	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
Timberline Mountain Guides Attn: Pete Keane P.O. Box 1167 Bend, OR 97709	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
University of Oregon, Outdoor Pursuits Program Attn: Michael Strong Eugene, OR 97403-1273	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
Wilderness Ventures P.O. Box 2768 Jackson, WY 83001	Outfitter and Guide	Closure may affect operating season	Introduce the project at and outfitter and guide meeting.	Recreation
Black Butte Stables, LLC Attn: Cody Koch and Kristy Prosser P.O. Box 2003 Sisters, OR 97759	Outfitter and Guide	Closure may affect operating season	Letter, email, or phone call	Sommer Moore 541-549-7706
Wanderlust Tours Dave Nissen 143 SW Cleveland Ave. Bend, OR 97702 541-389-8359 dave@wanderlusttours.com	Outfitter and Guide	Closure may affect operating season	Introduce the project at an outfitter and guide meeting.	Recreation
Pacific Crest Trail Association Attn: Dana Berthold dhendricks@pcta.org Columbia Cascades Pacific Crest Trail Association	Non profit that "protects, preserves, and promotes" the PCT	Closure may affect hiking opportunities	Letter, email or phone call	Recreation

PO Box 359 Cascade Locks, OR 97014				
Obsidian Hiking Club email@obsidians.org Publicity: Janet Jacobson 541-343-8030	Non profit hiking club	Closure may affect hiking opportunities	Letter, email or phone call	Recreation
Oregon Wild Wilderness Coordinator Erik Fernandez (503)283-6343 ext 202	Environmental based nonprofit focused on environmental law	Prescribed burn may fall under question with Oregon wild.	Letter, email or phone call	Communication team
Elk Lake Resort Jim Bruce 63227 Service Road Bend, OR 97701	Resort	Closure of highway and associated smoke may affect business	Letter, email or phone call	Rick Wesseler 541-383-4722
Elk Lake Rec. Residence Homeowners Association Steve Skelton 541-225-7474 smskelton@juno.com	Cabins under special use permit	Closure of highway and associated smoke may affect use of cabins	Letter, email or phone call	Rick Wesseler 541-383-4722
Mt. Bachelor Inc. Dave Rathbun P.O. Box 1000 Bend, OR 97709 541-693-0913 drathbun@mtbachelor.com	Resort	Associated smoke may affect business	Letter, email or phone call	Rick Wesseler 541-383-4722
Hoodoo Recreation Services P.O. Box 8516 Coburg, OR 97408	Campground Concessionaire	Closure of highway and associated smoke may affect use of campgrounds	Letter, email or phone call	Ronda Bishop 541-433-3230
Back Country Horsemen of Oregon PO Box 543 Veneta, OR 97487	Backcountry Horseman User Group	Closure of trails	Letter, email or phone call	Recreation
Trail Keepers of Oregon PO Box 14814 Portland, OR 97293	Trail hiking group	Closure of trails	Letter, email or phone call	Recreation
The Chemeketans PO Box 864 Salem, OR 97308	Trail hiking group	Closure of trails	Letter, email or phone call	Recreation

The Wilderness Society Pacific Northwest Region 720 3rd Ave Ste 1800 Seattle, WA 98104	Environmental based nonprofit focused on Wilderness	Prescribed burn may fall under question with the Wilderness Society.	Letter, email or phone call	Communication team
Oregon Equestrian Trails 10117 SE Sunnyside Rd #F101 Clackamas, OR 97015	Backcountry Horseman User Group	Closure of trails	Letter, email or phone call	Recreation

** PLEASE NOTE – Recreation Events are always changing, so please contact Rick Wesseler at 541-383-4722 for an updated list when Rx fires are planned

ANSWER FINDINGS	CASUAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
High habitat quality in eight mature and late-successional habitat blocks has been identified as important to long-term spotted owl population and trend data.	Logging and plantation management.	Cook, Mack, and Upper Lookout Creek, and Lookout Mountain, Watershed 2 and North Carpenter areas	↓	• Cooperate with spotted owl researchers at the HJ Andrews to continue ongoing study and develop and respond to new research questions. Use spotted owl data to evaluate prescriptions for selective logging.
Known bat cave, roost snag and tree locations are important to consider.	Logging has potential to alter habitat such that it may no longer be used.	One known site in the Ore Creek drainage, and four additional sites near Blue River.	↓ for Townsend's big-eared bat, unknown for other bat species	• Maintain the current microclimatic conditions of known nest sites.
Snag levels in riparian and upslope areas not within the historic range of variability	Logging and fire suppression	Simmonds, Quartz, North Fork Quartz, Mann, and Wolf Creek riparian areas; Mona Scout, Lower Blue River, Upper Blue River, South Blue Lake, and Mann Creek subdrainages	↓	• Create snags where needed in a variety of size classes, promote conifer development in riparian areas.
Use guilds in future planning efforts. Wildlife guild analysis has identified two guilds of concern which have low amounts of habitat in the Blue River watershed: TLME and TMME guilds. Although habitat for these guilds is well provided for in the westernmost portion of the McKenzie subbasin, there is no mid or high elevation habitat.	Logging has fragmented the landscape, other considerations have resulted in openings smaller than optimal for these guilds Fire suppression.	Throughout the watershed	↓ in habitat for these guilds	• Continue forest-wide discussions about the need to provide all types of guild habitat at all elevations and the type of distribution that is needed.

ANSWER FINDINGS	CASUAL ACTIVITY	LOCATION	TREND	RECOMMENDATION

ANSWER FINDINGS	CASUAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Wildlife guild analysis shows that TLC and TMC guild habitat is sparse west of the Willamette National Forest which indicates a greater need to track available habitat and possibly a need for creation of future habitat.	Logging on private land	McKenzie Subbasin west of the Willamette National Forest	↓	• Use presence data from future great gray owl surveys to help determine areas where habitat management could be most effective.
Consider possibilities for long-term large block mature/late seral habitat restoration in highly fragmented areas.	Logging	Wolf Rock, Mann Creek, lower North Fork Quartz Creek, upper Tidbits Creek and Squaw Mountain	↓	• Increase structural diversity by thinning young plantations and older stands lacking structure • Create snags and logs within these areas.
Manage the landscape to provide connectivity between suitable habitat for late seral, low mobility patch species such as the red tree vole (TSP. guild).		Mann and Wolf drainage's.		• Maintain late seral habitat in fairly contiguous habitat corridors between larger blocks.

Issue#2: Natural Disturbance

QUESTION#1: What is the past pattern and intensity of fire disturbance in the Watershed?

FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
There is a variable regime of frequent low intensity surface fires and long return interval, stand replacing fires.	Wind ; Topography Climate	Throughout watershed		• Information to be used in landscape analysis of Blue River Watershed.
The Lookout Drainage has a mean fire return interval of 160 years mainly due to Lookout Ridge which blocks strong east winds.	Protected from east winds	Lookout Creek Drainage		
The Cook/Quentin area and the western half of the watershed has a mean fire return interval of approximately 96 years.	Exposure to winds	Western half of watershed		
In general south exposures have a higher intensity and north exposure has less intensity.				
Fire return intervals are increasing dramatically. The fire return interval post fire suppression efforts is approximately 587 years.	Fire suppression		↑ Fire regimes are increasing due to fire suppression efforts	• Consider using fire in the larger project area when planning timber harvest rather than just within the unit boundaries. • Encourage fire history studies that examine low intensity underburns.
Understory fires have more than likely been underestimated in past fire studies. These underburns have played a role in the development of a layered structure in older forest stands				

Issue#2: Natural Disturbance

QUESTION#2: Fire pattern, behavior, and burn intensity are affected by fuel loading conditions and leave behind characteristic levels of large wood and snags. How do current conditions compare to fuel loading conditions before fire suppression?

FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Current fuel loadings are higher than past conditions in stands that have not burned in the last 100 years	Fire suppression	Natural stands throughout watershed	↑	• Consider underburning in areas of high risk.
Current fuel loadings within managed stands are lower than what would have been seen pre management	Timber harvest Slash burning	Managed stands	↓ Continues to be less even with new prescriptions	• Consider fuel treatment decision matrix for basing decisions on end result fuel profile

Issue#2: Natural Disturbance

QUESTION#3: What is the speculated role of human caused fire in altering the vegetation, now and in the past?

FINDINGS	CAUSAL ACTIVITY	LOCATION	TRENDS	RECOMMENDATIONS
Average fire frequencies did not differ significantly between the pre-ssettlement and settlement period (Weisberg Draft). This is consistent with the findings of Morrison and Swanson in 1990. Also Morrison and Swanson noted that the fire frequencies were highest during the early 1800s when human populations were the lowest suggesting humans have not strongly influenced the overall fire frequency of the region prior to fire suppression. \	Lack of fire suppression	Watershed wide	↓	
Presently, fire frequencies are strongly influenced by humans. Fire return intervals have increased to 587 years. Native Americans may have had an active role in fire starts as has been seen in other areas of the country. Early settlers allowed fires to burn in order to improve grazing opportunities and probably also used fire to improve travel routes.	Fire suppression			• Fire suppression efforts will continue. • Incorporate structure and variability that was seen with historic fire into the landscape through forest management prescriptions.

Issue#2: Natural Disturbance

QUESTION#4 How did natural disturbance shape the vegetation in the watershed? What patterns were created both in the upslope and riparian?

ANSWER	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Fire has had the major role in shaping the vegetation pattern on the landscape in the upslope.	Lightning Some human	Throughout the watershed	↓	• Use fire regimes to help develop desired conditions for the landscape.
Landscape pattern in upslope consisted of large openings during stand replacement events with a variable amount of snags, residual trees and down logs left on site depending on intensity of burn. Many areas also experienced repeated underburns which resulted in much diversity of age, size and species.	Slope Aspect Elevation	Throughout the watershed	↓ Due to fire suppression	• Increase stand structure within managed stands and in future harvest units. • Use prescribed fire on the landscape to increase diversity of structure.
There were large areas where disturbance did not occur frequently and where there would be large areas of older interior forest.	Protected from east winds	Mainly in Lookout Creek	↓ Mainly due to harvest activities	• Ensure large areas of contiguous late successional forest remain on the landscape within a range seen historically
Fire played a significant role in returning many of the lower order stream channels to early seral stages.	Similar to upslope conditions, not a large riparian microclimate	Landform Blocks 1-3 would have a higher percentage in early seral Landform Block 4 would have some in early seral but lower percentage than other blocks		• Consider historical disturbance regimes when analyzing riparian mangement.
Many of the Class II and I and some III streams seem to have a longer fire return interval than the upslope. Although fire would burn on both hillsides it would not	Moister and more protected microclimate	Landform Blocks 1-3		• Same as above

ANSWER	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
burn with the same intensity in the riparian areas.				
Debris slides and debris flows reset vegetation in riparian areas to early seral conditions mainly in Class IV and Class III streams.	Triggered during periods of large storm events	Landform Block 1 especially Tidbits	⟷	
Floods played a role in resetting vegetation in riparian areas to early seral conditions.	Storm events in large unconstrained valley	Landform Block 4, Lookout Creek.		• Consider riparian widths wider than in the ROD along the mainstem of Lookout Creek.
Insects and Disease appear to occur in small scale outbreaks that result in creation of gaps and structural diversity on the landscape.	Blowndown trees escalate populations	Throughout the watershed	⟷	• Consider the structural and species diversity created through this process when writing harvest prescriptions.
Windthrow is a small scale disturbance within the watershed usually occurring sporadically within stands and more consistently adjacent to openings creating gaps and additions of down wood.	Wind Openings	Throughout the watershed	↑ Due to increased numbers of openings created by harvest and roads	• Feather edges of harvest units.

Issue#2 Natural Disturbance

QUESTION#5: Are there individual species or communities of plants that are decreasing or increasing due to fire suppression? Are there wildlife species associated with these communities that would also be increasing or decreasing?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
In general meadow communities are smaller and overall meadow acreage and numbers has been decreasing.	Fire suppression resulting in natural encroachment of conifers	Along the ridge tops in the west and along Lookout Mountain	↓	• Consider maintenance of early seral communities in landscape design. • Consider prescribed burns to maintain meadow communities especially in the Lookout Mountain area but also in the other meadow complexes. • Consider letting lightning caused fire burn in the Lookout Mountain area. • If prescribed burns are used vegetation plots should be installed and measured to assess effectiveness of the prescriptions.
Early seral communities tend to stay as early seral for a shorter period of time.	Aggressive replanting of burned areas with conifer species and planting of harvested areas	Throughout the watershed		
The wildlife species associated with these meadows are not being affected due to the presence of early seral that is created through logging.	Early seral created through logging is providing habitat	Same as above	←→	

Issue#2: Natural Disturbance

QUESTION#6: What are the dominant erosional processes and sediment delivery mechanisms operating within the uplands and riparian areas? What are the relative rates of delivery?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Uplands				
Deep-seated, ancient landslides and earthflow complexes dominate the eastern portion of the watershed.	Major earthflows were initiated by glacial processes and earthquake forces. Rates now controlled by precipitation cycles. Most site specific failures as a result of the 1964 flood are coincidental with road construction and timber harvest	Lookout, McCrae and Mack Creeks	Ongoing at about the same or somewhat lower rate due to fire suppression	• Site specific geotechnical studies should support all planned harvest and road building. • Use ATM process to identify road to decommission. • In the case of wildfire, rehabilitation plans should include strategy for to limit increased mass wasting in areas of potential instability. • Initiate earthquake awareness program and include landslide damming effects on streams in any emergency response contingency plans.

Question #6 continued.....What are the dominant erosional processes and sediment delivery mechanisms operating with the uplands and riparian areas?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Uplands continued				
Shallow debris avalanches dominate the western portion of the watershed.	Post fire and precipitation cycles Road construction on steep slopes Clearcuts Roads and cuts account for 60% of the site specific failures currently	Simmonds, Quartz, Tidbits, Cook, Quentin and Mann Creeks mainly on SRI 21	Site specific failures are now lower than reference conditions however they are expected to accelerate as road maintenance levels decrease	• Fill pullback on Forest Service road 15 (Blue River) and 1509 (Tidbits) • Consider slope stabilization projects in Mann Creek drainage.
Natural sediment delivery to streams was modeled by Landform Block using historic fire regimes and slope stability. Highest rates were in Landform Block 1 and lowest were in Landform Block 4.			Decreased ...potential to increase slightly without road maintenance	

Question #6 continued......What are the dominant erosional processes and sediment delivery mechanisms operating with the uplands and riparian areas?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Riparian				
Stream encroachment of deep-seated ancient landslides and earth flow complexes dominate the eastern portion of the watershed. • *Soil Transfer rates from naturally occurring earthflows may be in the range of 600 cubic meters per square kilometer per year.*	Natural stream erosion of earthflow toe areas	Lookout, and Upper portions of Quentin and Mann Creeks..	Constant, varying with climatic cycles	• Geotechnical studies should be incorporated into planning harvest and road construction.
Debris slides, debris flows, debris avalances in steeply incised, high gradient streams throughout watershed. • Slides in Quartz Creek, on west side of upper drainage • Slides on south side of Tidbits drainage • Debris slides/avalanches in upper drainage of Cook causes open main channel • Debris slides in Blue River tributary near Mann Creek junction • Debris chutes(old) off Lookout Mountain into Lookout Creek • Mann Creek debris slide (one source area) causes channel opening	Large storm events; filling of "0" order and 1st order channels			
Streamside slides particularly associated with glacial terraces. Mass wasting along Blue River adjacent to glacial terrace; mass wasting adjacent to steeply incised depostional reaches of Cook and Quentin Creek.	Unconsolidated material becoming destabilized by large storm events Debris slides/ debris flows	Blue River approximately 1 3/4 miles upstream of Quentin mouth; lower several miles Cook and Quentin Creeks		

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Cutting of earthflow toes by adjacent stream channel, especially in Lookout Creek which flows through earthflow terrain.	Natural progression of channel migration across floodplain Large storm events.	Mid-section of Lookout Creek		
Erosion of floodplain surfaces mainly in relatively wide floodplains of Lookout, Cook, and Quentin Creeks.	Large storm events Debris flows.	Mid-section of Lookout Creek; lower several miles of Cook and Quentin Creeks		
Fire and floods--fire removed riparian vegetation to some extent in all drainage's except Lookout. Loss of riparian vegetation due to fire likely resulted in extensive erosion during high flows. Floods erode and transport floodplain substrate	Fire High stream flows	Throughout watershed		

Issue#3: Mining

QUESTION#1: What ecological processes have been affected by mining operations and to what extent?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Prospecting had minor effects.	Digging holes Panning	Throughout the watershed		• Continue to work with individual miners to minimize effects to the environment from all mining activities.
Placer mining resulted in disruption of gravels, erosion and stream bank instability and water quality. Overall the effects appear to be limited in scope and extent for the entire watershed. There may, however, be localized effects to aquatic amphibians. .	Dredging and "high banking" (removal of streambank to wash gravels) Use of mercury	Quartz Creek		• Water quality monitoring (determine extent and severity of impacts). Utilize the aquatic health assessment plan for Quartz Creek that was developed in 1994. • Take necessary steps to clean up the mercury. • Survey amphibians in North Fork Quartz Creek. • Tissue sampling for potential effects to aquatic species
Lode mining had the most noticeable effects on the landscape. Processes that appear to have been affected include stream channel characteristics, erosion, subsurface flow, water quality, vegetation and archeological sites. After completion of mining activities some mining equipment was left in the stream channels.	Road building, Digging shafts and adits, Cutting vegetation, Creating mine waste sites, Building and operating mill sites and other structures	Quartz Creek North .Fork. Quartz Simmonds	May continue	• Identify amount and location of equipment in streams. Determine hazards to aquatic ecosystem and remove if determined necessary. • Complete SIA guide for Gold Hill

Issue#3: Mining

QUESTION#2: What mitigation could be used for future mining activities?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
A variety of mitigations could be used depending on which activity was being proposed and where.	See question 1.	Throughout Watershed.	5-6 inquires per year. Trend appears stable (maybe slightly increasing) Decrease of existing claims since requirement of annual payment.	• Continue process of compiling mitigations in form of booklet. Work with Supervisors Office to compile. • Work with researchers to identify mitigations specific to individual research studies in watershed, although the Agency may not be able to require all mitigations. • Identify large scale projects that may be affected by mining activities and discuss withdrawing affected areas from mining activities.

