SALMON CREEK

WATERSHED ANALYSIS

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WILLAMETTE NATIONAL FOREST
OAKRIDGE RANGER DISTRICT
WESTFIR, OREGON
SEPTEMBER 1996

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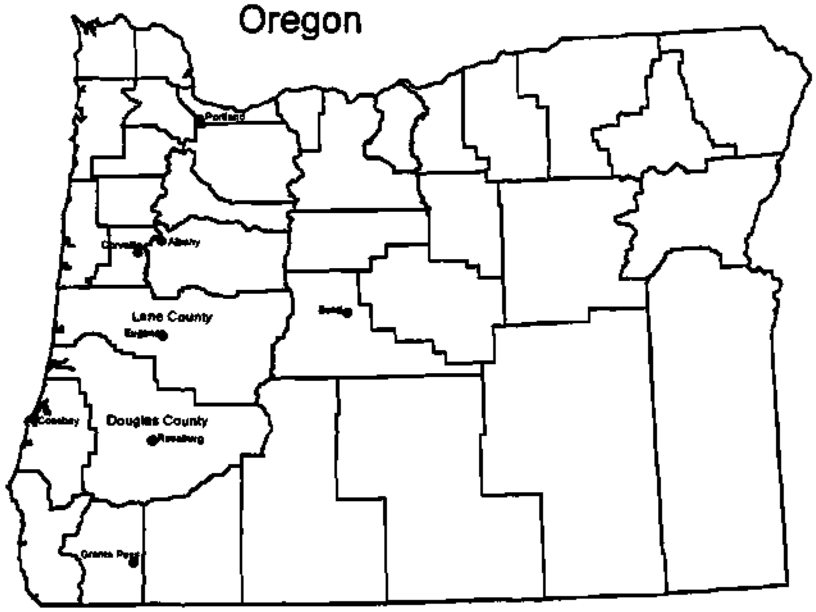

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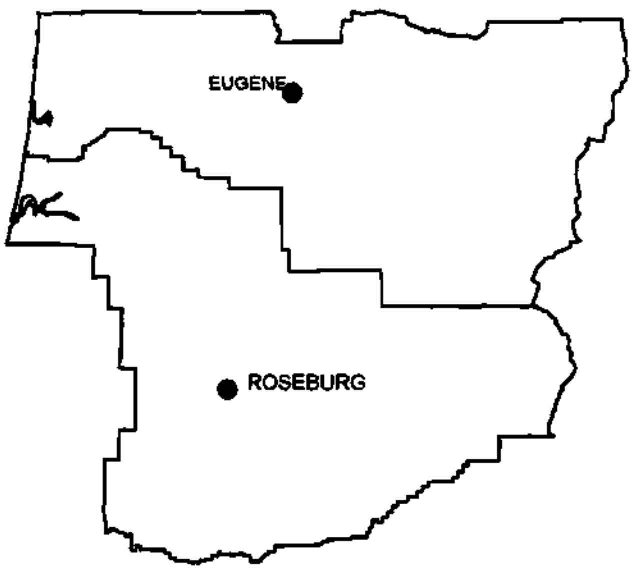


Middle Fork Willamette Subbasin

INTRODUCTION

LOCATION AND LAND OWNERSHIP

The Salmon Creek watershed is located within the Oakridge Ranger District of the Willamette National Forest, approximately 38 air miles (or 44 river miles) from the Eugene/Springfield metropolitan area. It lies immediately upstream from and to the northeast of the City of Oakridge. The watershed consists of one fifth field watershed (Salmon Creek, #18) and three sixth field watersheds (Lower Salmon Creek, 18 1; Black Creek, 18 2; Upper Salmon Creek, 18 3). The Salmon Creek watershed totals 82,432 acres. Approximately 2,049 acres (two percent of the watershed) is privately owned, most of which is used for residential, agricultural, or forestry purposes. The remainder of the watershed is National Forest land.

MANAGEMENT DIRECTION

The Record of Decision for the Final Supplemental Environmental Impact Statement (FEIS) on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (USDA, USDI, et. al. 1994a) requires that a watershed analysis be completed for all watersheds on federal lands. The SEIS has become popularly known as the Northwest Forest Plan, and has resulted in the amendment of the Willamette National Forest Land and Resource Management Plan (USDA, 1990). This watershed analysis has been done to comply with this direction and in a larger sense to provide decision-makers with a more comprehensive body of information upon which to base their land management decisions.

DOCUMENT FORMAT

This analysis tells how this watershed came to have the characteristics it has, of the particularly important processes occurring within it, and how management activities have affected landscape processes and patterns in the watershed. The document is comprised of the following components:

- A Characterization chapter that describes the unique or particularly important characteristics of the watershed.
- An Issues and Key Questions chapter that describes the various concerns and opportunities that exist in the management environment. This chapter identifies the questions that need to be answered to better make the many decisions that need to be made now, and in the future.
- A Reference Conditions/Current Conditions chapter that discusses the historical conditions of the watershed and how those conditions have changed over time. This chapter puts into perspective the current condition existing in the watershed, presented in relation to the various relevant resources.
- An Interpretation chapter that explains the differences between historical, current and natural conditions and how those factors affect the our ability to achieve management objectives in this watershed, presented in relation to Issues and Key Questions. This chapter provides answers to the Key Questions.
- A Recommendations chapter that identifies those management activities that could move the system towards reference conditions or management objectives.

This format is based on that presented in "Ecosystem Analysis at the Watershed Scale, (USDA, USDI, revised, August 1995). The presentation of this analysis is essentially linear; one page follows another. The processes and features of this watershed are complex, interact with one-another, and can be generally conceived of as a multi-dimensional entity. Describing such a complex phenomenon as a watershed in a linear format invariably will result in a substantial amount of overlap and/or generalization. For example, water quality can be influenced by a number of very different activities, processes, and underlying structures. While water quality can be considered a physical condition (as opposed to biological), biological processes may have profound influences on the quality of water. We beg the readers' indulgence for the unavoidable repetition of some key concepts and conditions as we attempt to illustrate the three-dimensional nature of this watershed and the complex processes occurring within it.

CHARACTERIZATION

CHAPTER I

CHARACTERIZATION

This section describes the dominant characteristics of the physical, biological, and human aspects of the watershed that are useful in understanding how the processes occurring within the watershed affect its conditions and functions. This chapter describes the unique and particularly important characteristics of the physical, biological, and social aspects of the watershed.

PHYSICAL ENVIRONMENT

GEOLOGICAL FEATURES

The Salmon Creek Watershed Analysis area is 82,432 acres in size. It is located in the transition from the Western Cascades to the High Cascades physiographic subprovince of the Cascade Range. The downstream area from the confluence of Salmon Creek and the Middle Fork Willamette River to the confluence of Salmon and Black Creeks are within the older Western Cascades. From the confluence of Salmon and Black Creeks, bedrock transitions from younger Western Cascades to High Cascades in the uplands.