Issue# 4 Roads

QUESTION#1: Where and to what extent has the density and condition of roads influenced natural and management induced disturbance including mass movement, landslides, and surface erosion? Where and to what extent does the input of sediment influence channel conditions? What effects have these changes had upon fish habitat?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Road related failures account for 26% of the total number of site specific failures in the watershed. *The following are the specifics for each block:*	See below	Block 1...28 road related failures Block 2....10 road related failures Block 3.....16 road related failures Block 4.....33 road related failures	Rates of failure have decreased. Future trend will depend upon road maintenance. Reduced maintenance will cause a significant increase.	• More intensive culvert survey needs to occur in conjunction with road maintenance recommendations. Use failure rate per density to prioritize.
The highest number of incidents related to road density are in Landform Block 1 (Quartz/Tidbits). There were 28 incidents per mile per square mile or about 90 per 100 miles of road. This has resulted in high embededness in Quartz Creek.	Sidecast road construction on steep slopes and on SRI 21 soil complexes		same as above	• Consider pullback of sidecast on the 1509 road
Chronic input into Tidbits Creek may fill some pools, but transport channel type probably flushes most fines into Blue River and down to Blue River Reservoir.	Poorly constructed and placed roads: full-bench construction on steep terrain	Tidbits drainage	*Reference to management*: ↑ *Management to current*: ↓ (Due to no new road building and no large storm events) *Future*: ↑ (likely with little road maintenance and undersized culverts).	• Complete a culvert inventory • Tidbits system is a high priority for maintenance

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Landform Block 4 (Lookout) has the next highest rate at 11.4 per mile per square mile or 45 per 100 miles of road. This may have resulted in the decreased pool numbers in Lookout Creek. Landform Block 3 (Wolf/Mann) had the next with 4.3 per mile per square mile. This has contributed in part to the filling of pools in Mann Creek and Blue River.	Roads located on ancient landslides and earthflows and timing of road construction just prior to the 1964 and 1986 flood events.	Lookout Creek Mann Creek and Blue River	same as above	• Project level slope stability analysis should be accomplished for newly proposed roads in areas of potentially unstable soils
Landform Block 2 has the lowest at 3.4 per mile per square mile.	Gentle terrain Road locations avoided unstable soils	Cook Creek Quentin Creek	same as above	
Surfacing is generally good throughout the watershed and surface erosion does not appear to be a concern. However it really isn't known at this time whether surface erosion is causing instream problems. The roads in the Gold Hill area are contributing to overland flow and surface erosion.	Native surfacing.			• Install sediment traps at representative sites on the road system to evaluate typical surfacing and subgrade types to determine if there is a significant contribution from the road system. Use the Lowell RD Test Road Sediment Study as a guide.

Issue#4: Roads

QUESTION#2: Where and to what extent has the density and configuration of roads affected surface and subsurface hydrology through expansion of the drainage network?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Quentin, Mann, Blue River Face, Lookout, and Mccrae drainage's have likely expanded the drainage network and have caused increased peak streamflows. Midslope roads within these drainage's occur in potentially high contributing areas to rain-on-snow.	Roads located midslope can intercept subsurface flows at cutslopes and through ditchlines concentrating water and routing it more quickly to downstream channels	See findings	*Reference to management:* increase of drainage network. *Mangement to current*: remains high though not increased since no new road construction. *Future:* depends on action. Static if no new roads, increased if new road construction , potentially decreased if there is some obliteration of midslope roads.	• Consider decommissioning roads where extensive miles located midslope in areas of high contributing areas to rain-on-snow. • Build new roads outside area of potentially high contributing area to rain-on-snow and minimize midslope location.

Issue#4: Roads

QUESTION#3: Where and to what extent have roads affected drainage patterns that have created or eliminated wet areas or meadows?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
There did not seem to be many areas where the drainage patterns have been affected by roads causing changes to wet areas or meadows.				

Issue#4: Roads

QUESTION#4: Where are high risk or high priority stream crossings which do not have drainage structure designed to withstand 100 year events? Where are the culverts that would prevent fish passage?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Most culverts are undersized. Lookout, Cook, and Quentin Creeks are the high priority stream crossings. These were determined high priority due to having good habitat. Floodplain function and fish passage are both being affected by the culvert on Road 1509 at the mouth of Ore Creek. Fish passage is blocked at 2620.126	Undersize culverts	Most of the drainage		• Inventory culverts and begin replacement with a priority on these three streams. • Replace Road 1509 culvert at the mouth of Ore Creek • Replace culvert at Road 2620.126 at reservoir

Issue#4: Roads

QUESTION#5: Where and to what extent have roads affected riparian function by encroaching on stream channels causing constriction of stream channel, conversion of conifer stands to hardwood and decreasing large wood potential and increasing sediment to streams?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
The road adjacent to Tidbits Creek constricts the channel in a few localities and one side of the stream is dominated by hardwoods. The building of the road coincided with harvest of all riparian vegetation along one side of stream length. This one side is nearly 100% hardwoods	Roading and harvesting	From Tidbits mouth for 3 1/2-4 miles up 15-1509	*Reference to management*: roads increasingly affecting riparian area *Management to current*: static. *Future*: improving as stand along Tidbits Creek progresses through seral stages	• Encourage establishment of conifers by interplanting among alders and light thinning of hardwoods around planted conifers.
Old roads and harvest on Simmonds, Quartz and North Fork Quartz have left the entire riparian area dominated by hardwoods.	Roading and harvest	Entire stream length of all three drainage's where flow is perennial	same as above	• same as above
Blue River adjacent to road 15 has a good portion of riparian vegetation and habitat eliminated due to wide road width.	Road placement in riparian area and wide road width	Road 15 from Tidbits to Cook Creek		• Decrease width of road from Road 15 from Tidbits to Cook Creek

Issue#4: Roads

QUESTION#6: Where and to what extent have roads affected wildlife populations?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
There are three areas where road density appears high based on results of big game modelling. These could be areas where other species sensitive to vehicle disturbance and easier human access may be affected.	Road building	Blue River, Cook, and Quentin Big Game Emphasis Areas	Decreased habitat quality for big game and other species who are sensitive to disturbance	• Prioritize these three areas to be reviewed during Access and Travel Management Planning for possible road closures.

Issue#4: Roads

QUESTION#7: Where and how is road use contributing to the spread of non-native plants?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
There are established population of noxious weeds and invasive non-natives on most roads, trails, riparian areas, rock quarries and campgrounds.	Ground disturbance. Road maintenance; ditch cleaning; brushing; road construction. Seed propagales movement; non-native seed road mix; movement of soil.	Throughout the watershed.	Increasing, especially along Road 15.	• Site specific analysis to determine if ground disturbing machinery should be washed clean of dirt and other foreign material prior to on site work. Road construction or timber sale contract language should be used to accomplish this if needed. • Evaluate the need for cleaning of road maintenance equipment. • Implement integrated weed management plan and emphasize prevention. • High priority for control are: spotted knapweed, giant knotweed, Himalayan blackberry and everlasting peavine. Brushing along Road 15 will remove flower/seedheads of spotted knapweed. • When decommissioning roads allow early seral plants to establish and shade out weed species. Use presence/absence of noxious weeds to help set priorities for closure. • Inventory for noxious weeds during all project planning. • Experiment with the use of prescribed fire to eradicate noxious weed populations. Use site specific analysis.

Issue#4: Roads

QUESTION#8: Where are the high priority areas that need maintenance based on access needs, potential resource impacts and reconstruction costs?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Overall the areas that are high priority for maintenance are the Level 2 Collectors: 1509 1510 1513 1516 1517	Steep cut slopes ravel into ditches.	Greatest problems are on roads with sustained grades.	Budgets will go down and maintenance is going to be harder to do.	• Use ATM to prioritize the work to be done. • Ditch relief culverts need to be a high priority for maintenance
Road surfaces are being maintained to a higher standard than the objective maintenance level.				• Maintenance activities should match the maintenance level objectives. • Need annual maintenance planning.
There are 27 miles of roads that are in need of closure devices. Currently overall resource impacts are low except long roads with culverts.	If left open, continued vehicle could cause resource damage.	See potential road closure list.	Resource damage could increase.	• Complete a process to close these roads.

Issue#5: PAST HARVEST

QUESTION#1: How does the current landscape pattern compare with historic patterns? How has timber harvest contributed to the landscape contributed to the landscape?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
The current landscape is much patchier than the historic landscape, however there are still some areas of considerable size that are intact and offer interior habitat. There are more patches of a smaller size and there is increased edge. In harvested areas between the 1950s and 1980s there are less snags. Early private logging more closely resembles natural disturbance in terms of size and intensity. Larger areas of interior habitat still exist in Lookout Creek, Cook Creek and Tidbits Creek. Large areas of mature forest still exist in Quentin Creek and along Carpenter Mountain	Harvest	Smaller patches scattered throughout the watershed.	↓ ↓ ↓ ⟷	• Incorporate lessons from past natural disturbance into future planning efforts. • Minimize additional fragmentation and increase patch size by locating harvest units adjacent to past harvest. Consider fragmented areas for first for harvest.
Late Successional Forest is at the low end of the range of variability	Harvest	Lowest percentages are in Wolf/Mann	↓	• Accelerate late-successional development in this area.

a) What is the seral stage distribution? How does it compare to the past?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
The seral stage distribution resulting from harvest is different than that In 1900 that resulted primarily from fire.		Watershed wide		• Accelerate late successional characteristics over time • Continue discussion on range of variability and historic conditions
More early —28% vs 11%	Clearcutting		↑	
Less young.—9% vs 21%	Clearcutting		↑	
More mature—26% vs 11%	Growth		↓	
Less old—37% vs 57%	Clearcutting		↓	

Issue#5: PAST HARVEST

QUESTION#1b: Where and what kind of non-forested habitat is present within the watershed? Are there some that have limited distribution across the watershed/Forest/Region? What threatens these areas?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Non forested areas include (in order of occurrences) rock outcrops, sitka alder communities, rock talus, vine maple communities, dry meadows, vine maple/talus communities ponds, and very few rock cliffs, rock gardens and wet and mesic meadows. Lakes, ponds, bogs and wet meadows are relatively uncommon.	Threats include harvest, fire suppression and roads	See map	Decreasing	• Continue field identification. • Objectives for these areas should be considered when designing management activities. Measures that preserve habitat integrity and longevity should be discussed. • Monitor for disturbance and invasion of noxious weeds and other invasive nonnative plant species. • Complete an implementation and monitoring guide for the Wolf Lake Special Interest Area. Assess the location of the public restrooms located 75 feet from the edge of Wolf Lake to determine if any environmental impacts are occurring.

Issue#5: Past Harvest

QUESTION#1c): What vegetative species of concern as identified in the Presidents Plan exist within the watershed: What species may occur based on their range and habitat requirements?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
There are 38 survey and manage species within the watershed.		See Chapter III	unknown	• Aggregating harvest units will reduce fragmentation and protect old-growth associated species. Large patches of old-growth forests and longer rotations would enhance the dispersal and longevity for many survey and manage species. • Maintaining hardwoods and Pacific yew in managed stands may enhance lichen and bryophyte communities. • Include easily identifiable species in stand exams. • Maintain diversity of species within riparian areas: both conifer and hardwood. Consider thinning red alder stands and planting red-cedar and Douglas-fir. • The creation of gaps or early successional thinning would probably enhance epiphyte species in upland and riparian areas.

Issue#5: Past Harvest

QUESTION#1d): What TE&S species are known to occur or could potentially occur within this watershed? What is the conditions of their habitat?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
There is one plant species listed on the Forest Sensitive List; Thompson's mistmaiden. There is one species, Cascade daisy, on the Watch List. There are six uncommon plant associations win the watershed.			unknown	• Continue to monitor Thompson's mistmaiden populations and habitat. No timber harvest should occur near the vicinity of the habitat site. The actual distance will need to be determined. • Implement the conservation of rare and uncommon forested plant associations in the landscape analysis and design.
Amphibians: Red-legged frogs: One known breeding site and a few other sightings of foraging frogs	NA	One breeding pond on the HJ Andrews Experimental Forest and other dispersing individuals	Assumed to be stable	• Protect breeding pond from any activity which might impact tadpoles or frogs, and monitor at least every three years. • Continue to survey for red-legged frogs.

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Birds: Bald Eagles: One nest site	NA	Around Blue River Reservoir	Construction of reservoir may have enhanced foraging habitat	• Increase ground protocol survey efforts in less accessible areas of the reservoir during nesting season as well as locations of repeated sightings. Continue to document sightings and create flyers to educate the public.
Northern Spotted Owls: 37 activity centers are known. The owl study is showing a gradual decrease in population and productivity.	Logging	Throughout the watershed in mature and late seral habitat.	↓ With AMA management future habitat suitability is likely to be reduced.	• Avoid incidental take where possible, based on U.S. Fish & Wildlife Service guidelines. • Consider maintenance of high quality habitat quality in eight identified mature and late-successional habitat blocks during landscape design to allow continued data collection in a few selected areas to provide long-term northern spotted owl population and trend data. . Improve structured habitat diversity in unmanaged stands in the Hagan LSR. Effectiveness monitoring could tie in with the ongoing owl study • Review young managed stands surrounding the above eight areas for the need to improve structural diversity. • Develop prescriptions that would accelerate late successional characteristics in Mann, Wolf, North Fork Quartz and Upper Tidbits subdrainages..

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Peregrine Falcons: One active nest site and several potential nesting cliffs.	N/A	See special habitat map and cliff habitat.	Stable	• Monitor potential nest sites and rank their nesting habitat potential on a scale of 1-3 to set priorities for future ground monitoring.
Harlequin Ducks: Several sightings and documented nesting.	Impacts of fishing are believed to be low.	Lookout Creek and Blue River.	Unknown	• Continue creek enhancement projects by adding large woody material or planting conifers in riparian zones where they are lacking in the lowermost reaches of Lookout, Tidbits, and Mann Creeks, as well as Blue River.
Townsend's big eared bat and other bat species of concern have been found but surveys have been limited. Caves and cave-like structures are critical habitat. Reduced snag levels has resulted in reduced levels of habitat.	Removal of snags and large trees through logging	Throughout the watershed but especially near riparian areas.	↓	• Monitor known Townsend's big-eared bat location at least once every 3 years. • Protect and monitor known snag and bridge roosts at blue River and Tidbits Creek at least once every 3 years. • Provide large snag habitat at historic condition levels. Route cavities in cedar trees for bat enhancement.

Issue#5: Past Harvest

QUESTION#2: What is the distribution of habitat for animal species resulting from harvest patterns and how does that compare with pre-harvest conditions?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Early seral habitat has doubled in acreage (12% →26%) between 1900 and 1995 but has much smaller patch size now. This amount of early seral has resulted in a decrease in the amount of late seral interior habitat.	Logging and fire suppression	Across the entire watershed	There will continue to be an increase in early seral.	• Consider distribution of seral stages in past and present and maintain an acceptable range of variability which would still support viable and healthy populations of all species. • Consider improvement of low quality habitat patches for the TLME and TMME guilds. • Manage landscape to provide connectivity between suitable habitat for late seral, low mobility patch species.
Log habitat is moderate to high in units harvested until 1960. Many units harvested between 1960 and the mid 1980s have decreased amounts of large wood. By 1990, scattered logs were required to be left in logged units	Logging between 1960-1980s decreased down log habitat	Throughout the watershed.		• Log levels should be prescribed considering past fire regimes and aspect. • Consider the wide range of variability that nature provides.
Snag habitat may not meet 40% levels. Much of early and mid seral habitat lacks snags and logs.	Logging	Mona Scout Lower Blue River Upper Blue River South Blue Lake and Mann Creek subdrainages.		• Plan restoration needs in subwatersheds lacking snags. • Provide for a wide range of different types of snag habitat, including >42.5" dbh which is preferred by some species such as bats.

Issue#5: Past Harvest

QUESTION#3: How has the landscape pattern created from harvest affected overall habitat for specific wildlife species of interest?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Past modifications of riparian areas may have negatively effected local areas for aquatic amphibians of concern (red-legged frogs, tailed frogs, southern and Cascade torrent salamanders). This is especially true in Landform Blocks 1 and 4 where historic and current proportions of the early and young seral stage in riparian areas differs considerably.	Logging	Throughout watershed	↓	• Future activities in riparian areas should consider historic conditions, disturbances and possible seral stages distributions. • Amphibian surveys should be conducted prior to activities in riparian areas.
Riparian snag habitat on Class I-II streams has decreased, resulting in less nesting habitat for species such as common merganser.	Logging	Class I-II riparian areas	↓	• Review the need and opportunites for large snag creation and routing of large cavities in mature seral stage habitat adjacent to Class I-II streams and Wolf Lake.
Reduction of snag habitat, particularly large snags >30" dbh has decreased habitat suitability for many species, including bats, fishers, and marten.	Logging	Most pronounced in Lower Blue River and Upper Blue River subdrainages..	↓	• Focus on creation of snags of all sizes, including >30" in Lower Blue River and Upper Blue River subdrainages.
Red tree vole dispersal habitat conditions may be decreased due to high fragmentation. There is a concern that populations between late-successional reserves might become isolated if lands between the reserves do not provide suitable dispersed habitat conditions.	Logging	Most pronounced in Mann and Wolf drainage's but reduced effects could be occurring throughout the watershed.	↓	• Landscape analysis should consider the needs of this small home range late seral stage species. Fairly contiguous riparian and upslope habitat connections wide enough to prevent blowdown and prevent the invasion of edge predators appears

				to be needed.

Species which depend on down woody material, for example, Oregon slender salamander and clouded salamanders have fairly high habitat quality in the earliest logged units (between 1890 - 1960) but low habitat quality in units logged between 1960 and the 1980s. More recently logged units will have moderate habitat quality once the canopy again closes in to provide longer tern moist and cool microclimatic conditions. Historic fire also left variable amounts of logs, from high levels to none.	Logging which left little to no overstory and did not provide for down woody material.	Scattered units throughout the watershed.	↓	• See recommendations under log habitat
Big game habitat quality has been improved by creation of smaller foraging areas which have often times been burned, while increased road densities have reduced habitat conditions. Overall forage values are lower than the guidelines in the 1990 Forest Plan.	Clearcut logging and road building.	Forage creation: Units throughout the watershed with a moderate to gentle slope. Forage quality is too low in the Blue River, Gold Hill, Cook, McRae, Lookout, Tidbits and Quentin management areas.	↑Forage quality ↓Road density	• Evaluate the need for forage improvement and reduction of road densities.

Issue#5: Past Harvest

QUESTION#4: What are the most important sediment delivery mechanisms generated by harvest activities? How do rates of delivery compare with natural processes? Where are the high risk areas?

ANSWERS FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Debris avalanche and debris flow initiation in clearcut units following rain-on-snow precipitation events have been the dominant sediment delivery mechanism as a result of harvest activities. Rates exceeded reference conditions between 1945 and 1979. Sediment delivery is high in Lookout Creek. Moderately high in Wolf/Mann/Blue River	Loss of root shear strength, tree surcharge, and evapo-transpiration on slopes >70% on SRI 21 complexes. Followed by a rain on snow event.	87% of the failures have been in Lookout Creek and the Wolf/Mann/Blue River area.	Decreasing recently Could increase with harvest in SRI 21	• Planned harvest units in SRI 21 soils complexes, especially clearcuts on slopes greater than 70% in the Lookout or Wolf/Mann-Blue River drainage's within the rain-on-snow elevations should be evaluated for conditions and probabilities of post-harvest failure.
Debris slides reaching streams from harvest units and road fill failures dominate the western portion of the watershed. Road related failure is greatest here, about 152 per 100 miles of road. Historic soil transfer rates from debris slides range from 57 to 242 cubic meters per square kilometer per year. These were exceeded during 1945-1979 but are well below that value now.	Debris avalanche initiation accelerated by road construction and timber harvest units	North Fork Quartz, Tidbits and Lower Blue River	Constant on about a 50 year recurrence interval; decreased road maintenance will increase recurrence interval	• Fill pullback on Road 15 and Road 1509 (as stated above). • Slope stabilization in Mann Creek drainage. (as above)

Issue#5: PAST HARVEST

QUESTION#5: Where and to what extent has timber harvest amount and distribution affected water yield and water quality? Where and to what extent have these changes affected stream channel function and habitat?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Water yield has potentially been increased in the following drainage's: Tidbits, Blue River Face, and Quentin. There is a lesser probability that water yield has increased in Cook and Mann drainage's. Of all the listed drainage's, Blue River Face is the most probable drainage to have experienced increased water yields. ARP is 87%, but drainage has much acreage in early seral stage condition.	Harvest in areas of potentially high contributing areas to rain-on-snow.	Stated in finding	Reference to management: increased. Mangement to current: increased. Future: declining as units hydrological recover. Could increase with new harvest units.	• Consider the harvest pattern and timing of harvest within these drainage's to compensate for potentially increased water yields, paying particularly attention to those high contributing areas to rain-on-snow.
Summer stream temperatures in Lookout Creek exceeded proposed standards from 1965-1981. These temperatures appear to be a result of environmental factors (base flows and air temperature) and not management related activities.	Low base flows High air temperature	Lookout Creek	Unknown	• Collect stream temperature data during June - December at the mouth of Lookout Creek and in Blue River below Tidbits Creek. Both devices should be located at the old USGS gaging stations in order to continue data collection begun in the 1950s and establish trends.
Summer stream temperature in Blue River below Tidbits Creek exceeded proposed standards 2% of the time between 1963 and 1986. Summer stream temperatures in Blue River below the reservoir exceed proposed standards.	Unknown at this time	Blue River	Unknown	• Continue analysis of summer base flows and air temperatures to determine the cause of increased temperature.

Issue#5: PAST HARVEST

QUESTION#6: Where and to what extent has the removal of in-stream large wood and harvest of source wood areas changed the routing of sediment and in-stream habitat?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Harvest of source areas has occurred mainly in Landform Blocks 1 and 3. A decrease in large wood has increased sediment transport due to increased stream velocities. A loss of large pool formation has occurred. Landform Block 2 has heavily managed riparian areas along Class I, II, III and IV stream channels resulting in a reduction of area with potential to supply large wood to the stream in the near term. Landform Block 1 has been heavily managed along Class II, III and IV stream channels resulting in a reduced ability to supply large wood to the stream in the near term. Habitat suitability for wildlife species which depend on pool habitat has decreased. Species this affects include harlequin ducks, American dippers, and river otters.	Harvest adjacent to streams	Quartz, North Fork Quartz, Simmonds, Tidbits, Mann, and Wolf Creeks. Blue River and adjacent to the Reservoir.	*Reference to management*: increased wood removal and loss of source wood. *Management to current*: static as riparian areas have been left as stream buffers. *Future*: source wood should increase as harvested stands recover.	• Move toward riparian vegetation seral stages more consistent with historic conditions particularly in Landform Blocks 1 and 2. • Restore large wood in Blue River, particularly in the reach from Cook creek to the reservoir, Simmonds, lower Quartz, lower North Fork Quartz, Mona, Tidbits, lower Cook, middle Quentin and Mann Creeks. • Create a priority setting strategy for placement of wood. Potential criteria: a) Start low due to downstream movement of wood; b) Start in headwaters due to the effect on slowing velocities; c) Set priorities based on fish species that would benefit; • Create a study using a variety of the above techniques and compare results. • Encourage rapid growth of conifers in riparian areas that have been harvested through silvicultural treatments.

Issue#6: PEOPLE

QUESTION#1 How has stocking of hatchery rainbow trout affected the wild rainbow population in the watershed?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
26,000 catchable rainbow trout are released per year in the reservoir and in Blue River. Literature suggests that this release is affecting the wild rainbow trout in Blue River by potentially displacing the wild trout, increasing wild trout susceptibility to anglers, increasing stress on the wild fish population, increasing competition and interactions between wild and hatchery trout, and potentially genetic mixing.	Potential competition between hatchery and wild rainbow trout	Reservoir and river up to Quentin Creek	Continuing as long as there is stocking	• Estimate the effect of stocking catchable size hatchery rainbow trout on the Blue River wild rainbow trout population through a cooperative field study with ODFW. • Assess the popularity of the river catchable rainbow trout stocking program and develop recommendations which should be submitted to Oregon Fish Commission.

Issue#6: People

QUESTION#2: Can a balance be maintained between the in-river wood and kayaker opportunities?

ANSWER FINDING	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
There is use of Blue River for kayaking although there do not appear to be large numbers of kayakers who use it. It appears to be possible to work with kayakers to minimize hazards and mange the river for large wood.	Large wood in river creates potential hazards to kayakers	Quentin Creek to Reservoir.	Wood in river will increase and potential for recreation conflict may increase.	Any project to place large wood in river between Quentin and reservoir should be coordinated with kayaker groups and individuals.

Issue#6: People

QUESTION#3: What effect does ATV use in the reservoir drawdown zone have upon the establishment of vegetation and how can impacts to vegetation (if they exist) be avoided?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
There have been isolated cases of impact related to ATV use but overall there does not appear to be a conflict. .	Minimal users of 4-wheelers.	Vicinity of access points to the reservoir.	Stable	Revegetation efforts should be focused around "hard points" such as stumps and rocks. This will protect the plantings from ATV related damage.

Issue#6: People

QUESTION#4: How can preservation of heritage sites be enhanced?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	RECOMMENDATION
Through identification and protection the major heritage sites can be enhanced. One large site has received damage with road reconstruction and another site is within the area of the reservoir. The drawdown of the reservoir affects heritage resources located within this area. Other sites have been affected by various activities.	Road construction Reservoir construction Reservoir drawdown exposing sites to "wave actions" and erosion Timber harvest Ilegal collection of artifacts	Gold Hill Road junctions at high elevation saddles; Ridgelines River terraces	Impacts are continuing	• Inventory sites • Complete a Gold Hill SIA implementation guide. • Rehabilitate site areas. • Use of paraprofessionals • Asking Native Americans what would be most important to preserve • Revegetate of sites to eliminate bare dirt • After identification of sites within reservoir, determine their elevation. Incorporate recommendation to drawdown reservoir past this zone quickly to minimize disturbance to cultural resource site. Then utilize vegetation to stabilize sites.
There have been impacts to historic mining sites associated with modern mining. Knowledge of site locations would help protect these sites in the future.	Potential for new mining operations of affect historic sites.	Gold Hill, Quartz Creek drainage.	May be increasing.	• Complete an overall site evaluation • Create an education program, particularly at Lookout Boat Site. It may also be beneficial to utilize Delta Amphitheater. • Distribute flyers to adjacent landowners advocating preservation of historical sites.
Use of "Squaw Mountain" for place name is offensive to modern Native Americans. Sensitive renaming of that location would help to enhance understanding of Native American use of this area.	Turn of century racist naming practices.	North end of watershed	Increased concern over name.	• Begin process to rename the mountain in coordination with the American Indian Program manager and tribes.

Issue#6: People

QUESTION#5 : How does maintaining full pool later in the summer of good water years affect established drawdown zones vegetation? How does the timing and amount of drawdown of the reservoir affect recreation users?

ANSWER FINDINGS	CAUSAL ACTIVITY	LOCATION	TREND	
The effects of late drawdown of the reservoir upon plants in the drawdown zone are unknown, but it is assumed that maintaining full pool until late in the year will have a detrimental effect on plants if it happens continually. It is assumed the longer the growing season, the healthier the plants. The longer the reservoir is up in the summer, the more recreational use is provided. Fees collected are more than double in a year that had drawdown initiated on Labor Day rather than on July 4th which is more typical Non-native plants were used in experimentation with revegetation of the drawdown zone. One especially invasive plant, reed canarygrass, is already spreading.	Drawdown schedule	Reservoir drawdown zone		• Study key elevations in reservoir as they relate to boat ramp. Determine if problem exists. (Willow Island, minimum elevation of boat ramp, key planting areas.) • Establish monitoring plots to assess vegetation and habitat conditions. • Any additional work within the drawdown zone needs to focus on use of native plants. A plan should be developed that addresses the eradication of reed canarygrass. • Continued planning for revegetation should consider elevations and "typical" as well as "good" water year levels. • Revegetation efforts should be designed to minimize conflicts during high water years.

Appendix

Appendix A -- Geology

Erosion/Mass Wasting Probability and Soil Transfer Rates following Historical Fire Events

LANDFORM BLOCK 1 SIMMONDS-QUARTZ-TIDBITS

ASSUMPTIONS: Fire recurrence interval of 96 years.
Major storm event (10 years+) following fire.

CONDITIONS: Potentially unstable soils on side slopes >70%
Sandy to Clayey Silts overlying tuffs and breccias with <3 ft. depth
SRI Units 201/203/212/21

AREA: Landform Block: 20,398 acres (82 km^2)
SRI Soils: 14,419 "
Slopes >70%: 2,730 "

INTERSECTION: Soils/Slopes: 1,916 " (409 polygons)

LISA PROBABILITY ANALYSIS

ASSUMPTIONS:

Scenario 1: High intensity wildfire, all biomass removed, natural stand replacement

VARIABLES:

Soil Depth:	1-3 ft.
Slopes :	70 - 110%
Surcharge:	0
Root Cohesion:	0
Phi:	28-34 degrees
Soil Cohesion:	0 - 50 pcf
Unit Weight:	85 pcf std. dev. 1.5
Moisture:	10%
Spec. Grav.:	2.5
Groundwater Ratio:	0 - 0.8

P[FS<=1] = 0.866

(0.866)(1916 ac.) = 1,659 ac. ~ 8% of landform block area
(0.866)(409 polygons) = 354 possible events
(3691 m^3/ac)(1659 ac) = 6,123,369 m^3

Scenario 2: Medium to Low intensity wildfire, crowns and stems burned, root system still intact, natural stand replacement

VARIABLES:		
	Soil Depth:	1-3 ft.
	Slopes :	70 - 110%
	Surcharge:	6 - 12 psf
	Root Cohesion:	0 - 80 psf
	Phi :	28-34 degrees
	Soil Cohesion:	0 - 50 pcf
	Unit Weight:	85 pcf std. dev. 1.5
	Moisture:	10%
	Spec. Grav.:	2.5
	Groundwater Ratio:	0 - 0.6

P[FS<=1] = 0.214

(0.214)(1916 ac.) = 410 ac. ~ 2% of landform block area
(0.214)(409 polygons) = 88 possible events
(3691 m^3/ac)(410 ac) = 1,513,310 m^3

EROSION RATES by cumulative Area per unit Time (C.A.T.) method

	Period yrs	Frequency events/km^2/yr	Volume/Event m^3	Soil Transfer Rate m^3/km^2/yr
1/	96	0.045	17,298	778
2/	96	0.011	17,197	189

1/ High intensity burn

Frequency 354 events/82km^2/96yrs = 0.045
Volume 6,123,369 m^3/354 events = 17,298 m^3/event

2/ Med-Low intensity burn

Frequency 88 events/82km^2/96yrs = 0.011
Volume 1,513,310m^3/88 events = 17,197

LANDFORM BLOCK 3 WOLF-MANN BLUE RIVER

	Period yrs	Frequency events/km^2/yr	Volume/Event m^3	Soil Transfer Rate m^3/km^2/yr
1/	96	0.0164	13,185	216
2/	96	0.004	13,033	52

1/ High intensity burn

P[FS<=1] = 0.866

(0.866)(83 polygons) = 72 possible events
(.866)(3691 m^3/ac)(297 ac) = 979,323 m^3
Frequency 72 events/46km^2/96yrs = 0.0164
Volume 979,323 m^3/72 events = 13,185 m^3/event

2/ Med-Low intensity burn

P[FS<=1] = 0.214

(0.214)(83 polygons) = 18 possible events
(0.214)(3691 m^3/ac)(297 ac) = 234,593 m^3
Frequency 18 events/46km^2/96yrs = 0.004
Volume 234,593m^3/18 events = 13,033

LANDFORM BLOCK 3 MARION THESIS

	Period yrs	Frequency events/km^2/yr	Volume/Event m^3	Soil Transfer Rate m^3/km^2/yr
1/	22	0.240	2,684	644
2/	34	0.001	3,115	31
3/	25	2.534	1,292	3,274

1/ Clearcut
2/ Forested
3/ Roads

S.R.I. Landtype and stability classification conditions

Unstable: areas which are prone to mass failure under natural conditions (unroaded, unharvested), and where human activities such as road construction and timber harvest are likely to increase landslide distribution in time and space to the point where this change is likely to modify natural geomorphic and hydrologic processes..."FSEIS glossary p. 18. Classified by the Forest S.R.I. as **moderately (several failures observed within a polygon) to very unstable (entire polygon shows evidence of recent and past failures).**

35, 25, &
251 to 256: Cohesive residual and colluvial soil, Sandy Silt with some Clay and rock fragments overlying pyroclastic bedrock on 20 to 40% slopes.

334 to 336: Cohesive residual and colluvial soil, Clayey Silt to Silty Clay with rock fragments overlying pyroclastic bedrock on 20 to 40% slopes.

NOTE: Only landtype 25, 255, and 35 identified in the watershed.

Methods: Frequency analysis for SRI types and air photo interpretation.

Potentially Unstable: Areas which contain conditions of steep geometry, high ground water potential, and soil with low shear strength characteristics that "...considers the probability of landslide-triggering storms within the period of minimum root strength and elevated ground water (as well as slope adjustment to piping changes), and the probability of channel adjustments that trigger streambank and toeslope failures." FEMAT IX-38 These conditions include high intensity fire and clearcut harvesting. Classified by the Forest S.R.I. as **stable or moderately stable to locally unstable.**

3 Rock outcrops of basalt, andesite and pyroclastic material which are prone to differential weathering and stress relief from glacial unloading which produce talus slopes and debris avalanches.

8 Slope deposits over pyroclastic bedrock in deeply dissected valleys.

33 Clayey Silt over pyroclastic bedrock.

55 Sideslope and bench deposits containing glacially derived material in a finer grained matrix of cohesive soil.

133, 143 163, 166	Granular glacial/fluvial deposits on mid-slope and toeslopes.
213, 225, 233, 235,237, 331, 332, 333,	Clayey Silts to Silty Clays overlying pyroclastic bedrock on steep slopes up to 70 %
617	Colluvial granular soil less than 3 feet deep overlying basalt and andesite on slopes up to 90%.