The bedrock of the older Western Cascades is predominantly pyroclastic (tuffs and breccias) and altered flows and intrusions. Soils range from clay to sand dominated, depending upon whether derived from pyroclastics or flows / intrusions respectively. Several large earthflow landforms exist, most notably on the north side of Salmon Creek from Wall Creek to Mule Creek, the Polallie Creek area and the Warble Creek area. These earthflow features are currently stable on the large scale, but have localized areas of active or potential slope instability, especially in areas where water is concentrated (creeks, draws and swales).

The bedrock of the younger Western Cascades and High Cascades are predominantly unaltered flows and minor intrusions. Soils tend to be sand and cobble dominated. The geomorphology of this area (from the confluence of Black and Salmon Creeks to the uplands) is best characterized as alpine glacial with U-shaped valleys and an abundance of glacial till. Valley sidewalls are steep and prone to debris slides.

HYDROLOGY

Salmon Creek is a major tributary of the Middle Fork of the Willamette River. Surface hydrologic features within the Salmon Creek watershed are composed of an extensive intermittent and perennial stream network, many small seeps and wetlands, and numerous ponds and lakes located primarily in the upper portion of the watershed. The elevation ranges from 1,300 feet near the mouth to 7,200 feet in the upper watershed. Figure 1 of this chapter shows the location of the Subwatersheds within the Salmon Creek watershed.

Structures

The only dam located within the boundaries of the watershed is a relatively small diversion dam utilized to channel water to an Oregon Department of Fish and Wildlife salmon and trout hatchery located near the mouth of Salmon Creek. This dam is currently a barrier to resident salmonids.

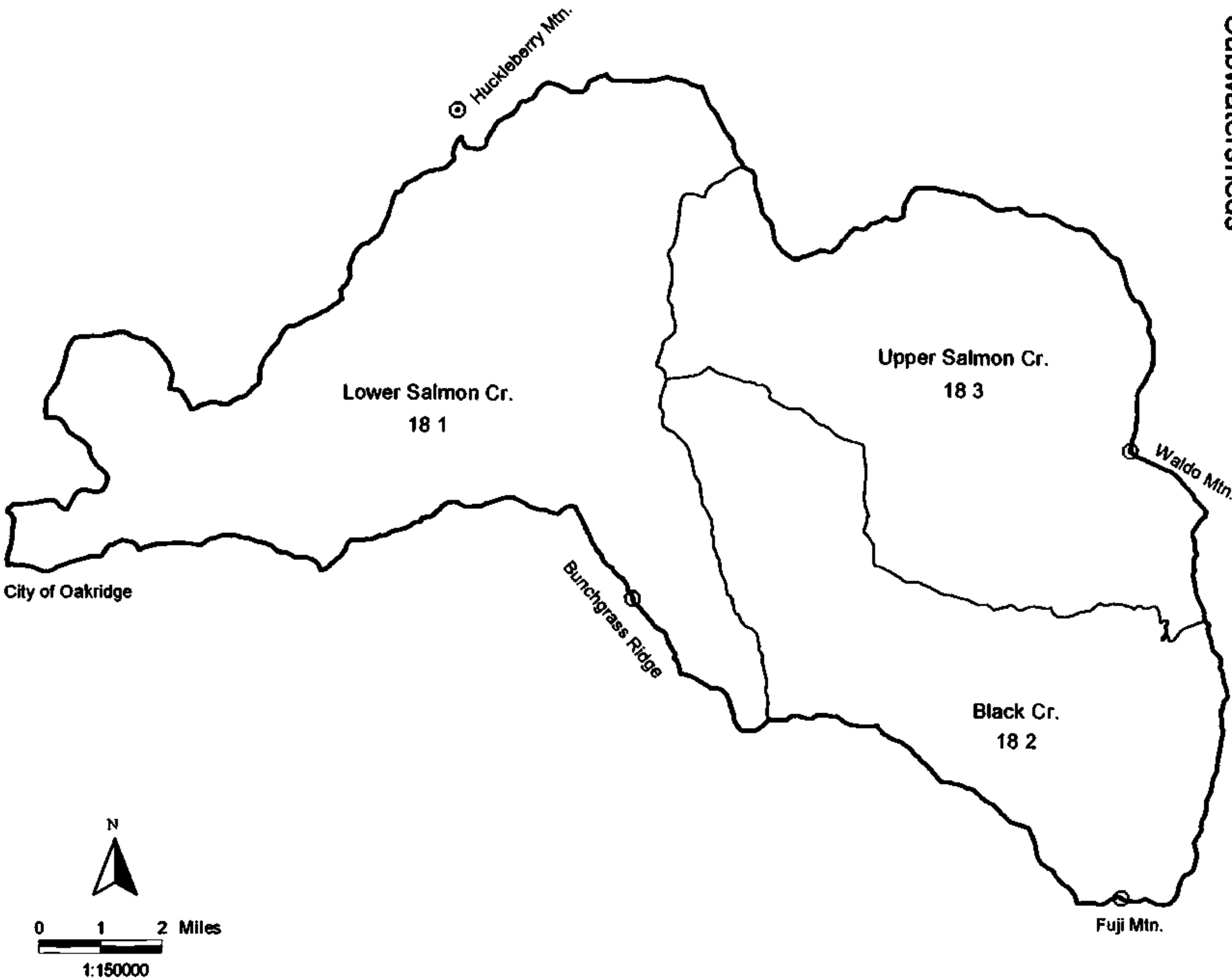
At this time the Salmon Creek watershed has approximately 259 miles of developed roads with 9 major culvert installations and 12 bridge installations. Of the 259 miles of roads, 29 miles are of maintenance level 5 which is assigned to roads that provide a high degree of user comfort and convenience. Normally, these roads are double-lane and paved or single-lane paved with turnouts. 57 miles of this system is of maintenance level 3 which is assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities on level 3 roads. The remaining 173 miles of the system is of maintenance level 2 which is assigned to roads open for use by high clearance vehicles. Passenger car traffic is not a consideration in maintenance of level 2 roads.

Climatic Factors

The watershed has a temperate climate with generally wet cool winters and dry warm summers. Average annual precipitation ranges from about 40 inches in the lower portion of the watershed to approximately 80 inches in the higher elevations. Above 4,000 feet in elevation, the majority of the winter precipitation falls

Salmon Creek Watershed Analysis

Figure 1:
Salmon Creek Subwatersheds



as snow. Between 1,300 and 4,000 feet in elevation, fluctuating weather patterns result in a transient snow pack. Approximately 61 percent of the watershed is considered to be within the transient snow zone.

Streamflow
The lowest flow period during the year is typically August and September. The majority of the runoff occurs between November and May. High flow events generally occur between November and May and usually occur during periods of high rainfall associated with rapid snowmelt (Harr 1981). During the summer months, melting of the seasonal snowpack at high elevations contributes to summer base flows. Timber harvesting and road construction have likely increased the magnitude and frequency of peak stream flows.