NOTE: Only Landtypes 3, 233, 235 and 8 identified in the watershed. Total of 3,580 acres.

Methods: Air photo interpretation and frequency query for SRI types.

Potentially Unstable on slopes >70% Shallow soils in steep sideslope or valley headwall areas that have a potential for debris avalanche failure. Classified by the Forest S.R.I. as **stable**.

13	Glacial deposits
16	Toe slopes glacial/fluvial deposits
61, 64 610 610U, 614	Glacial till overlying basalt and andesite soil depth 3-6 feet
71	Ridges and cirque headwalls w/ less than 3 feet of granular soil
21,201.203,210u 212,21s,301, 31 310U	Sandy Silt to Clayey Silt overlying Tuffs and Breccias with less than 3 feet of slightly plastic soil.

NOTE: **Only Landtypes 13, 21, 201,203,210u, 212, 21s, 610, 301, and 610, identified in the watershed.**

METHODS: Frequency Query for SRI Types and intersections with slopes >70%

<u>Methods of analysis</u>

Using the Cumulative Area per unit Time Method (Marion,81) and the Level I Stability Analysis Program (Hammond, et.al., 88) to estimate historical soil transfer rates induced by wildfire, the results were compared to results of Marion's 1981 study.
Marion found that the majority of slope failures occurred in S.R.I. soil type 21 on slopes between 30 and 40 degrees.
A Geographic Information System (G.I.S.) frequency query of the number of failures intersecting S.R.I. polygons showed that SRI units 201, 203, 212, and 21 (all SRI type 21 complexes) accounted for over 50% of the landslides. A slope map of the watershed was prepared from a digital elevation model which shows slopes bracketed <30%, 30-50%, 50-70%, and >70%. An intersection querry was then run to obtain the number of polygons and their area in which SRI 21 complexes intersected slopes >70%.

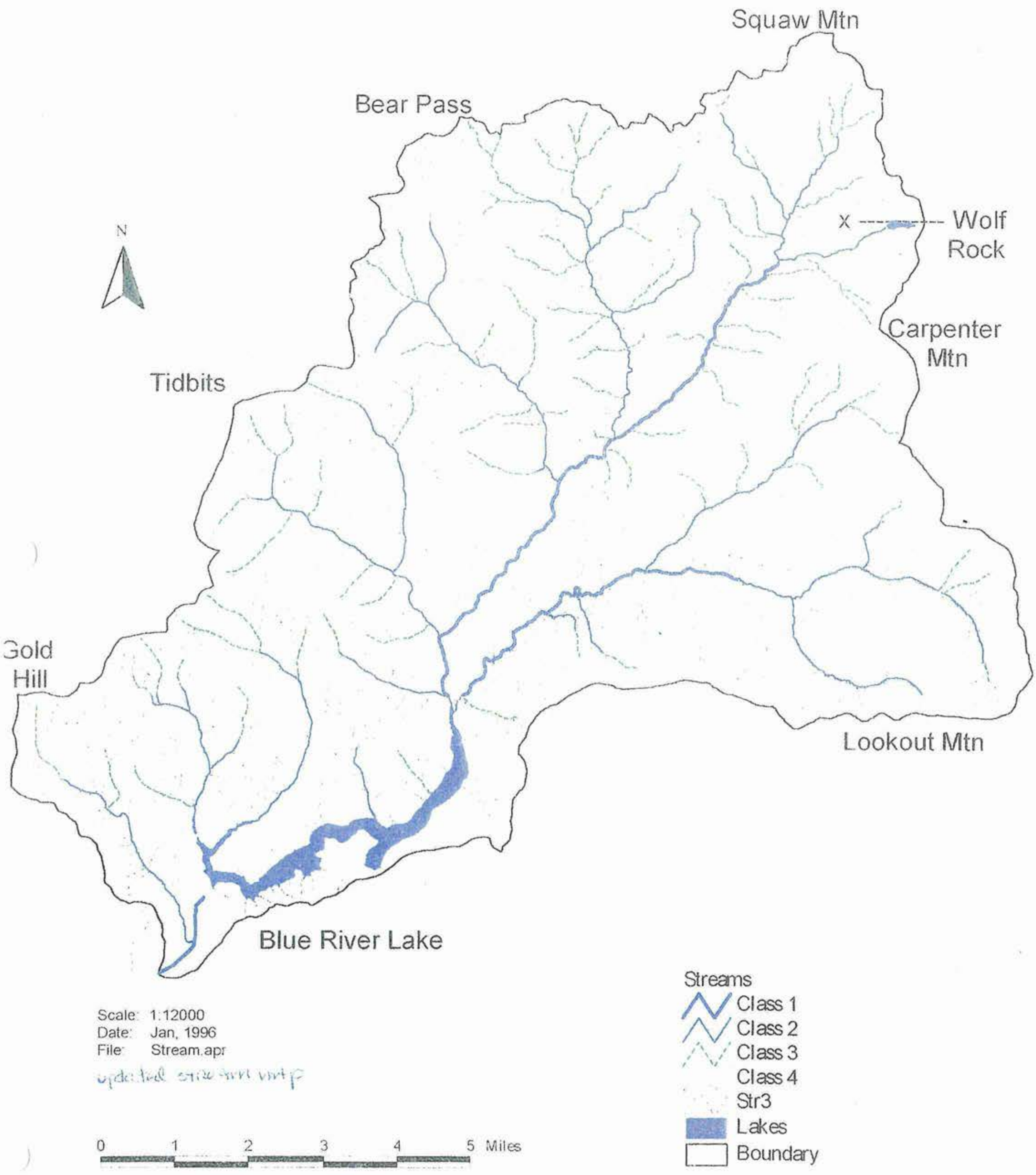
Probability Analysis

A probability analysis was made for these polygons using the Level I Stability Analysis program, LISA (91), developed by the Intermountain Research Station to statistically analyze the probability of failure within these polygons under historical fire return interval conditions coincidantal with normal and extreme precipitation events.

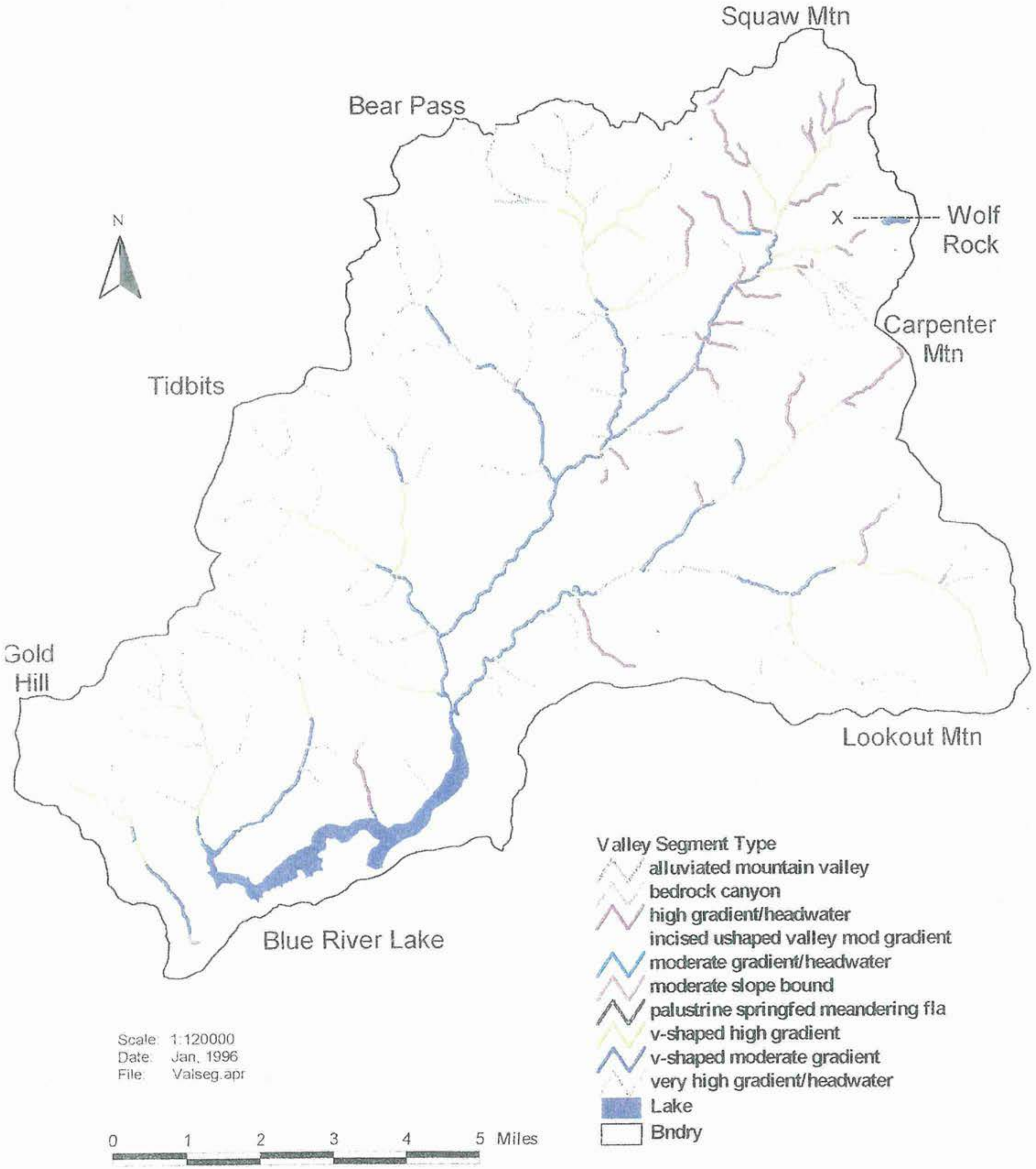
The 1973 S.R.I. database for soil engineering properties was used for assigning ranges for physical variables such as soil depth, soil classification and shear strength. Slope angles were varied as intersections occurred between the S.R.I. layer, and a Slope layer which was created by bracketing slope angles into polygons < 30%, 30-50, 50-70, and >70%. These ranges of values were then entered into LISA which develops cumulative and probability distribution functions for each variable used in the infinite slope equation to calculate a factor of safety. The equation is iterated 1,000 times using a Monte Carlo simulation subroutine to randomly select variables with the ranges and distribution functions defined to solve the equation. A factor of safety frequency histogram is produced along with a Probability of Failure. This can be interpreted as a percent of area within a polygon susceptible to failure, or the relative frequency of events.

Validation studies have been completed in areas of western and eastern Washinton and southwest Oregon by Ristau (88), McHugh (91), and Wooten (88). The results from the LISA analysis were then used to back-calculate soil transfer rate values for Landform Blocks 1 and 3 for what could be used as a reference condition prior to fire supression or human occupation. Landform Block 1 was used as a test to determine if the calulated values for soil transfer rate for reference conditions would be in the same order of magnitude as those calculated for field measured conditions by Marion (81). The results were encouraging, therefore Landform Block 3 was analyzed in the same manner to make a direct comparrison. The results are listed below.

Appendix B -- Hydrology


Squaw Mtn
Bear Pass
N
Wolf Rock
Carpenter Mtn
Tidbits
Gold Hill
Lookout Mtn
Blue River Lake
Scale: 1:12000
Date: Jan, 1996
File: Stream.apr
0 1 2 3 4 5 Miles
Streams
Class 1
Class 2
Class 3
Class 4
Str3
Lakes
Boundary

Valley Segment Types



Appendix C -- Fish

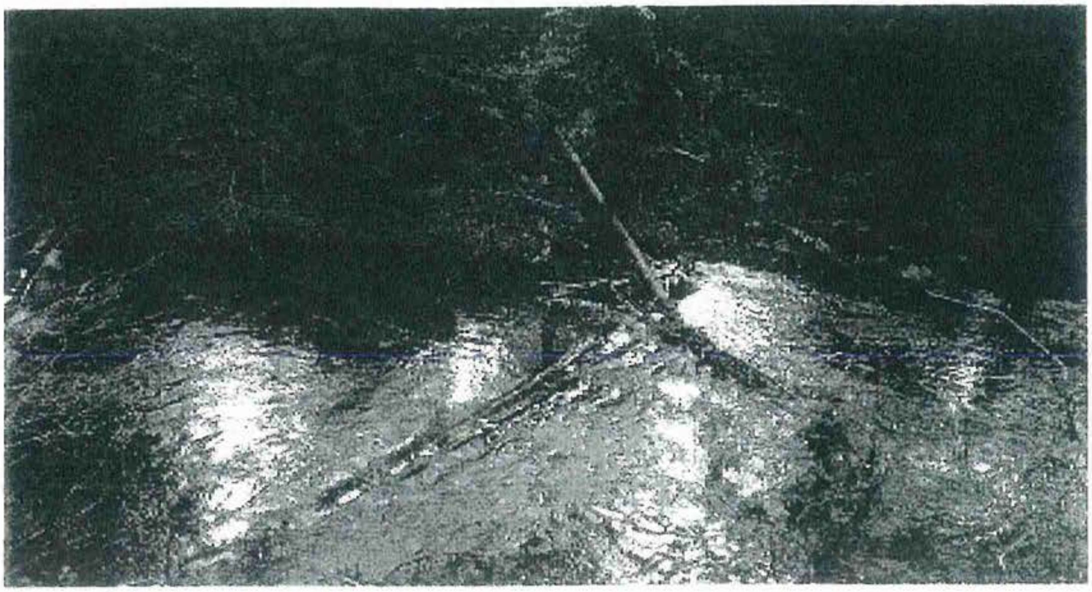
FISH SPECIES KNOWN TO EXIST WITHIN BLUE RIVER WATERSHED

COMMON NAME	SCIENTIFIC NAME	HABITAT
Pacific lamprey	*Entosphenus tridentatus*	River and tributaries below dam
Western brook lamprey	*Lampetra richardsoni*	River and tributaries
Mountain whitefish	*Prosopium williamsoni*	River
Cutthroat trout	*Salmo clarki*	River, tributaries, reservoir
Rainbow trout (wild + hatchery)	*Oncorhynchus gairdneri*	River, tributaries, reservoir
Chinook salmon	*Oncorhynchus tshawytscha*	River, tributaries, reservoir
Redside shiner	*Richardsonius balteatus*	River, tributaries, reservoir
Longnose dace	*Rhinichthys cataractae*	River and tributaries
Speckled dace	*Rhinichthys osculus*	River, tributaries, reservoir
Largescale sucker	*Catostomus macrocheilus*	Reservoir and river near it
Torrent sculpin	*Cottus rhotheus*	River, tributaries, reservoir
Piute sculpin	*Cottus beldingi*	River and tributaries
Mottled sculpin	*Cottus bairdi*	River and tributaries

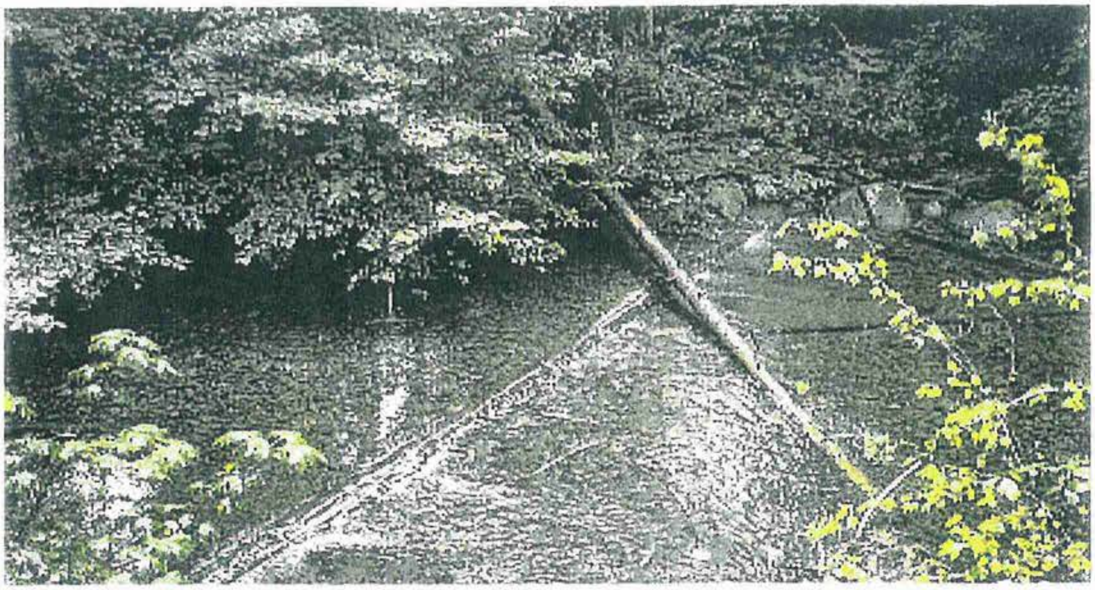
AQUATIC AMPHIBIAN SPECIES KNOWN TO EXIST WITHIN BLUE RIVER WATERSHED

COMMON NAME	SCIENTIFIC NAME	HABITAT
Cascade frog	*Rana cascadae*	Ponds
Red-legged frog	*Rana aurora*	Ponds, river, tributaries
Tree frog	*Hyla regilla*	Ponds
Northwestern salamander	*Ambystoma gracile*	Ponds
Rough-skinned newt	*Taricha granulosa*	Ponds, reservoir, river, tributaries
Western toad	*Bufo boreas*	Ponds
Pacific giant salamander	*Dicamptodon ensatus*	River and tributaries
Tailed frog	*Ascaphus truei*	In or near river and tributaries
Cascade torrent salamander	*Rhyacotriton cascadae*	Near river and tributaries
Dunn's salamander	*Plethodon dunni*	Near river and tributaries