Stream Channel Variation
Considerable variation exists in the valley characteristics of the mainstem of Salmon Creek. At the mouth of the watershed, the channel is constrained by levies installed in approximately 1958 to provide flood protection for the City of Oakridge. Lower mainstem stream reaches of Salmon Creek and Black Creek tend to have relatively low gradients except where the channel is highly constrained by valley walls and controlled to a large extent by bedrock (e.g., Salmon Creek Falls). Depositional areas, occurring in the relatively low gradient areas are typically less constrained by valley walls, and the channel displays a higher degree of sinuosity.

Water Quality and Use
The Oregon Department of Environmental Quality (DEQ) has identified beneficial uses for Willamette River tributaries (OAR 340-41-442). Relevant beneficial uses for Salmon Creek include: public domestic water supply, resident fish and aquatic life, fishing, boating, water contact recreation and aesthetic quality.

The primary sources of water pollution along the length of Salmon Creek are considered nonpoint sources. These pollutants originate from diffuse sources rather than a discharge at a single location. The primary nonpoint source problems of concern include elevated levels of sediment and increased stream temperatures. Elevated levels of sediment are often associated with soil erosion from road surfaces and hill slopes where vegetation has been disturbed. Elevated stream temperatures can be attributed to reduced amounts of streamside vegetation, generally from past harvesting prior to establishment of policies requiring retention of riparian vegetation and natural disturbance.

The City of Oakridge relies on wells located near the mouth of Salmon Creek as its primary municipal water supply. A study conducted in 1993 found that there is a potential for surface water from Salmon Creek to influence the City's well field. The estimated surface water contribution to the Oakridge well field within a six month period was estimated to be 60 percent. Surface water withdrawn from Salmon Creek provides a secondary municipal water supply for the City of Oakridge.

The operation of the Oregon Department of Fish and Wildlife hatchery relies on the diversion of high quality water from Salmon Creek. One water quality parameter of particular concern affecting hatchery operations is elevated stream temperatures in Salmon Creek during the summer months. Another is sedimentation.

BIOLOGICAL ENVIRONMENT

VEGETATION
Plant communities in the watershed are diverse and reflect landscape influences, varied soils and landforms, and a wide elevation gradient. Most of the plant associations described by Hemstrom et al. (1987) are represented within this watershed. Forest age classes and structure reflect the influences of wildfire and timber harvesting.

Plant Communities
Approximately 94 percent of the watershed is occupied by coniferous forests ranging in age from several to over 600 years. Other plant community types that are found within the watershed include: herbaceous wetlands (bogs, marshes, and meadows dominated by sedges, rushes, and grasses); hardwood and shrubby wetlands (hardwood marshes and swamps); coniferous wetlands (cottonwood and western red cedar swamps); red alder stands acres (wet and dry types); coniferous-hardwood forests; temperate and high temperate coniferous forests (with lodgepole pine); subalpine forest parks; rock outcrops, talus and talus/shrub communities; Oregon white oak woodland inclusions; and grass and forb dry hillsides. None of

these communities are unique to the province except as mentioned in the following remnant populations section.

Stand Age and Structure
The harvesting which has occurred over the last 55 years has created most of the younger forest age classes but wildfire has had the largest influence of any natural process upon the structure and distribution of vegetation age classes within this watershed.

Approximately 19,641 acres have been regeneration harvested in the last 55 years, leaving approximately 62,783 acres (76%) of the watershed unharvested. Approximately 68,460 acres is vegetated with forests at least 40 years of age. These totals include land allocations available and unavailable for timber management. Very little harvest has occurred in the upper, eastern area of the watershed; which is occupied by the Waldo Lake Wilderness and the Waldo Lake Recreation Area. If the amount of past harvest is applied only to areas outside of non-harvest allocations, about 65 percent of the land available for timber harvest has already been harvested.

Remnant Populations
Though the non-forested areas represent a small portion of this watershed, these areas provide habitat for some relatively uncommon plant communities. Some south-facing rock outcrops support populations of rabbit brush, a shrub that typically grows only on the east side of the Cascades. Some of the rocky meadows on south facing slopes contain stands of Oregon white oak, a species typically found at lower elevations and is quite abundant in the Willamette valley.

Alaska yellow cedar and sub-alpine fir, trees more typically found at much higher latitudes, can occasionally be found on high ridges and north-facing cirque basins. Whitebark pine, typically a sub-alpine and alpine tree, occurs in limited areas within the watershed, generally on the two percent of the watershed above 6500 feet in elevation.

Fire History
Aside from the general climate that provides for the forest growth in this watershed, wildfire is the most dominant natural force shaping the structure and age class distribution of the forest. Over the past two centuries, about 44,000 acres, or 53 percent of the watershed, has been subject to stand replacing, or catastrophic, wildfire. Some of these areas have burned twice in this period. The Waldo fire that burned around 1900 in the Salmon Creek drainage is an example of such an area. Approximately 13 percent of the acreage affected by fire over the last 200 years burned with less severity, retaining small to moderate numbers of trees from the pre-fire stand. Many stands in the watershed also have experienced ground fire with little overstory mortality. It appears that these areas of underburning were extensive and underburning is possibly more frequent than stand replacing fire.