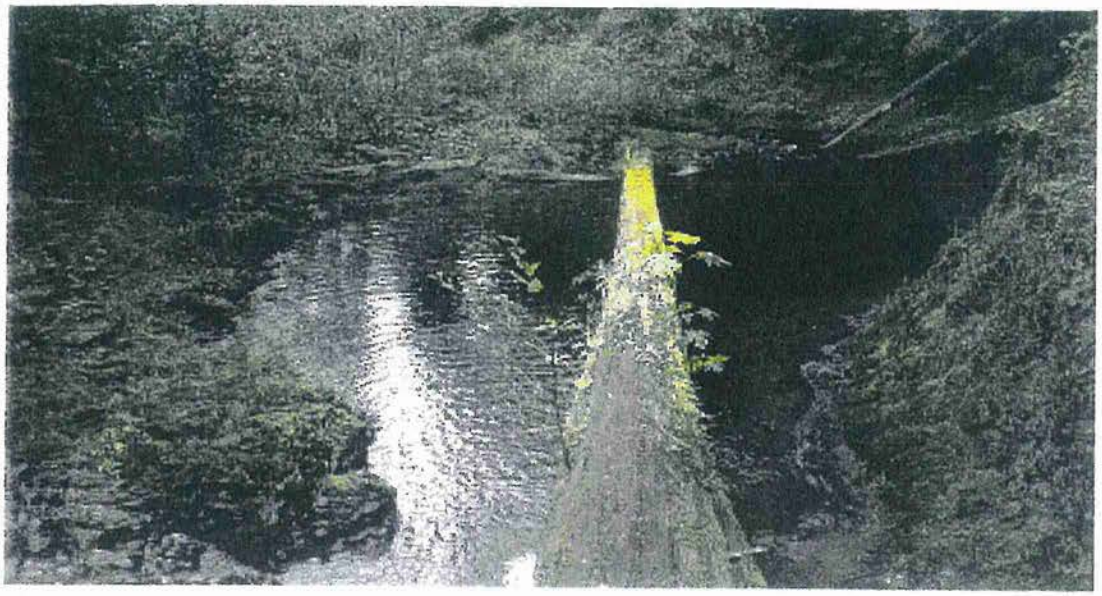
Appendix D -- Vegetation



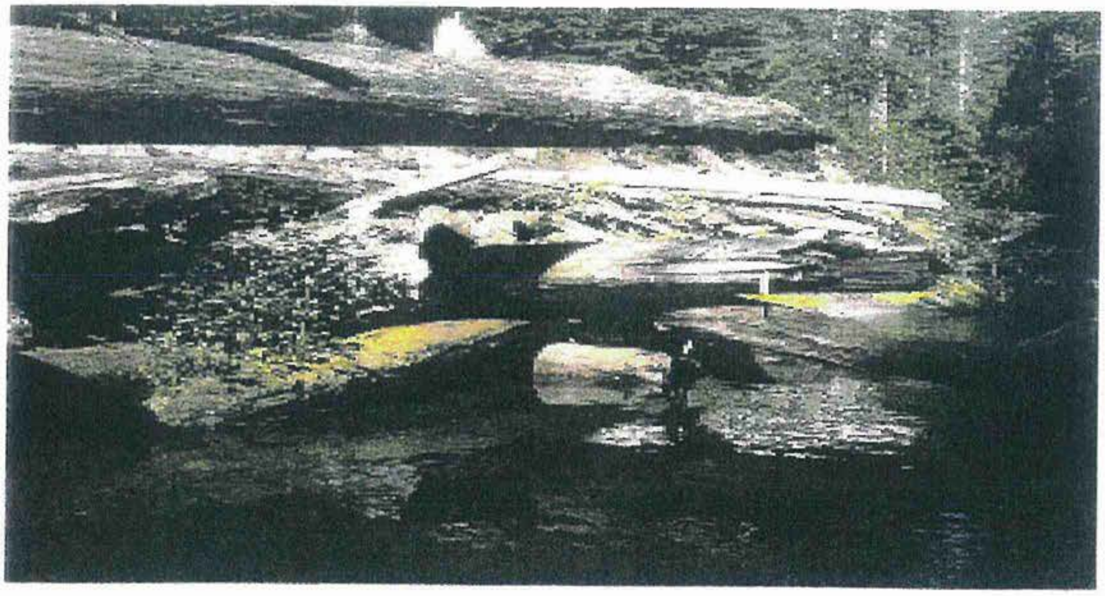
Blue River aquatic ecosystem restoration project photopoint monitoring. Photopoint 2 taken autumn 1993. Notice logs attached to bare bedrock. The wood was placed on bedrock in summer 1993.



Blue River aquatic ecosystem restoration project photopoint monitoring. Photopoint 2 taken summer 1995. Notice recruitment of gravels on once bare bedrock.



Bedrock controlled pool in Lower Quentin Creek, October 1994.

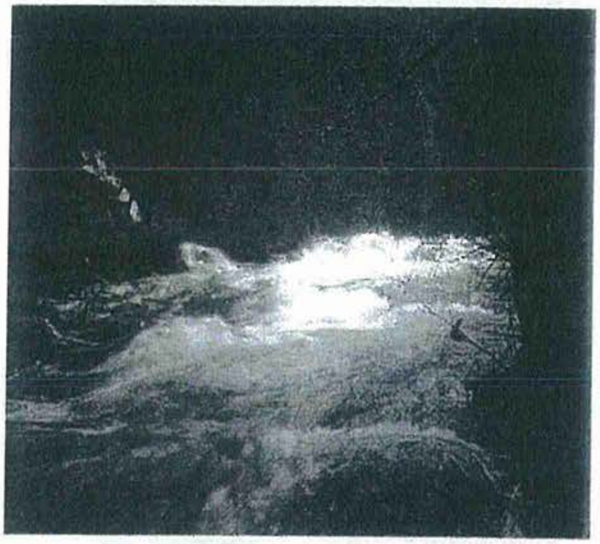


Large wood in pool of lower Quentin Creek, October 1994.

Bedrock controlled pool in Lower Quentin Creek, October 1994.

Large wood in pool of lower Quentin Creek, October 1994.

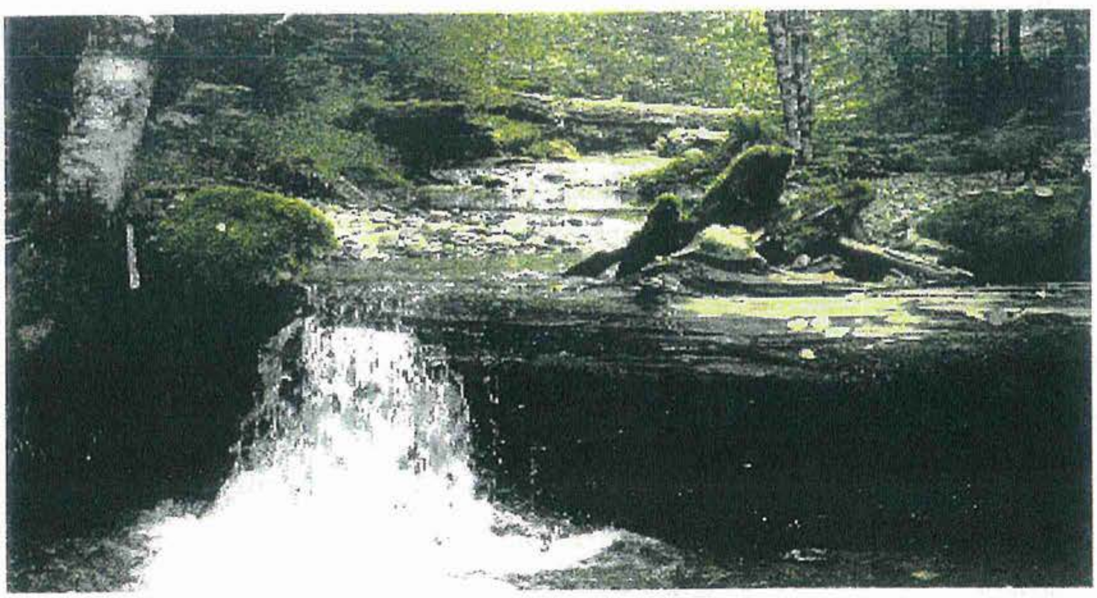
Pool 4011 of the Pool Complexity Study at Tidbits Creek. Photo taken in the autumn after the installation of the large wood complexes.



Pool 4011 of the Pool Complexity Study at Tidbits Creek. Photo taken in the winter after the installation of the large wood complexes.

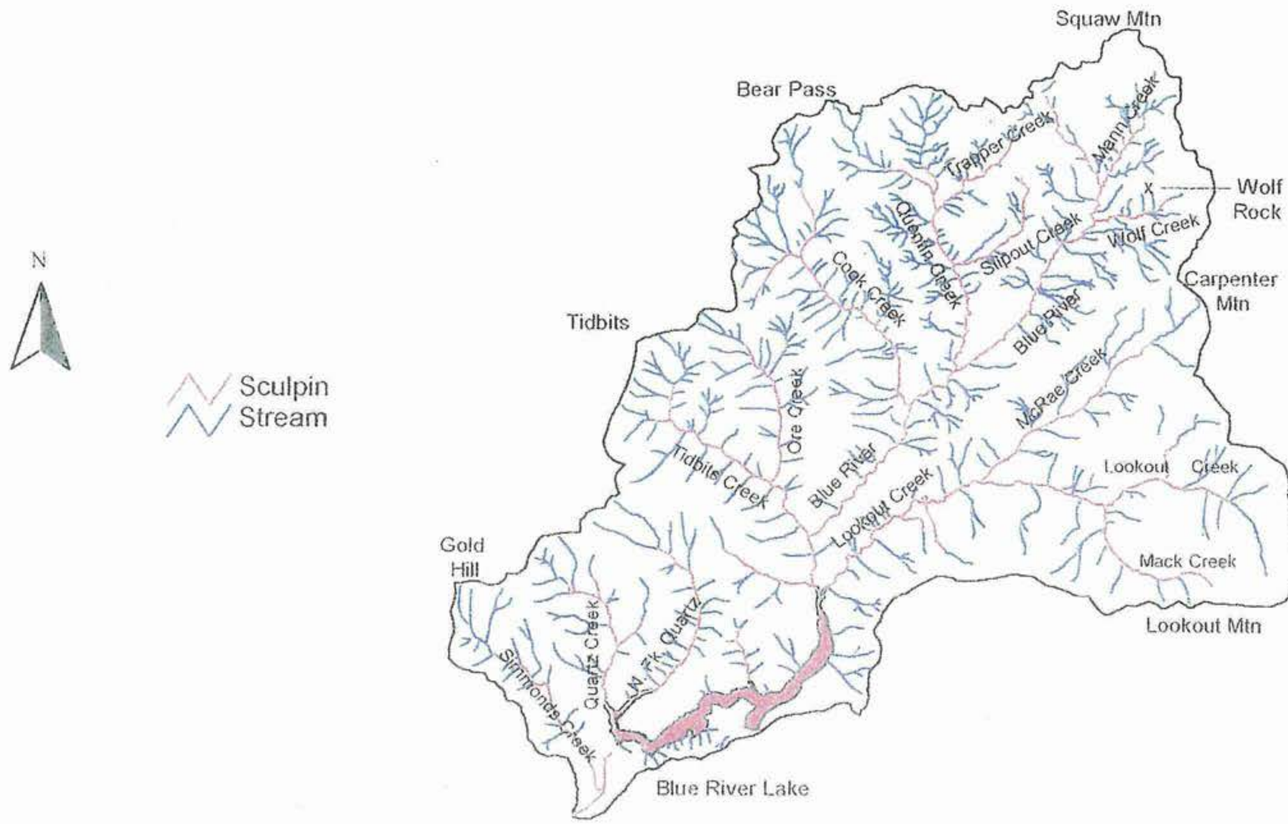
Pool 4011 of the Pool Complexity Study at Tidbits Creek. Photo taken in the spring after the installation of the large wood complexes.

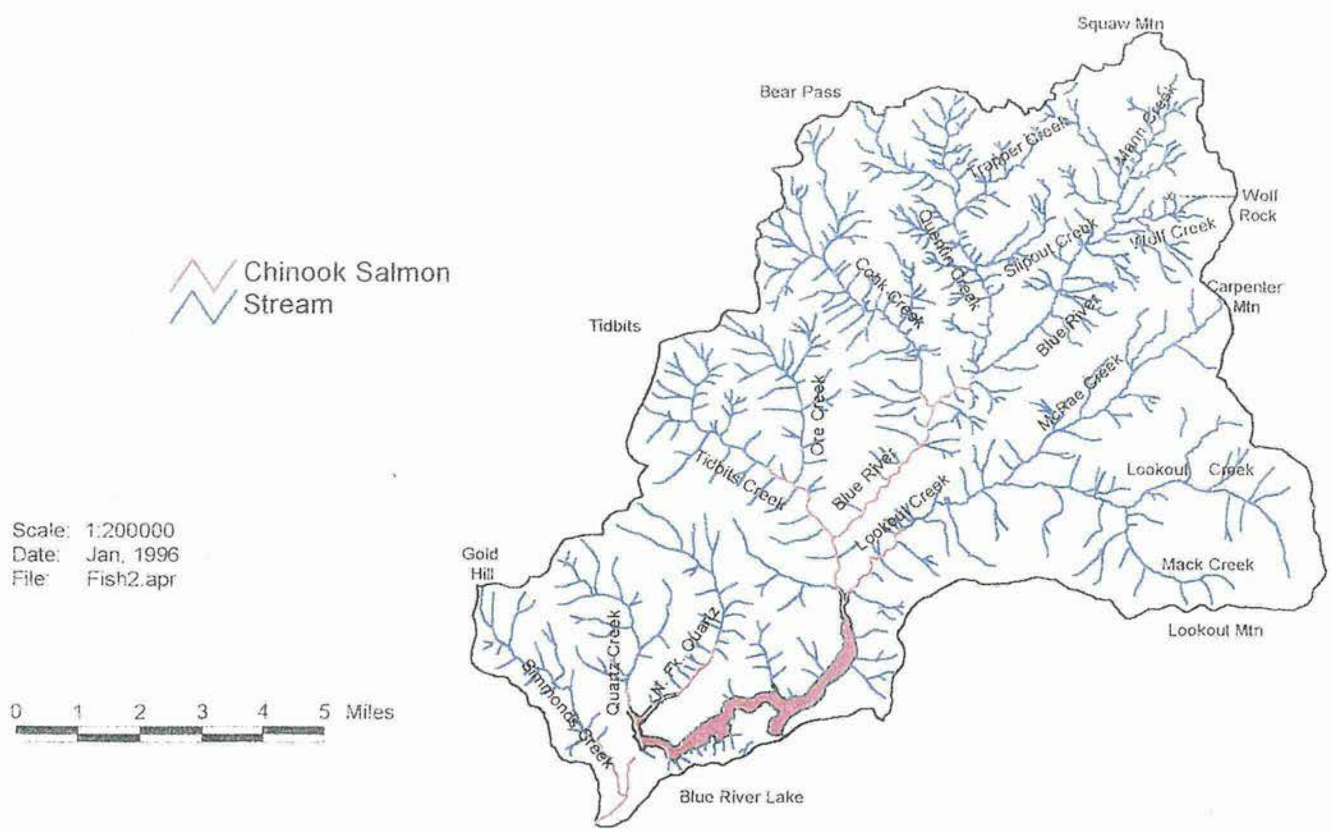
Exposed bedrock as stream substrate in Simmonds Creek, July 1993.



Water plunges over an embedded log in North Fork Quartz Creek, August 1993.