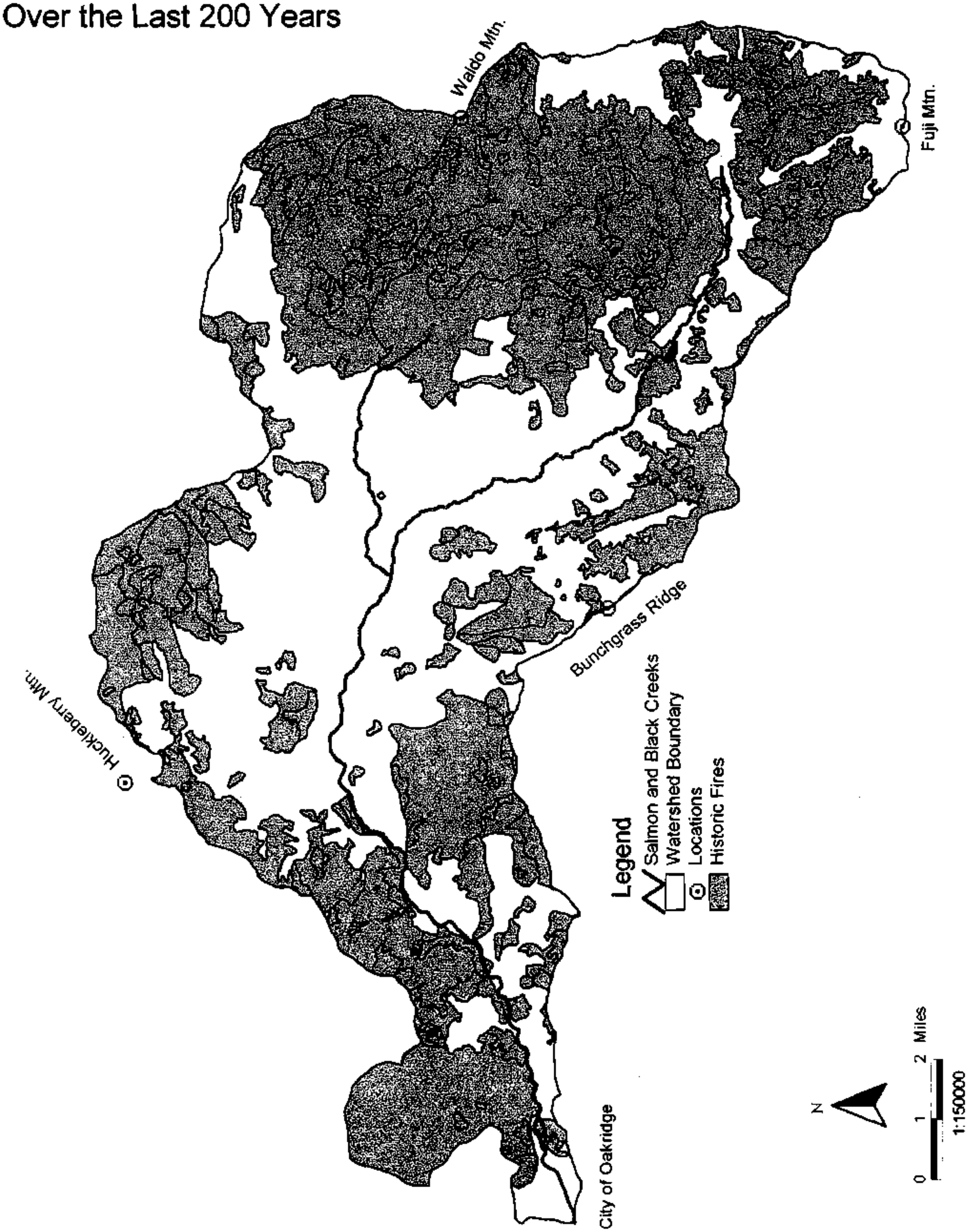
As shown by Figure 2 of this chapter, the wildfire occurrence has not been uniform over the watershed. More than 75 percent of all acres above 5,000 feet in elevation have burned. The center of the watershed has had very little fire activity in the last 200 years. The eastern third of the watershed and the northern third from Salmon Creek to the northern watershed boundary have a fire return interval of 40 to 50 years while the remaining southern one-third from Salmon Creek south to the watershed boundary has an 80 to 100 year fire return interval. Dividing the last 200 years into four 50 year periods shows that during the first 50 year period approximately 21,000 acres burned. During each of the next two periods, at least 12,000 acres burned per period, while during the last 50 year period only a little over 4,000 acres burned, of which more than half can be attributed to the 1991 Warner Creek Fire. Average tree ages in undisturbed areas of Salmon Creek watershed indicate that this area probably experienced very large fires that may have affected most of the watershed at intervals in excess of 370 years.

WILDLIFE SPECIES AND HABITAT

General Terrestrial (Including Spotted Owls and Other Late-Successional Species)
The range of elevation, aspect, slope, and soil types described previously contribute to a wide ranging diversity of wildlife habitat types within this watershed. As described in the Vegetation section, timber harvest and wildfire have contributed greatly to the diversity of stand conditions and stand ages present within the watershed.

Figure 2:
Occurrence of Wildfire
Over the Last 200 Years

Salmon Creek Watershed Analysis



Habitat for northern spotted owls and other late seral dependent species such as northern goshawk, brown creeper, American marten, and red tree vole is found in a variety of stand sizes and configurations throughout the watershed.

Higher elevation areas within the watershed provide habitat for high-elevation associates such as fisher and great gray owls. Mule Mountain and Bunchgrass Ridge provide western extensions of high elevation habitat and link these areas to the High Cascade Plateau in the eastern portion of the watershed. Lower and mid elevation habitat predominates in the remainder of this watershed, and provides important wintering ground for numerous altitudinally migratory wildlife species such as Roosevelt elk.

Appendix A contains a list of species expected to occur within the watershed along with their guild identification. Many of the vertebrate species expected to occur on the Willamette National Forest (327 species of birds, mammals, reptiles and amphibians combined; USDA, 1995) have suitable habitat, and are expected to occur within this watershed. The distribution of these species and their aggregation into communities vary with the distribution of plant communities, vegetational condition, and climatic conditions across the landscape.

Federally listed threatened or endangered species known to occupy habitat within this watershed include northern bald eagle, American peregrine falcon, and northern spotted owl. In addition, notable terrestrial species listed as sensitive by Oregon Department of Fish and Wildlife, candidates for Federal listing, or ROD and J2 wildlife species of concern (USDA, USDI, 1994b) that have been documented (indicated by a "D" after the species in the following species list) or that have potentially suitable habitat within this watershed include: great gray owl (D), flammulated owl, northern goshawk (D), harlequin duck (D), common merganser (D), black-backed and three-toed (D) woodpeckers, American marten, fisher (D), California wolverine, Pacific western big-eared bat (D), and red tree vole.

Aquatic Habitat

Reports made during 1938 stream surveys indicate that Salmon Creek had some of the best spawning habitat in the Middle Fork of the Willamette and its tributaries at that time. Those native to this area claim that Salmon Creek Falls (located approximately 5 miles above the confluence with the Middle Fork of the Willamette) was passable to salmon during the high flows of late spring, but was impassable during the low flows of summer.

In many Salmon Creek tributaries, however, waterfalls do create year-round upstream migration barriers for fish. In addition to these natural barriers, numerous road/stream crossing culverts were installed in a manner that creates additional barriers to the upstream migration of fish and have resulted in isolated resident populations of fish in some of these tributaries.

Habitat complexity in streams and localized stream bank stability has in many areas been reduced below natural levels due to removal of in-channel large woody material in the past.

Significant diversity exists in the numerous lakes and ponds that are mostly located in or adjacent to wilderness areas. The majority of the lakes within the watershed can be categorized as being either oligotrophic or ultraoligotrophic. These classifications mean the lakes have low to very low concentrations of nutrients in the water and low organic production.

Fish

Salmon Creek historically supported runs of spring chinook salmon. Migration was blocked in the 1950's with the construction of Lookout and Dexter dams on the Middle Fork of the Willamette, downstream from Oakridge. Bull trout are believed to have inhabited the watershed but there have been no official sightings in recent years (although an angler reported catching a bull trout in the summer of 1995). Bull trout numbers are thought to have declined in this watershed due to a lack of an anadromous fish prey base, dam construction, and habitat decline.

The Salmon Creek watershed contains a variety of aquatic species. Wild populations of cutthroat and rainbow trout exist throughout the watershed. Although brook trout have been stocked in many of the high lakes in this watershed, none have been observed in the main stem of Salmon Creek or Black Creek. Brook trout were, however, observed in the upper reaches of Mule Creek and Wall Creek.