Sculpin and Chinook Salmon Distribution





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Date: Jan, 1996
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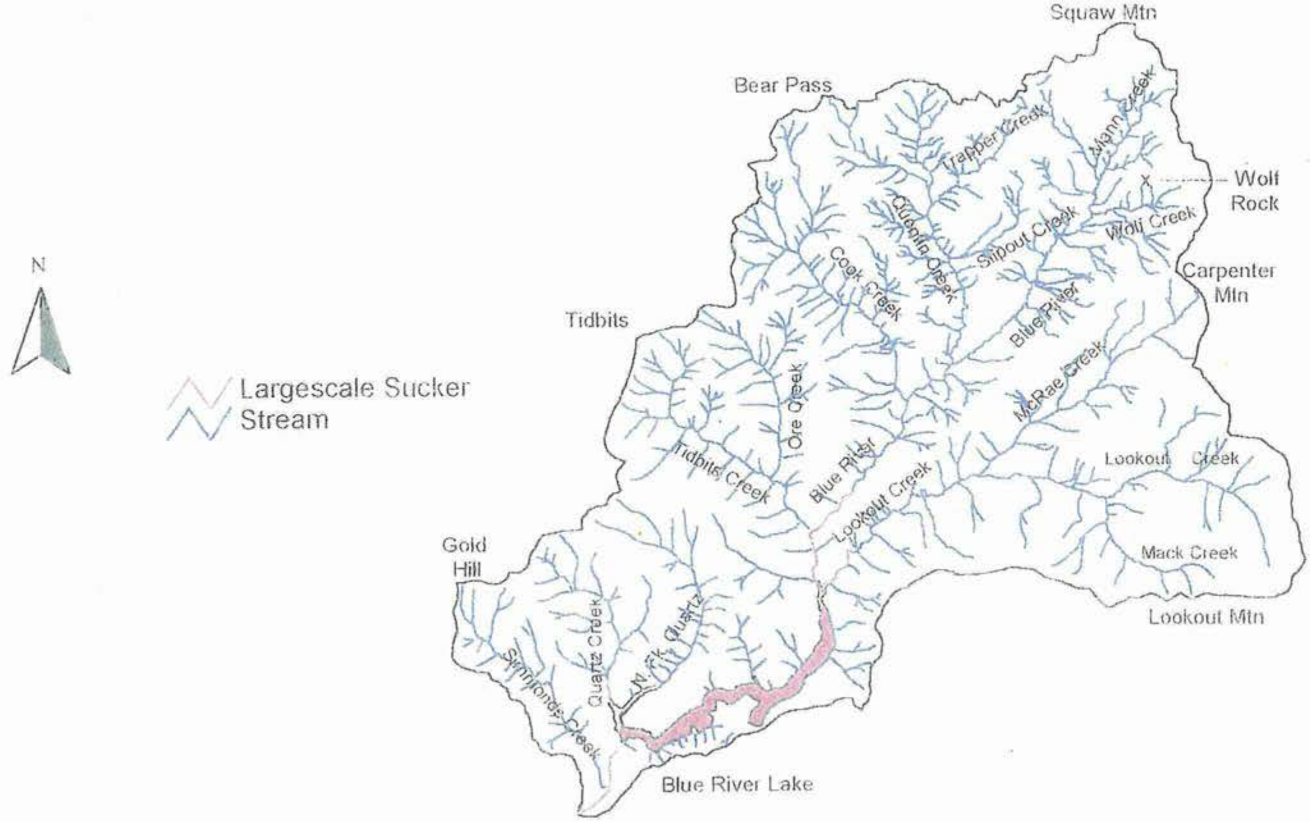
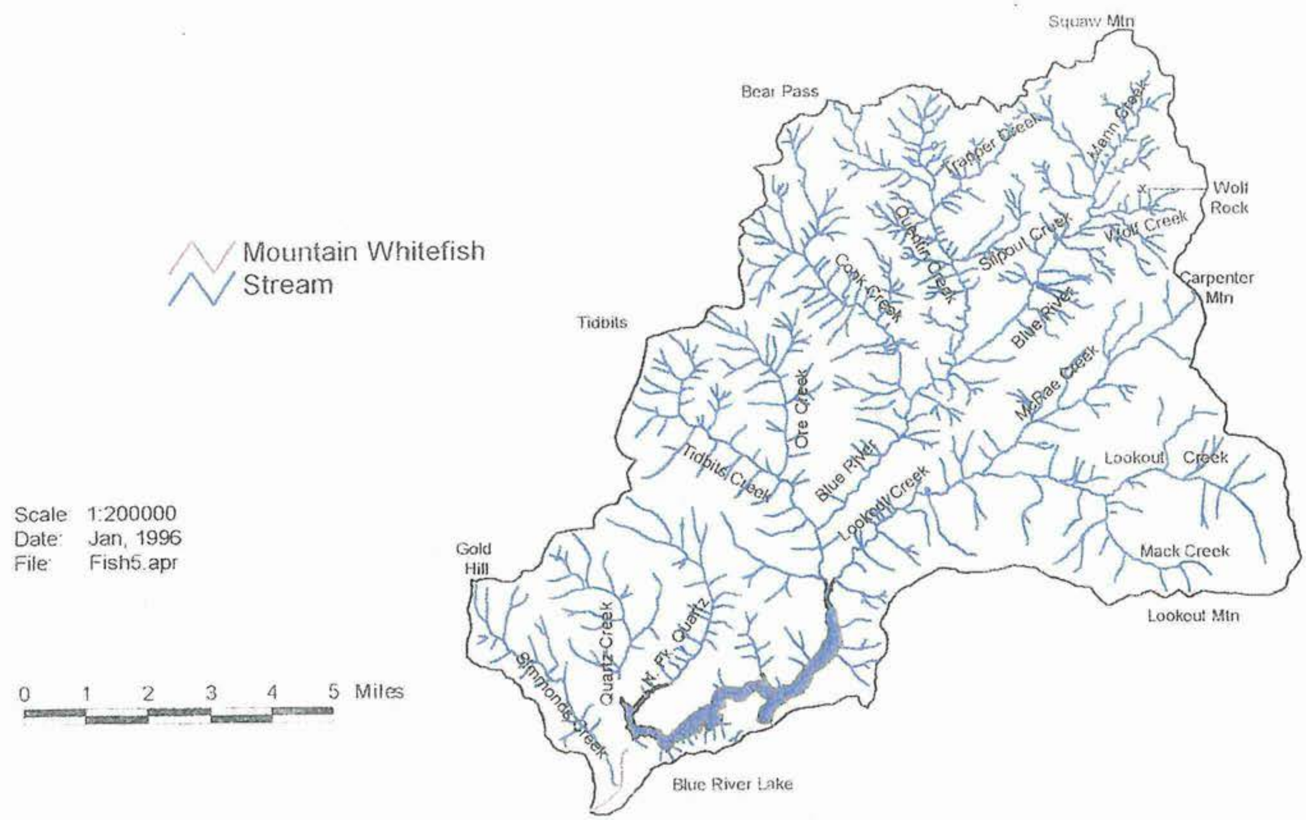
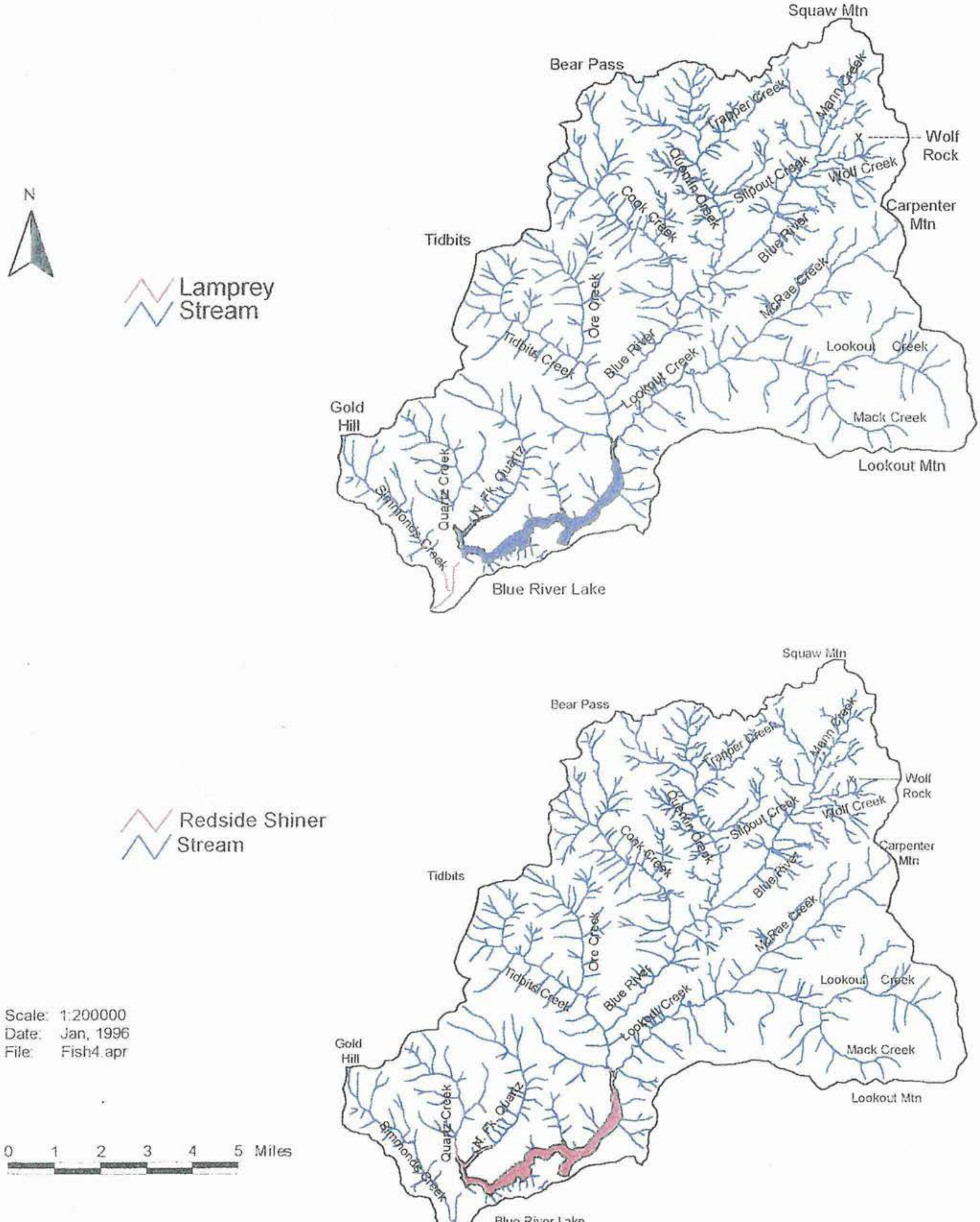
Largescale Sucker and Mountain Whitefish Distribution

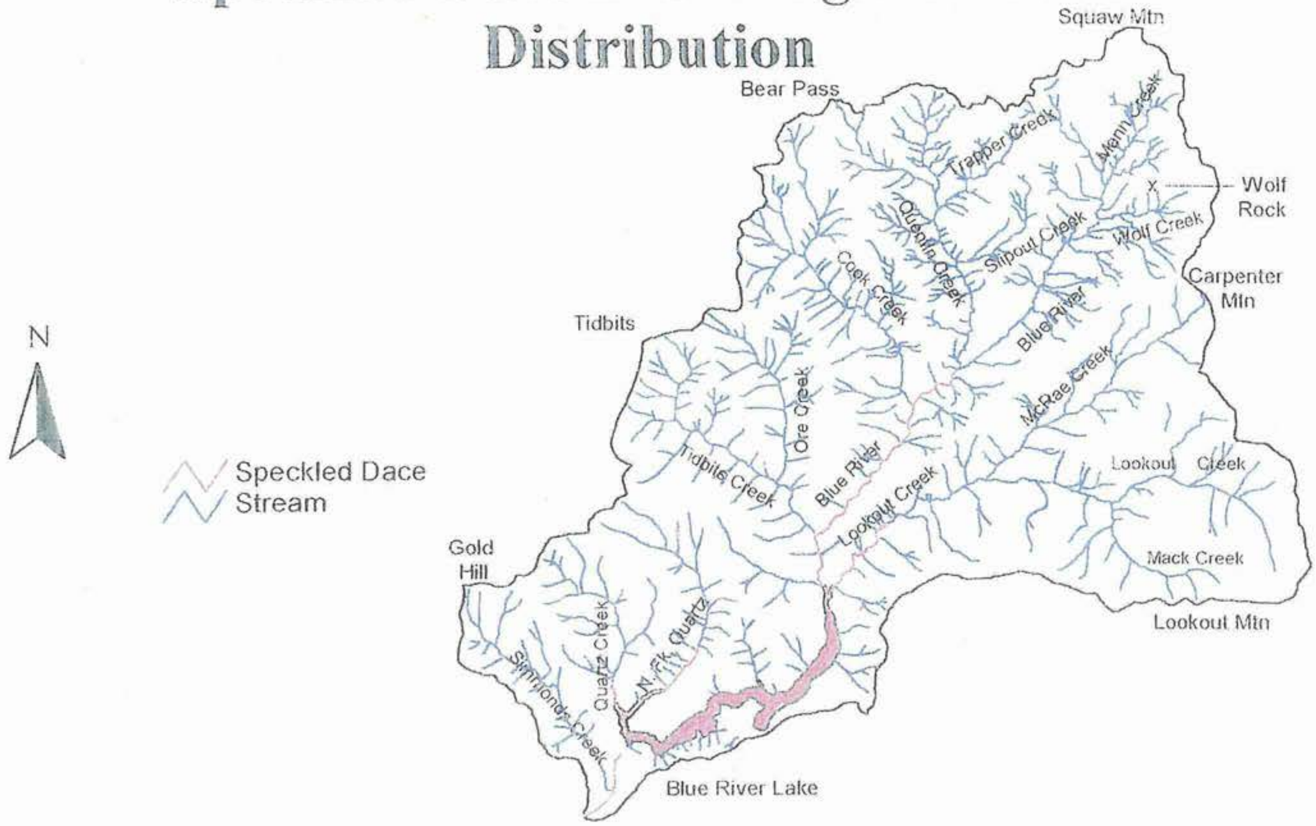


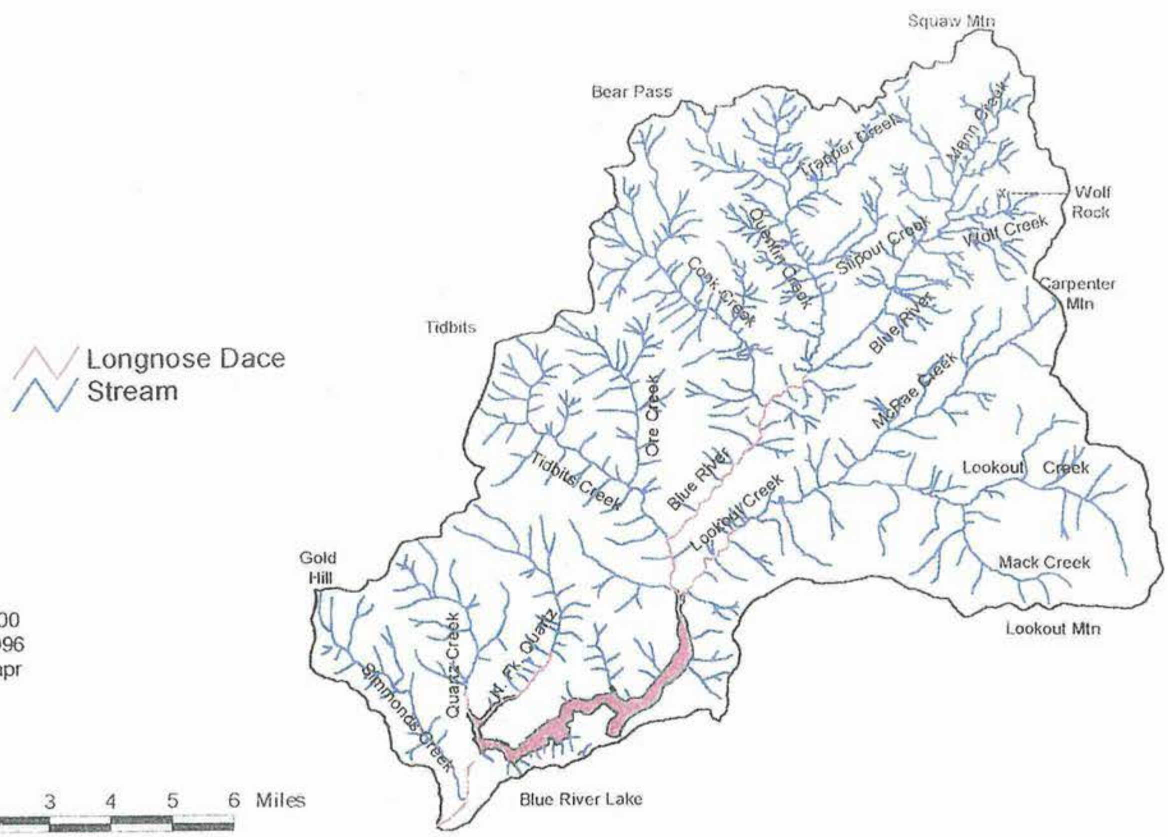


Lamprey and Redside Shiner Distribution



Speckled Dace and Longnose Dace Distribution





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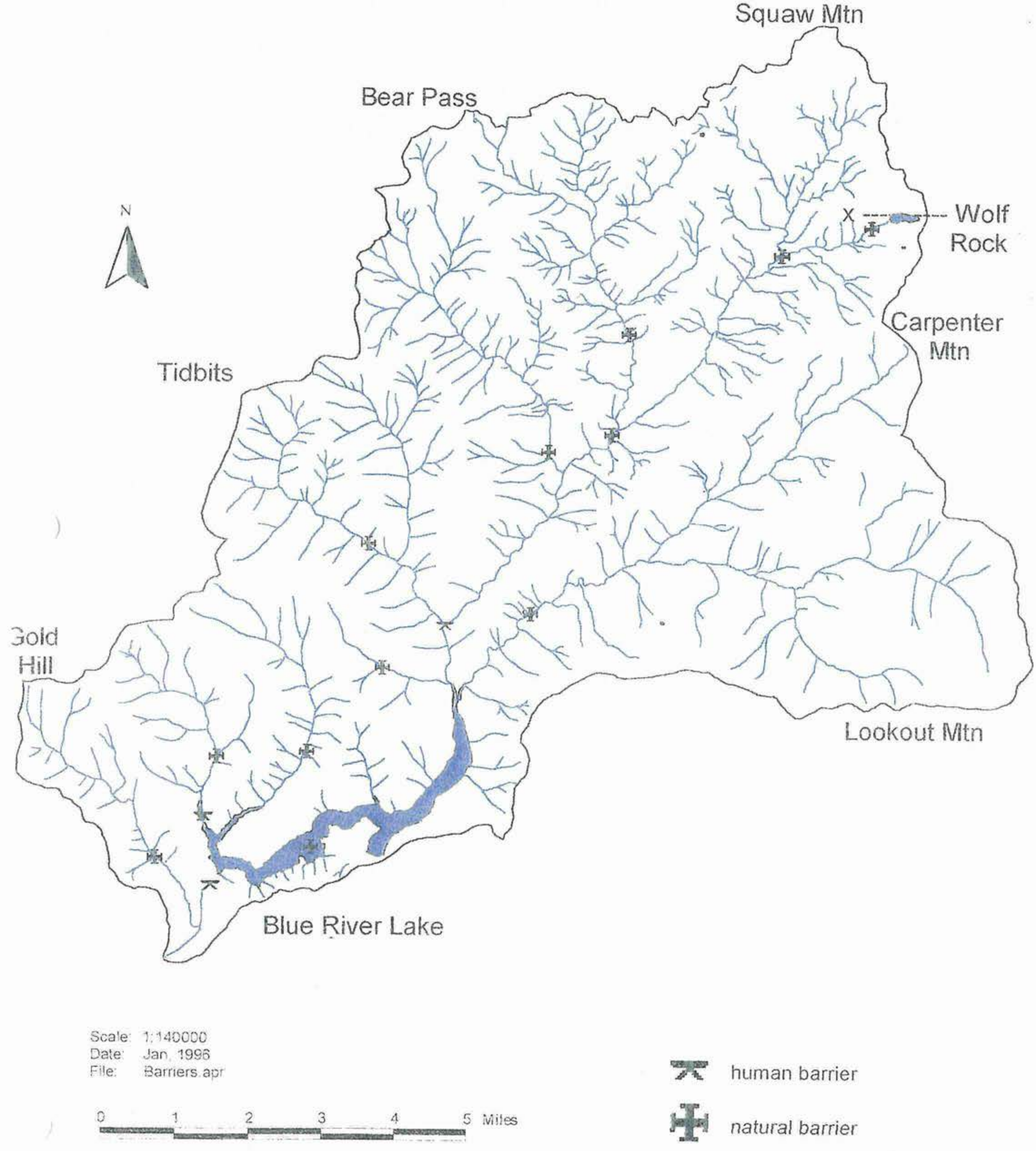
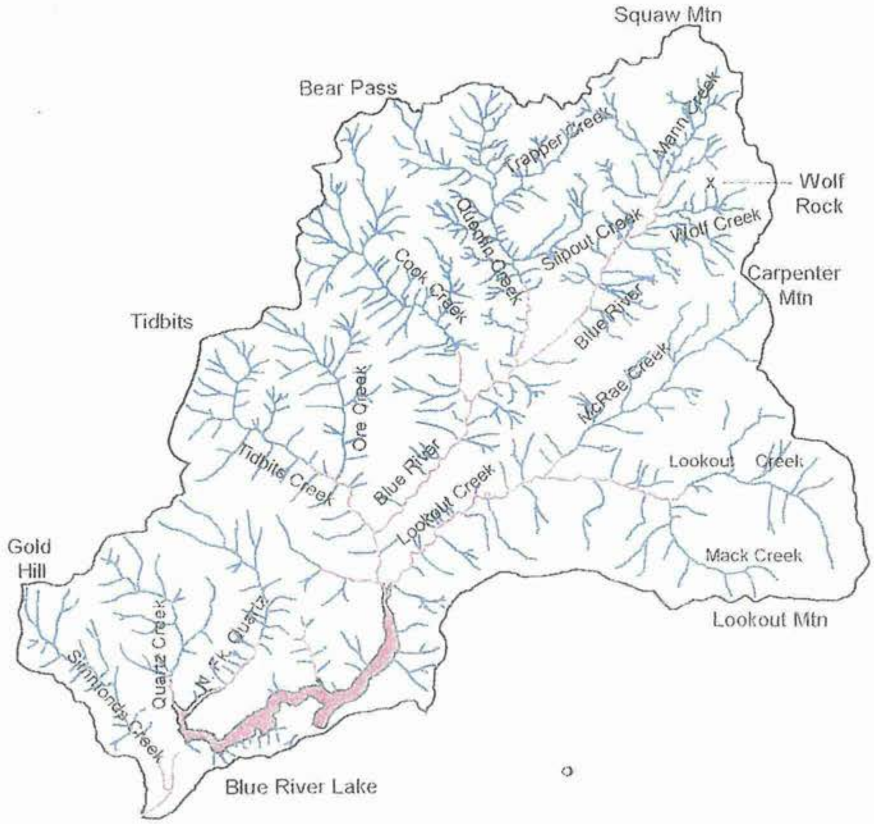
Date: Jan, 1996
File: Fish2.apr

0 1 2 3 4 5 6 Miles

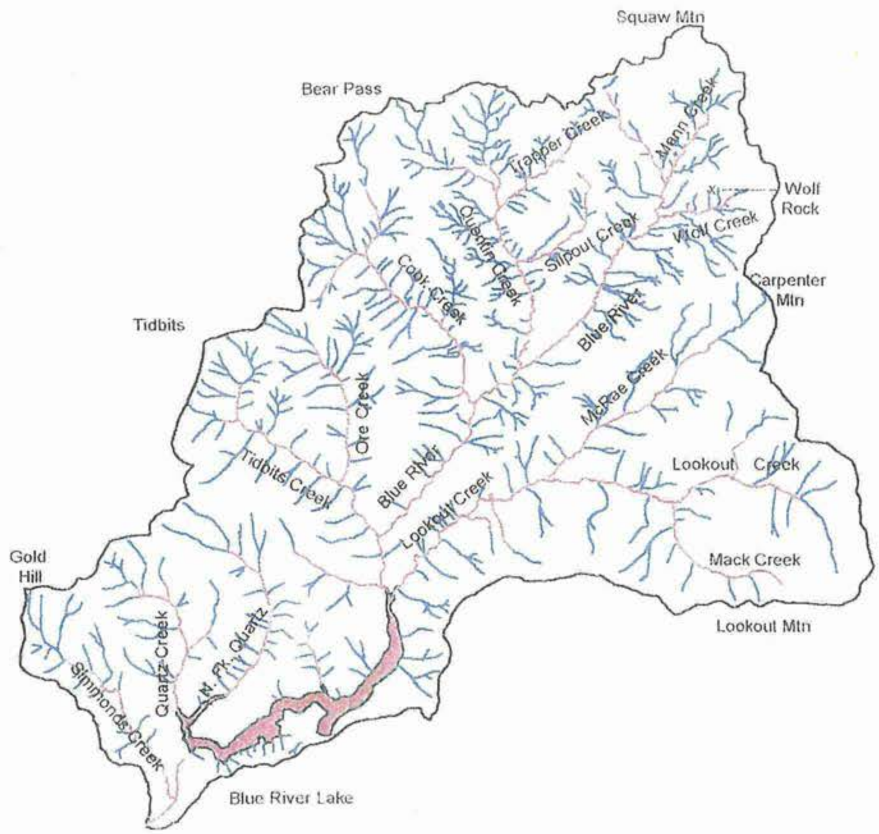
Significant Upstream Migration Barriers



Rainbow Trout and Cutthroat Trout Distribution



Rainbow Trout
Stream



Cutthroat Trout
Stream

N

Scale: 1:200000
Date: Jan, 1996
File: Fish1.apr

0 1 2 3 4 5 Miles

Appendix **Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants**

BRYOPHYTE

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Ptilidium californicum	1	1, 2	LS/OG	LDD, M/W	high
Antitrichia curtipendula	1	4	LS/OG	RZ, M/W	low
Douinia ovata	1	4	LS/OG	RZ, M/W, RO	low to mid
Kurzia makinoana	3	1, 2	LS/OG	RZ, LDD, M/W	low
Marsupella emarginata var. aquatica	3	1, 2		RZ	mid to high
Tritomaria exsectiformis	3	1, 2	LS/OG	RZ, RO	low to high
Plagiochila satori	3	1, 3	LS/OG	LDD, RO	low
Tetraphis geniculata	3	1, 3	LS/OG	LDD, M/W	low to mid
Tritomaria quinquedentata	3	1, 3	LS/OG	RO	
Scouleria marginata	3	4		RZ	
Bartramiopsis lescurii	4	1, 3	LS/OG	LDD	
Encalypta brevicolla ssp. crumiana	4	1, 3	LS/OG	M/W, RO	

FUNGI - Mycorrhizal

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Destuntzia fusca	1	1, 3	LS/OG		low
Leucogaster microsporus	1	1, 3	LS/OG	LDD	mid
Boletus piperatus	1	3		LDD	low to mid
Gomphus clavatus	1	3	LS/OG		
Gomphus floccosus	1	3	LS/OG		
Hydnum repandum	1	3	LS/OG, 2G		
Rhizopogon truncatus	1	3	LS/OG		high
Cantharellus cibarius	1	3, 4	LS/OG, 2G	LDD	
Cantharellus subalbidus	1	3, 4	LS/OG, 2G	LDD	
Choiromyces venosus	2	1, 3	LS/OG		
Ramaria rubrievanescens	2	1, 3	LS/OG	LDD	
Rhizopogon inquinatus	2	1, 3	LS/OG, 2G	LDD	
Alpova alexsmithii	3	1, 3	LS/OG		mid to high
Arcangeliella crassa	3	1, 3	LS/OG	LDD	mid to high
Boletus haematinus	3	1, 3			high
Boletus pulcherrimus	3	1, 3	LS/OG		low to mid
Cantharellus formosus	3	1, 3	LS/OG	LDD	
Choiromyces alveolatus	3	1, 3	LS/OG	LDD	mid to high
Cortinarius boulderensis	3	1, 3	LS/OG		low to high
Cortinarius magnivelatus	3	1, 3	LS/OG		low to high

Appendix **Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants**

BRYOPHYTE

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Ptilidium californicum	1	1, 2	LS/OG	LDD, M/W	high
Antitrichia curtipendula	1	4	LS/OG	RZ, M/W	low
Douinia ovata	1	4	LS/OG	RZ, M/W, RO	low to mid
Kurzia makinoana	3	1, 2	LS/OG	RZ, LDD, M/W	low
Marsupella emarginata var. aquatica	3	1, 2		RZ	mid to high
Tritomaria exsectiformis	3	1, 2	LS/OG	RZ, RO	low to high
Plagiochila satori	3	1, 3	LS/OG	LDD, RO	low
Tetraphis geniculata	3	1, 3	LS/OG	LDD, M/W	low to mid
Tritomaria quinquedentata	3	1, 3	LS/OG	RO	
Scouleria marginata	3	4		RZ	
Bartramiopsis lescurii	4	1, 3	LS/OG	LDD	
Encalypta brevicolla ssp. crumiana	4	1, 3	LS/OG	M/W, RO	

FUNGI - Mycorrhizal

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Destuntzia fusca	1	1, 3	LS/OG		low
Leucogaster microsporus	1	1, 3	LS/OG	LDD	mid
Boletus piperatus	1	3		LDD	low to mid
Gomphus clavatus	1	3	LS/OG		
Gomphus floccosus	1	3	LS/OG		
Hydnum repandum	1	3	LS/OG, 2G		
Rhizopogon truncatus	1	3	LS/OG		high
Cantharellus cibarius	1	3, 4	LS/OG, 2G	LDD	
Cantharellus subalbidus	1	3, 4	LS/OG, 2G	LDD	
Choiromyces venosus	2	1, 3	LS/OG		
Ramaria rubrievanescens	2	1, 3	LS/OG	LDD	
Rhizopogon inquinatus	2	1, 3	LS/OG, 2G	LDD	
Alpova alexsmithii	3	1, 3	LS/OG		mid to high
Arcangeliella crassa	3	1, 3	LS/OG	LDD	mid to high
Boletus haematinus	3	1, 3			high
Boletus pulcherrimus	3	1, 3	LS/OG		low to mid
Cantharellus formosus	3	1, 3	LS/OG	LDD	
Choiromyces alveolatus	3	1, 3	LS/OG	LDD	mid to high
Cortinarius boulderensis	3	1, 3	LS/OG		low to high
Cortinarius magnivelatus	3	1, 3	LS/OG		low to high

Appendix Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants

FUNGI - Mycorrhizal

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Dermocybe humboldtensis	3	1, 3	LS/OG		low
Gastroboletus ruber	3	1, 3	LS/OG	LDD	mid to high
Gautieria magnicellaris	3	1, 3	LS/OG		high
Hebeloma olympiana	3	1, 3	LS/OG		low to high
Hygrophorus caeruleus	3	1, 3	LS/OG		low to high
Hygrophorus vernalis	3	1, 3	LS/OG		low to high
Leucogaster citrinus	3	1, 3	LS/OG	LDD	low to high
Martellia idahoensis	3	1, 3	LS/OG		mid to high
Martellia monticola	3	1, 3	LS/OG	LDD	mid to high
Phaeocollybia californica	3	1, 3	LS/OG	M/W	low to high
Phaeocollybia carmanahensis	3	1, 3	LS/OG	M/W	low to high
Phaeocollybia dissiliens	3	1, 3	LS/OG	M/W	low to high
Phaeocollybia gregaria	3	1, 3	LS/OG	M/W	low to high
Phaeocollybia kauffmanii	3	1, 3	LS/OG	M/W	low to high
Phaeocollybia oregonenis	3	1, 3	LS/OG	M/W	low to high
Phaeocollybia piceae	3	1, 3	LS/OG	M/W	low to high
Phaeocollybia scatesiae	3	1, 3	LS/OG	M/W	low to high
Phaeocollybia sipei	3	1, 3	LS/OG	M/W	low to high
Ramaria abietina	3	1, 3	LS/OG	LDD	
Ramaria amyloidea	3	1, 3	LS/OG	LDD	
Ramaria araiospora	3	1, 3	LS/OG	LDD	
Ramaria aurantiisiccescens	3	1, 3	LS/OG	LDD	
Ramaria botryis var. aurantiiramosa	3	1, 3	LS/OG	LDD	
Ramaria celerivirescens	3	1, 3	LS/OG	LDD	
Ramaria claviramulata	3	1, 3	LS/OG	LDD	
Ramaria concolor f. marri	3	1, 3	LS/OG	LDD	
Ramaria concolor f. tsugina	3	1, 3	LS/OG	LDD	
Ramaria coulterae	3	1, 3	LS/OG	LDD	
Ramaria cyaneigranosa	3	1, 3	LS/OG	LDD	
Ramaria fasciculata var. sparsiramosa	3	1, 3	LS/OG	LDD	
Ramaria gelatiniaurantia	3	1, 3	LS/OG	LDD	
Ramaria gracilis	3	1, 3	LS/OG	LDD	
Ramaria hilaris var. olympiana	3	1, 3	LS/OG	LDD	
Ramaria largentii	3	1, 3	LS/OG	LDD	
Ramaria lorithamnus	3	1, 3	LS/OG	LDD	
Ramaria maculatipes	3	1, 3	LS/OG	LDD	
Ramaria rainierensis	3	1, 3	LS/OG	LDD	
Ramaria rubella var. blanda	3	1, 3	LS/OG	LDD	

Appendix Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants

FUNGI - Mycorrhizal

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Ramaria rubribrunnescens	3	1, 3	LS/OG	LDD	
Ramaria rubripermanens	3	1, 3	LS/OG	LDD	
Ramaria spinulosa	3	1, 3	LS/OG	LDD	
Ramaria stuntzii	3	1, 3	LS/OG	LDD	
Ramaria suecica	3	1, 3	LS/OG	LDD	
Ramaria thiersii	3	1, 3	LS/OG	LDD	
Ramaria verlotensis	3	1, 3	LS/OG	LDD	
Rhizopogon brunneiniger	3	1, 3	LS/OG		low to high
Rhizopogon exiguus	3	1, 3	LS/OG		low
Catathelasma ventricosa	3	3	LS/OG		low to mid
Cortinarius azureus	3	3	LS/OG		low to high
Cortinarius cyanites	3	3	LS/OG		low to high
Cortinarius spilomius	3	3	LS/OG		low to high
Cortinarius tabularis	3	3	LS/OG		low to high
Cortinarius valgus	3	3	LS/OG		low to high
Gomphus bonarii	3	3	LS/OG		
Gomphus kauffmanii	3	3	LS/OG		
Hydnum umbilicatum	3	3	LS/OG, 2G		
Hygrophorus karstenii	3	3	LS/OG		low to high
Phaeocollybia attenuata	3	3	LS/OG	M/W	low to high
Phaeocollybia fallax	3	3	LS/OG	M/W	low to high
Phaeocollybia olivacea	3	3	LS/OG	M/W	low to high
Phaeocollybia pseudofestiva	3	3	LS/OG	M/W	low to high
Phaeocollybia spadicea	3	3	LS/OG	M/W	low to high
Phellodon atratum	3	3	LS/OG, 2G		
Rhizopogon atroviolaceus	3	3	LS/OG		high
Russula mustelina	3	3	LS/OG		low to mid
Sarcodon fuscoindicum	3	3	LS/OG, 2G		
Sarcodon imbricatus	3	3	LS/OG, 2G		
Thaxterogaster pingue	3	3		LDD	mid to high
Cantharellus tubaeformis	3	3, 4	LS/OG	LDD	
Albatrellus avellaneus	4	1, 3	LS/OG		
Cortinarius canabarba	4	1, 3	LS/OG	LDD	
Cortinarius rainierensis	4	1, 3	LS/OG	LDD	
Cortinarius variipes	4	1, 3	LS/OG	LDD	
Nivatogastrium nubigenum	4	1, 3	LS/OG	LDD, D	mid to high
Sedecula pulvinata	4	1, 3	LS/OG	LDD	mid to high
Tricholoma venenatum	4	1, 3	LS/OG	LDD	low to mid