The Salmon Creek watershed contains several lakes, located primarily in wilderness areas. Many of these lakes were originally fishless. Most of the larger wilderness lakes have been stocked with fish species such as Rainbow trout, cutthroat trout, and brook trout and many have naturally reproducing populations. The introduction of fish to naturally fishless lakes in the North Cascades in Washington has been shown to affect amphibian, macroinvertebrate, and zooplankton populations (Liss, 1991). It is possible that similar results have occurred in the Salmon Creek watershed. These effects may be due to competition for food or due to the fact that these organisms are often prey for introduced fish species.

The lower reaches of the mainstem of Salmon Creek between the Fish Hatchery Road bridge and the confluence with Black Creek are stocked with rainbow trout.

There is potential for the reintroduction of spring chinook and bull trout into this watershed if a method can be developed to capture and transport migrating juveniles downstream where they could be released below Lookout and Dexter dams. The low summer water temperatures of the upper Salmon Creek watershed would be suitable for the reintroduction of bull trout.

Amphibians
There are several sensitive amphibian species located in the Salmon Creek watershed, including the tailed frog, the red-legged frog, the cascade frog, the Oregon slender salamander, and the western toad.

Macroinvertebrates
There is not much information available on the macroinvertebrate species occurring in much of the watershed, however, several sensitive species of aquatic insects are known to occur on the Willamette National Forest.

SOCIAL ASPECTS

MANAGEMENT HISTORY
The Salmon Creek watershed has been visited by people for perhaps 10,000 years. Historic, archaeological and paleoclimatic research in the watershed suggests that people adapted to changing conditions and influenced the development of their environment, especially over the last 150 years.

Native Americans
At the time of European exploration, at least three tribes are thought to have used the Salmon Creek watershed. The Molala are believed to have had winter villages in the Oakridge/High Prairie area and, with the Kalapuya of the Willamette Valley, to have seasonally visited the higher elevations of the watershed. In later times, possibly after the arrival of the horse, the Klamath made trips into the area on their way to the Willamette Valley to trade.

Over 40 archaeological sites representing seasonal base camps and campsites of a more temporary nature have been found in the Salmon Creek watershed to date. The majority of these sites are located in lower elevation terraces or meadows and prairies which were much more extensive before Euro-American settlement.

There is good evidence from General Land Office survey plats, explorer's journals and tribal oral history that fire was used as a tool to maintain a more open landscape. Both prairie fires and underburning were techniques used to hunt game and to ensure the return of berries, roots, and other important plants.

The local tribes were nearly decimated by the epidemic diseases and social dislocation that followed the arrival of fur trappers, explorers, and settlers between 1790 and 1840. A few well-known Molala, especially Charlie Tufti and Jim Chuck Chuck, remained in the Oakridge area and shared their skills with the new settlers. Many of the descendants of local tribes are currently part of the Siletz, Grande Ronde, Warm Springs, and Klamath reservations.

The Homestead Era
The majority of early settlement in the Oakridge area was along the main stem of the Middle Fork Willamette River. A few homesteads were claimed on the lower portions of Salmon Creek near Oakridge. No mining claims were made in the watershed.

Beginning in 1914, the Forest Service permitted grazing allotments in the Salmon Creek watershed for cattle and sheep. Animals were trailed up Salmon Creek to allotments at Blair Lake and the prairies leading into the Waldo Wilderness.

Administrative History
In 1891, Congress gave the President the power to create forest reserves from public domain. In 1897, Congress passed the Organic Administration Act which provided for the administration of the reserves, including controlling forest fires. The early Forest Service embarked on a ground patrol system of fire detection in the early 1900's, using rangers on horseback covering a system of trails and vantage points connected to ranger stations by telephone lines. In the Salmon Creek watershed, lookout sites or stations were established on Mule Mountain, Waldo Mountain and Fuji Mountain.

In 1908, the Flat Creek administrative site was withdrawn and a ranger station constructed between 1910 and 1918. The complex was expanded from 1924 to 1936 to include a warehouse, barn, residences, and a gas and oil house. The complex has since been modernized.

A system of trails was constructed which accelerated greatly with the advent of the Civilian Conservation Corps, from 1933 to 1942. This labor force made possible the construction of a system of trails and bridges with shelters, guard stations, lookout towers and associated buildings, as well as ranger stations. The Oakridge CCC Camp was located to the south of Salmon Creek and west of the Fish Hatchery. Their projects included development of the Salmon Creek Falls Campground and construction of the Salmon Creek Ranger Station at the junction of the present day Fish Hatchery Road and Forest Road 24.

Forest Management
Commercial logging within the watershed began with the construction of the Davis-Weber sawmill in 1920. From 1920 through 1924, about 328 acres were logged in the lower portion of the watershed.

CURRENT MANAGEMENT DIRECTION
The Willamette National Forest Land and Resource Management Plan (USDA, 1990) prescribes land uses by assigning various Management Area designations to land within the Forest. The Salmon Creek watershed contains 23 management areas (Table 1 and Figure 3 of this chapter). Late-Successional Reserve RO220 Assessment also provides specific management direction for portions of this watershed.