Appendix Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants

FUNGI - Mycorrhizal

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Albatrellus ellisii	4	3	LS/OG		
Albatrellus flettii	4	3	LS/OG		
Rhizopogon abietis	4	3	LS/OG		high

FUNGI - Saprobe

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Sparassis crispa	1	3	LS/OG		low to mid
Clavariadelphus ligula	1	3, 4	LS/OG	LDD, M/W	
Aleurodiscus farlowii	2	1, 3	LS/OG	LDD	
Plectania melastoma	2	3	LS/OG	LDD	
Bondarzewia montana	3	1, 2, 3	LS/OG	LDD	high
Oxyporus nobilissimus	3	1, 2, 3	LS/OG	LDD	
Clitocybe senilis	3	1, 3	LS/OG	LDD, M/W	low to mid
Clitocybe subditopoda	3	1, 3	LS/OG	LDD, M/W	low to mid
Collybia bakerensis	3	1, 3	LS/OG	LDD	low to mid
Dichostereum granulosum	3	1, 3	LS/OG	LDD	
Gelatindiscus flavidus	3	1, 3	LS/OG		
Gymnopilus puntifolius	3	1, 3	LS/OG	LDD	low to mid
Helvella compressa	3	1, 3	LS/OG	RZ, M/W	low to mid
Helvella crassitunicata	3	1, 3	LS/OG	RZ, M/W	low to mid
Helvella elastica	3	1, 3	LS/OG	RZ, M/W	low to mid
Helvella maculata	3	1, 3	LS/OG	RZ, M/W	low to mid
Marasmius applanatipes	3	1, 3	LS/OG	LDD	low to mid
Mycena hudsoniana	3	1, 3	LS/OG	RZ, LDD	low to mid
Mycena monticola	3	1, 3	LS/OG	RZ, LDD	low to mid
Mycena overholtzii	3	1, 3	LS/OG	RZ, LDD	low to mid
Mycena quinaultensis	3	1, 3	LS/OG	RZ, LDD	low to mid
Neoumula pouchetii	3	1, 3	LS/OG	LDD	
Otidea smithii	3	1, 3	LS/OG	LDD, M/W	low to mid
Pholiota albivelata	3	1, 3	LS/OG	RZ, LDD	low to mid
Pithya vulgaris	3	1, 3			high
Plectania latahensis	3	1, 3	LS/OG	LDD	high
Plectania milleri	3	1, 3		LDD	high
Asterophora lycoperdoides	3	3	LS/OG	LDD	
Asterophora parasitica	3	3	LS/OG	LDD	

Appendix Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants

FUNGI - Saprobe

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Baeospora myriadophylla	3	3	LS/OG	LDD	low to mid
Chrysomphalina grossula	3	3	LS/OG	LDD	low to mid
Clavicorona avellanea	3	3	LS/OG	LDD, M/W	low to mid
Cordycepys capitata	3	3	LS/OG	LDD	
Cordycepys ophioglossoides	3	3	LS/OG	LDD	
Cudonia monticola	3	3	LS/OG	LDD	
Cyphellostereum laeve	3	3	LS/OG	M/W	
Fayodia gracilipes (rainierensis)	3	3	LS/OG	LDD	low to mid
Gallerina atkinsoniana	3	3	LS/OG	M/W	
Gallerina cerina	3	3	LS/OG	M/W	
Gallerina heterocystis	3	3	LS/OG	M/W	
Gallerina sphagnicola	3	3	LS/OG	RZ, M/W	
Gallerina vaittaeformis	3	3	LS/OG	M/W	
Hypomyces luteovirens	3	3	LS/OG	LDD	
Mycena lilacifolia	3	3	LS/OG	RZ, LDD	low to mid
Mycena marginella	3	3	LS/OG	RZ, LDD	low to mid
Mycena tenax	3	3	LS/OG	RZ, LDD	low to mid
Mythicomyces corneipes	3	3	LS/OG	LDD	low to mid
Otidea leporina	3	3	LS/OG	LDD, M/W	low to mid
Otidea onotica	3	3	LS/OG	LDD, M/W	low to mid
Podostroma alutaceum	3	3	LS/OG	LDD	
Rickenella setipes	3	3	LS/OG	RZ, M/W	
Sarcosphaera eximia	3	3		D	
Spathularia flavida	3	3	LS/OG	LDD	
Stagnicola perplexa	3	3	LS/OG	LDD	low to mid
Clavariadelphus borealis	3	3, 4	LS/OG	LDD, M/W	
Clavariadelphus lovejoyae	3	3, 4	LS/OG	LDD, M/W	
Clavariadelphus pistilaris	3	3, 4	LS/OG	LDD, M/W	
Clavariadelphus sachalinensis	3	3, 4	LS/OG	LDD, M/W	
Clavariadelphus subfastigiatus	3	3, 4	LS/OG	LDD, M/W	
Clavariadelphus truncatus	3	3, 4	LS/OG	LDD, M/W	
Clavulina cinerea	3	3, 4	LS/OG, 2G	LDD	
Clavulina cristata	3	3, 4	LS/OG, 2G	LDD	
Clavulina ornatipes	3	3, 4	LS/OG, 2G	LDD	
Gyromitra californica	3	3, 4		RZ, LDD	
Gyromitra esculenta	3	3, 4	2G	LDD	
Gyromitra infula	3	3, 4		LDD	
Gyromitra melaleucoides	3	3, 4		LDD	

Appendix Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants

FUNGI - Saprobe

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Gyromitra montana (syn. G. gigas)	3	3, 4		LDD	
Phlogoitis helevlloides	3	3, 4	LS/OG	RZ, LDD	
Phytoconis ericetorum	3	3, 4	LS/OG	LDD	

LICHEN

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Lobaria linita	1	1, 2, 3	LS/OG	RO	mid to high
Pseudocyphellaria rainierensis	1	1, 2, 3	LS/OG		low to mid
Hydrothyria venosa	1	1, 3	LS/OG	RZ	low to mid
Hypogymnia oceanica	1	1, 3	LS/OG		
Leptogium rivale	1	1, 3	LS/OG	RZ, RO	low to mid
Nephroma occultum	1	1, 3	LS/OG		low to mid
Calicium viride	1	4	LS/OG		
Lobaria oregana	1	4	LS/OG	M/W	low to mid
Lobaria pulmonaria	1	4	LS/OG	M/W, RO	low to mid
Lobaria scrobiculata	1	4	LS/OG	M/W, RO	low
Nephroma bellum	1	4	LS/OG	M/W, RO	low
Nephroma helveticum	1	4	LS/OG	M/W, RO	low
Nephroma laevigatum	1	4		M/W, RO	
Nephroma parile	1	4	LS/OG	M/W, RO	low
Nephroma resupinatum	1	4	LS/OG	M/W	low
Peltigera collina	1	4	LS/OG	M/W, RO	low
Pseudocyphellaria anomala	1	4	LS/OG	M/W	low
Pseudocyphellaria anthraspis	1	4	LS/OG	M/W	low
Pseudocyphellaria crocata	1	4	LS/OG	M/W	low
Stenocybe major	1	4	LS/OG		
Sticta beauvoisii	1	4	LS/OG	M/W	low
Sticta fuliginosa	1	4	LS/OG	M/W, RO	low
Sticta limbata	1	4	LS/OG	M/W	low
Dermatocarpon luridum	2	1, 3	LS/OG	RZ	low to mid
Leptogium burnetiae var. hirsutum	2	4		RZ	
Leptogium cyanescens	2	4		RZ	
Usnea longissima	2	4		RZ	low to mid
Dendriscocaulon intricatulum	3	1, 3	LS/OG	RZ, M/W	low to mid
Lobaria hallii	3	1, 3		RZ, M/W	low to mid

Appendix Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants

LICHEN

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Pannaria rubiginosa	3	1, 3	LS/OG		low to mid
Pilophorus nigricaule	3	1, 3	LS/OG	RO	
Tholurna dissimilis	3	1, 3	LS/OG		high
Cladonia norvegica	3	3	LS/OG		
Calicium abietinum	3	4	LS/OG		
Calicium adaequatum	3	4	LS/OG		
Calicium adspersum	3	4	LS/OG		
Calicium glaucellum	3	4	LS/OG		
Cetrelia cetrarioides	3	4		RZ	
Chaenotheca brunneola	3	4	LS/OG		
Chaenotheca chrysocephala	3	4	LS/OG		
Chaenotheca ferruginea	3	4	LS/OG		
Chaenotheca furfuracea	3	4	LS/OG		
Chaenotheca subroscida	3	4	LS/OG		
Chaenothecopis pusilla	3	4	LS/OG		
Collema nigrescens	3	4		RZ	
Cyphelium inquinans	3	4	LS/OG		
Leptogium teretiusculum	3	4		RZ	low to mid
Microcalicium arenarium	3	4	LS/OG		
Mycocalicium subtile	3	4	LS/OG		
Pannaria leucostictoides	3	4	LS/OG	M/W	low
Pannaria mediterranea	3	4	LS/OG	M/W, RO	low
Pannaria saubinetii	3	4	LS/OG	M/W, RO	low to high
Peltigera neckeri	3	4	LS/OG	LDD, M/W, RO	low
Peltigera pacifica	3	4	LS/OG	LDD, M/W	low
Ramalina thrausta	3	4		RZ	
Stenocybe clavata	3	4	LS/OG		
Heterodermia sitchensis	4	3	LS/OG, 2G		
Hygomnia vittata	4	3	LS/OG, 2G		
Hypotrachyna revoluta	4	3	LS/OG		high
Nephroma isidiosum	4	3	LS/OG, 2G	RO	mid

VASCULAR PLANT

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Allotropa virgata	1	1, 2	LS/OG	LDD, D	low to high

Appendix **Survey & Manage Species: Bryophytes, Fungi, Lichen, & Vascular Plants**

VASCULAR PLANT

Species	Rating	Survey Strategies	Seral Stage	Habitat	Elevation
Botrychium minganense	2	1, 2	LS/OG	RZ, M/W	mid
Botrychium montanum	2	1, 2	LS/OG	LDD, M/W	mid
Corydalis aquae-gelidae	3	1, 2		RZ	low to mid
Cypripedium montanum (west Cascades)	3	1, 2	2G	M/W	low to mid
Habenaria orbiculata	3	1, 2	LS/OG	RZ, LDD, M/W	mid to high

Rating:1=Species present; 2=Species highly probable; 3=Species suspected; 4=Insufficient data on habitat and/or range to determine status.
Survey Stategies:1=Manage known sites, activities implemented must include provisions for known sites; 2=survey prior to activities and manage sites, activites implemented in 1999 or later must have completed surveys; 3=Conduct extensive surveys starting in 1996 and manage sites; 4=Conduct general regional surveys starting in 1996.
Seral Stage:LS/OG=late successional/oldgrowth; 2G=2nd growth.
Habitat:RZ=riparian zones; LDD=litter, down & duff; M/W=mesic/wet; D=dry; RO=rock outcrops, & cliffs.

Appendix E -- Wildlife

Number of Spotted Owl Activity Centers Within the Watershed Above and Below the TakeThreshold

% and Amount of suitable habitat within 1.2 miles of the activity center	Number of activity centers
Greater than 50% (>1478 acres)	30
Greater than 40% (1182-1477 acres)	4
30% to 40% (887-1181 acres)	1
Less than 30% (<886 acres)	2
TOTAL	37

Spotted Owl Pairs in the Blue River Watershed with High Reproductive Rates and Suitable Habitat Acres Within a 1.2 Mile Radius of their Activity Centers

Spotted Owl Pair	Acres of Suitable habitat within a 1.2 mile radius of activity center
Cook Creek	2072
Mack Creek	1872
Lookout Mountain	2038
Upper Lookout Creek	2082
Watershed 2	1639
North Carpenter	1506

Suitable northern spotted owl habitat within a 1.2 mile radius of activity centers within the Central Cascades Adaptive Management Area, Critical Habitat Unit OR-16, and LSRs RO 215 and 217.

MSNO	DIST	NESTING HABITAT (ac)1)	FORAGING HABITAT (ac)1)	TOTAL HABITAT NRF(ac)1)	PAIR STATUS	TAKE 2)	AMA	CHU	LSR 3)
0017 *	BR	848	269	1117	PN	Y	X	X	
0029	BR	1448	194	1642	PN	N	X	X	
0030	BR	1986	207	2093	PN	N	X	X	
0032	BR	1952	125	2077	PN	N	X	X	
0033	BR	1223	719	1942	PN	N	X	X	
0043	BR	1771	216	1987	PN	N	X	X	
0104	BR	742	90	832	PN	Y	X		
0105	BR	902	581	1483	PN	N	X	X	
0106	BR	1552	313	1865	PN	N	X	X	
0107	BR	1210	302	1512	P	N	X	X	
0111	BR	309	1300	1609	PN	N	X	X	
0112	BR			2533	PN	N		X	X
0859	BR	715	1022	1737	PN	N	X	X	
0860	BR	760	1126	1886	PN	N	X	X	
0861	BR			1060	P	Y	X	X	
0870	BR	723	1117	1840	PN	N	X	X	
0871	BR	143	558	701	P	Y	X	X	
1416	BR			1103	PN	Y	X	X	
1817	BR			2135	PN	N	X	X	
2028	BR	1394	137	1531	P	N	X	X	
2029	BR	1741	294	2035	PN	N	X	X	
2030	BR	227	1175	1402	PN	N	X	X	
2032	BR	435	1047	1482	PN	N	X	X	
2033	BR	768	1032	1800	PN	N	X	X	
2036	BR	873	996	1869	PN	N	X	X	
2414	BR			628	P	Y	X	X	
2420	BR			1016	P	Y	X	X	
2422	BR	1477	271	1748	PN	N	X	X	
2426	BR	1462	188	1650	PN	N	X	X	
2430	BR			1022	P	Y	X	X	
2433	BR			1118	PN	Y	X	X	
2434	BR			497	PN	Y	X	X	
2435	BR	767	437	1204	PN	N	X	X	
2436	BR	308	1145	1453	P	N	X	X	
2439	BR	597	917	1514	PN	N	X	X	
2443	BR			na			X	X	
2948	BR	1080	1042	2122	P	N	X	X	
2450	BR			1056	PN	Y	X	X	
2452	BR			na			X	X	
3025	BR	1478	324	1802	PN	N	X	X	
3397	BR	1211	383	1594	PN	N	X	X	
3398	BR	161	1512	1673	PN	N	X	X	
3400	BR	1481	170	1651	P	N	X	X	
3401	BR	502	2011	2513	S	N		X	X
3960	BR	1059	607	1666	P	N	X	X	
4085	BR	514	1130	1644	P	N	X	X	
5066	BR	1082	878	1960	P	N	X	X	

MSNO	DIST	NESTING HABITAT (ac)1)	FORAGING HABITAT (ac)1)	TOTAL HABITAT NRF(ac)1)	PAIR STATUS	TAKE 2)	AMA	CHU	LSR 3)
5070	BR			1499	S	N			X
5071	BR			2630	P	N			X
0152	BLM	498	519	1017	PN	Y	X		
0163	BLM	1214	258	1572	S	N	X		
2126	BLM	765	145	910	P	Y	X		
2133	BLM	252	455	707	P	Y	X		
2134	BLM	326	778	1104	PN	Y	X		
4108	BLM	193	277	470	na	Y	X		
4109	BLM	1539	749	2288	S	N	X		
4110	BLM	176	52	228	S	Y	X		
0011	SH			1675	PN	N			Y
0014	SH			2171	PN	N		X	Y
0619	SH			1320	S	N		X	Y
0641	SH			2497	P	N			Y
0646	SH			2751	P	N			Y
0702	SH			2121	PN	N		X	
0644	SH			na	P	N	X		
0661	SH			295	S	Y	X		
0680	SH			1798	S	N	X		
0687	SH			2195	P	N	X		
0688	SH			1286	PN	N	X		
0697	SH			1317	S	N	X	X	
0698	SH			1222	P	N	X	X	
0702	SH			2121	PN	N	X		
2460	SH			2130	PN	N		X	Y
2956	SH			1673	PN	N			Y
2959	SH			2452	P	N		X	Y
2960	SH			1806	P	N	X		
2962	SH			2142	P	N		X	Y
2963	SH			1588	PN	N	X		
2966	SH			1087	S	Y	X	X	
2967	SH			1805	S	N			Y
2968	SH			1818	S	N			Y
2976	SH			1129	S	Y	X		
2980	SH			1296	P	N	X		
4095	SH			1203	P	N		X	
4098	SH			849	P	Y			Y
4196	SH			1899	P	N			Y
9002	SH			1611	PN	N		X	Y
0828	MK			1340	PN	N	X		
1739	MK			1743	PN	N	X		
1740	MK			1804	PN	N	X		
2034	MK			1009	PN	Y	X		
2035	MK			1176	P	Y	X		
2412	MK			1670	P	N	X		
2417	MK			1646	P	N	X	X	
2836	MK			1275	P	N	X	X	
2837	MK			1304	S	N	X	X	
2839	MK			1404	P	N	X		

* Sites within the Blue River Watershed are in italics.

1) Within 1.2 mile radius of activity center.

2) Take as defined by the U.S. Fish & Wildlife Service is less than 1182 suitable acres within 1.2 miles of the habitat activity center.

3) X=LSR 0217 Y=LSR 0215

Appendix F -- References

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