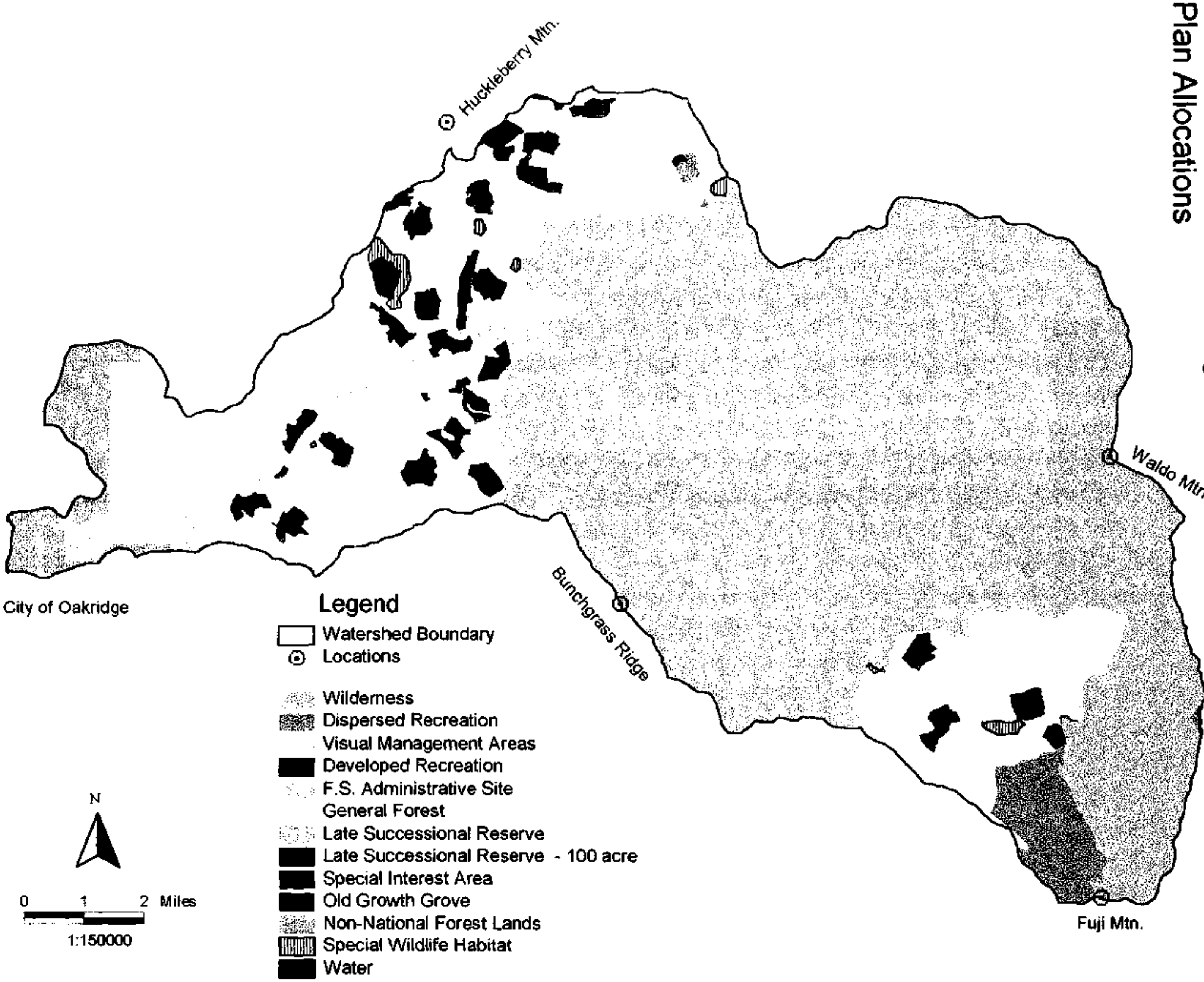
Table 1: Ownership Pattern and Willamette National Forest Plan Management Areas as Amended

Management Area	Description	Acres	Percentage
1	Wilderness	11,051	13
5a	Special Interest Area	9	<1
7	Old-Growth Grove	149	<1
9d	Special Wildlife Habitat Area	366	<1
10e	Dispersed Recreation - Semi primitive	1,839	2
10f	Dispersed Recreation - Lakeside setting	102	<1
11c	Scenic, Partial Retention Middleground	309	<1
11d	Scenic, Partial Retention Foreground	754	1
11e	Scenic, Retention Middleground	979	1
12a	Developed Recreation - Forest Service Site	32	<1
13a	Special Use Permit Areas	89	<1

Management Area	Description	Acres	Percentage
13b	Forest Service Administrative Use Areas	6	<1
14a	General Forest - Intensive Forest Management	15,027	18
15-1	Class I Riparian Reserve	1,394	2
15-2	Class II Riparian Reserve	1,730	2
15-3	Class III Riparian Reserve	1,367	2
15-4	Class IV Riparian Reserve	3,201	4
15-L	Lake Riparian Reserve	396	<1
15-WSH	Wet Special Habitat Riparian Reserve	100	<1
16a	Late-Successional Reserve	38,884	47
16b	Late-Successional Reserve - 100 acre	3,052	4
8000	Private Land not in Riparian Reserve	1,592	2
WA	Major Water Bodies	4	<1

Total Acres in watershed = 82,432

Figure 3:
1990 Willamette National Forest Land and Resource Management Plan Allocations



RECREATION EXPERIENCES

Scenic Values

The scenic resources of the Salmon Creek valley are shaped by ongoing geological and biological processes. The lower elevations are characterized by relatively steep, densely forested canyon walls, a diversity of managed and old-growth Douglas-fir stands, and riparian and wetland vegetation. As the visitor ascends by forest roads, the vista opens onto a flat, glaciated valley where dispersed camping is popular. Continuing up Furnish and Black Creeks, one climbs from the old Western Cascades geologic province to the High Cascades landscape of rolling terrain, mantled by pumice and ash. Punctuated by views of volcanic features, this landscape is generally forested with Pacific silver fir and mountain hemlock stands.

The Willamette Forest Plan Visual Quality Objective for the lower portions of the watershed adjacent to Salmon Creek is Partial Retention foreground.

Among the special places of scenic interest in the watershed are the gorge and falls through the area of the Salmon Creek Falls Campground, the Wall Creek Warm Springs, and Joe Goddard's Grove, a group of exceptionally large trees in the Black Creek drainage. The upper Salmon Creek watershed contains several trailheads accessing the Waldo Lake basin. Expansive scenic views of the Waldo Wilderness area exist from Waldo Mountain lookout and Fuji Mountain.

Developed Recreation

Only two campgrounds have been developed within the watershed. Salmon Creek Falls and Blair Lake campgrounds are both popular with local people, especially anglers. Salmon Creek Falls is also a popular day use destination, and use is predicted to increase as the Salmon Creek trail system becomes more well-known. Light motor vehicle traffic on the fourteen miles of paved road along Salmon Creek encourages moderate bicycle use.

The Trail System

Located adjacent to the Oakridge community, the Warrior (fitness) trail and Salmon Creek trail system is heavily used by walkers, joggers, and mountain bikers. Accessible from the rest stop area on Highway 58, this trail system is being cooperatively developed by the Forest Service, State of Oregon, and City of Oakridge.

The most popular trails for hiking, mountain biking and horseback riding are the Eugene to Crest trail and the Black Creek trail. About 75% of the equestrian users access the wilderness trails via Skookum Campground and Harrelson Horse Camps. The Blair Lake trail system is located along a series of prairies which provide excellent elk habitat. This trail receives the most use during the hunting season, as does the upper Black Creek trail system, especially in the area of Deer Camp. The Salmon Lakes trail, which accesses the Waldo Lake Wilderness, is very popular with hikers and anglers.

Dispersed Camping

The majority of the dispersed camp sites are located along Salmon and Black Creek because they offer easy road access and proximity to the river. The use is most concentrated in the lower portion of Salmon Creek, especially during hunting season.

The Waldo Lake Wilderness area provides numerous primitive camp sites, concentrated mainly at Salmon, Gander, and Swan Lakes.

Swimming and Boating

Swimming holes in lower Salmon Creek and the higher elevation lakes are used for swimming. There is currently some kayak and small raft use on lower Salmon Creek in the Spring.

Hunting and Fishing

The watershed is very popular with both elk and deer hunters, and the majority of use at dispersed sites takes place during the hunting season. Salmon Creek receives use mainly by local anglers, who take mainly hatchery-stocked rainbow trout.

COMMUNITY-BASED RECREATION AND RELATED ECONOMIC BENEFITS

Surrounded by forest lands, the community of Oakridge is heavily reliant on recreation and extractive resources for its economic base. Since World War II, the Forest Service has played an increasingly important role in community planning and development.

Community-Based Recreation

People in Oakridge use the forest for recreation, especially hunting and fishing. Hunting still retains the character of a subsistence activity for many people in this community.

The Salmon Creek watershed has the potential to provide the setting for increased recreation use. The Warrior/Salmon Creek trail system ties directly into the community and visitor use through the Highway 58 rest area. The area has been used since 1991 by the Fat Tire Festival, a mountain biking event which drew 500 participants in 1995.

Firewood

Firewood was the major source of heating fuel in local communities prior to rural electrification. It persisted as a major source in timber dependent communities such as Oakridge until the 1970's, when air pollution became an issue. A booming timber industry allowed for an ample supply of log decks where firewood could easily be obtained for very small fees.

Since the 1970's, more efficient wood stoves and pellet stoves, as well as the increasing availability of natural gas in the Eugene-Springfield area have reduced the demand for firewood. With reduced timber harvests in the 1990's, suitable log decks have become scarce, and any sizable area of timber blowdown is reserved for commercial salvage sales. Areas that have been administratively or Congressionally withdrawn place additional constraints on the availability of firewood. In the current year, two thirds of the permits issued by the Oakridge Ranger District were for the Deschutes National Forest, where firewood is more plentiful. Only portions of the lower Salmon Creek watershed are available for firewood collection. Permits for single logs, found by the permittee, comprise the majority of the wood permits issued. In the past year, only 34 of the 103 firewood permits issued on the Oakridge Ranger District were for the Salmon Creek watershed area. The majority are issued for the North Fork of the Middle Fork of the Willamette watershed, to the north. Over 80 percent of these permittees are residents of the Oakridge/Westfir community.

Special Forest Products

Special forest products such as ferns, boughs, beargrass, salal, and other plants are commercially extracted from the watershed. Huckleberries have the potential to become a more important product in the future.

Source of Raw Materials and Jobs

Traditionally, local people have worked in the woods as loggers and truck drivers, and in the sawmills and related businesses. Timber harvesting in this watershed helped supply the Pope and Talbot Mill that existed in Oakridge from the 1940's until it closed in 1989. The Pope and Talbot mill site is currently owned by the City of Oakridge. The industrial site has received some environmental clean up and is now the site of several secondary wood products businesses, with more development planned.

An average of 28 million board feet of timber has been harvested per year since logging began in this watershed, about 55 years ago. A grand total of about 1.6 billion board feet has been harvested to produce lumber and plywood products from this watershed. This timber harvesting and associated mill processing created many jobs over the years, as further discussed in the FEIS for the Willamette National Forest Plan on pages III-213 to 235.

As the supply of timber from National Forest lands declined in the 1990's, tourism and special forest products have played a more important role in the local economy. However, Oakridge is still home to a number of people who make their living cutting, yarding or hauling trees, or working for the Forest Service.

ISSUES/

KEY QUESTIONS

CHAPTER II

ISSUES AND KEY QUESTIONS

INTRODUCTION

The main purpose of this Watershed Analysis is to facilitate, direct, and support management activities and decisions by providing decision makers with current resource information and a priority listing of various potential management activities. Therefore, the issues identified in this Watershed Analysis are focused on past, current, and expected future management activities and how they affect the current and reference conditions. Individuals using this analysis during project development should find it to be user-friendly. They will be able to find direct references to the activities they are contemplating rather than having to sort through a number of resource discussions to find references to the activities in question.

Key questions have been developed for each issue. These are questions that need to be answered in order to understand how human activities may affect the processes occurring in the watershed. They are also those questions which most need to be answered in order for decision-makers to make fully informed decisions about current and proposed management and social activities in this watershed.

Key questions are answered in the last two chapters of this analysis: Interpretation and Recommendations. These conclusions are a synthesis, by issue, of the Reference/Current Conditions (Chapter III.) and the answers to the Key Questions.

ISSUE #1* - *INTENSITY AND PATTERN OF VEGETATION MANIPULATION RELATED ACTIVITIES
Timber harvest and associated activities such as slash disposal, reforestation, and precommercial thinning have played a significant role in shaping the vegetation patterns within this watershed, since fire suppression began near the beginning of this century (see Issue 2). Timber harvest for lumber production has been occurring in this watershed for about 55 years on federal land and for over 100 years on private land. This has resulted in a substantial economic benefit to local communities and the nation as a whole. Wildlife forage enhancement activities, such as brush cut-back, seeding, and fertilizing have also played a role, but to a lesser extent.

The intensity of vegetation manipulation activities, especially timber harvest, may be considerably outside the historic range of conditions which would have resulted from wildfires. The amount of stand replacement due to regeneration harvest over the past 55 years has been 29,843 acres, or 36 percent. This amount has ranged from 465 acres to 10,000 acres per decade. The amount of stand replacement due to wildfire in the last 200 years has been 53 percent, ranging from 5 acres to 13,000 acres per decade (the 5 acre decade occurred after fire suppression became standard practice). Continuation of past harvest intensities could ultimately result in low amounts of late-successional (80 years and older) forest at any given time in certain areas within the watershed and could result in eliminating late-successional forests on all but those acres reserved from harvest (such as wilderness and other non-harvest allocations and reserves).

The intensity of application of vegetation management activities (again, especially timber harvest) may have also had an effect on hydrological processes. Such effects may include increases in surface erosion, mass movement rates, peak stream flows, water quality, and water yield. Another effect has been the deterioration of stream channel conditions.

The pattern of vegetation manipulation activities across the landscape, especially harvest of timber, has resulted in fragmentation of late-successional forests, isolation and/or removal of riparian forests, a reduction in connectivity, and a net reduction of late-successional forest due to edge effects. These changes may have had a profound effect on the amount and quality of interior habitat and the dispersal of native and non-native plants and animals across the landscape. They have also created a pattern that is not natural, except on acres reserved from harvest.

Timber harvesting and associated activities have also reduced the bio-diversity and site productivity of the replacement stands and riparian areas of some harvest units. Most or all the large woody debris has been removed from some harvested stands. Regenerated stands were often planted densely to avoid reforestation failure. They were also typically planted with fewer species than occurred on the sites prior to harvest. Precommercial and commercial thinning have tended to homogenize stands by making the tree spacing, diameter, and species distribution more uniform. Where late-successional forests still exist, some have been salvaged leaving few snags and down logs on the ground or in streams. Certain species, such as Pacific yew, were removed, resulting in replacement stands with less vertical structure and species diversity than natural stands tend to have.

ISSUE #1 KEY QUESTIONS

1) Given current land allocations in the Willamette Forest Plan, as amended by the Northwest Forest Plan, what is the location and acreage of areas that are available for regeneration harvest for the next two decades and for commercial thinning, by decade, for the next 50 years?

2) How has the intensity and pattern of vegetation manipulation affected native and non-native plant and animal habitat diversity, species composition, guild viability, amount of interior habitat, and habitat connectivity?

3) How has the intensity and pattern of vegetation manipulation affected trails, recreation, aesthetics, special forest products, and firewood availability?

4) Where and to what extent has the change in spatial and temporal distribution of vegetation influenced the potential for water yield, water quality (especially water temperature), and peak flow changes?

5) What are the most important delivery mechanisms for sediment generated by vegetative manipulation in this watershed? What are relative amounts of sediment delivery to streams by these mechanisms? Where are the high risk areas?

6) Where and to what extent has removal of existing and future sources of large wood material in stream channels affected in-stream habitat condition? Where and to what extent has vegetation manipulation affected channel function and riparian habitat condition and its contiguity?

7) How have our vegetation management practices affected the Salmon Creek Fish Hatchery and the City of Oakridge emergency and secondary water supplies?

8) How will we protect small wetlands, seeps, and springs from management activities?

ISSUE #2 - THE EXCLUSION OF NATURAL FIRE FROM THE ECOSYSTEM HAS ALTERED THE NATURAL PROCESSES

Fire suppression, over the last seven decades, has reduced the impact of wildfire as a major shaper of vegetational landscape patterns and processes.

Given the amount of land affected by fire over the last few centuries (see the fire frequency discussion under Issue #1), this suppression effort may have had a number of vegetational effects across the landscape. For example, meadow sizes and abundance have been shrinking as trees encroach upon them; forest structure may have become more complex in some areas; the landscape distribution of natural forest age classes may have become less diverse in some areas; populations of some fire dependent species may have declined (such as lodgepole pine, *Montia diffusa*, and *Astragalus spp.*); and fuel loading across the landscape may have increased in some areas. However, as described in Issue #1, other areas have been treated to reduce fuel loading.

Continued fire exclusion in this watershed could have several negative consequences on long-term landscape processes. Increasing fuel accumulations may ultimately result in fires that are more frequent, more severe, larger, and less suppressible. Continued fire exclusion may result in an increase in insect and/or disease outbreaks on harsher sites where dense stands may develop in the absence of fire. It could also result in positive changes in long-term site productivity as more organic material accumulates, and negative changes as fires burn more intensely.

Fire exclusion may have increased the habitat available for threatened, endangered, and sensitive (TE&S) species such as spotted owls as forests become more structurally complex in terms of understory layers and snag and down wood accumulation. However, increasing fuel accumulations may be of special concern within the Late-successional Reserve (LSR), where there is much less opportunity for vegetation management activities to modify fuel accumulations and where there are or will be more contiguous fuel beds accumulating, which could lead to larger and more severe wildfires in the LSR.

ISSUE #2 KEY QUESTIONS

1) Fire pattern, fire behavior, and burn intensity are affected by fuel loading conditions. How do current conditions compare to fuel loading conditions before the advent of fire suppression? What areas are at high risk?

2) If we utilize prescribed fire within established forest stands (as opposed to post-harvest site preparation) in order to reduce high fuel loading and bring the landscape back to the reference condition, under what conditions could we control the fire? How many acres (per period of time and allocation) and under what conditions could we prescribed burn and still remain within air quality limits, and where are the high priority areas?

3) Under a reference condition fire regime, what would the habitat diversity look like? Where could prescribed fire help us to re-establish or maintain the reference condition?

4) How would prescribed fire affect TE&S and ROD species habitat, fire dependent plant species, big game habitat, and aquatic species habitat?

ISSUE #3 - THE DENSITY, CONDITION, USE, AND LOCATION OF ROAD AND TRAILS HAS ALTERED THE LANDSCAPE PROCESSES AND INFLUENCED WILDLIFE HABITATS

This watershed currently contains 270 miles of system and non-system roads and approximately 55 miles of maintained trails. About 35 miles of these roads are seasonally closed for a variety of reasons, most commonly to avoid traffic related wildlife disturbance, although some of these roads are used occasionally for administrative use, e.g., fire suppression. Approximately 4 additional miles of road are closed year around. This extensive road system is for the most part a direct result of past timber harvest as discussed in Issue #1. The system also provides access for recreational activities as well as administrative uses such as fire suppression. The roads in this system were generally designed for a 20 year service life. Roads that have reached their 20 year service life and have not been reconstructed are beginning to deteriorate. There are about 11 miles of non-system road that do not meet current standards for management.

Roads can result in increased peak flows as a result of vegetation removal, as with timber harvest (see Issue #1). Roads also increase peak flow by providing for more efficient slope drainage. Roads may increase the amount of mass movement and magnitude of peak stream flow because they often intercept and re-direct the surface and sub-surface flow of water.

Effects on wildlife and plants include elimination or creation of wetlands or a change in the hydrologic character of special habitats (for example the drainage of a moist meadow). Roads can also affect the connectivity of habitats. They fragment habitat for organisms that find it difficult to cross small bare openings and for organisms that find stream culverts impassable. Road and trail use has the potential to disturb wildlife and affect species viability. Roads and trails can be a vector for the spread of non-native plants.

An extensive road system can have beneficial impacts by providing access to large areas for various recreational activities such as hunting, fishing, dispersed camping, hiking, mountain biking, and driving for pleasure. Road closures can limit these opportunities and concentrate use in areas with more open roads, which could create resource problems. Local economies can be positively or negatively affected by changing the amount and ease of access, changing traffic patterns, recreational uses, and the availability of firewood and special forest products.

A portion of the road system is deteriorating and funds are no longer available for proper maintenance of the entire road system. Roads that are not properly maintained can cause sediment delivery to streams as a result of ditch and roadbed erosion. Maintenance needs, including culvert upgrading, need to be prioritized to most effectively make use of the limited maintenance funds. The Northwest Forest Plan standards and guidelines require existing culverts, bridges, and other stream crossing structures which pose a substantial risk to riparian conditions to be improved to accommodate at least a 100 year flood event. Many stream crossing structures do not meet this design criteria and correcting this situation would entail a substantial cost that is not now funded.

Recovery and growth of riparian vegetation immediately upstream from bridges and large culverts could result in the accumulation of large amounts of woody debris. This could ultimately threaten the stream crossing structure as well as down-stream resources.

ISSUE #3 KEY QUESTIONS

(ROADS - system and non-system)

1) Where has the density, condition, location, and use of roads influenced natural and management induced disturbance (i.e. landslides, surface erosion, slope movement)?

2) Where and to what extent have the presence, patterns, and use of roads and trails affected native and non-native plant and animal habitat diversity, species composition, guild viability, amount of interior habitat, habitat connectivity, and riparian reserves?

3) Where has the density and location of roads affected hydrological function (i.e. wetlands, expansion of the drainage network, and streamflows)?

4) What are the potential resource effects of not maintaining all the roads in this road system due to lack of funding?

5) Where are the high risk or high priority road/stream crossings which do not have drainage structures designed to withstand 100 year events?

(ACCESS)

6) How does changed access influence the potential for human caused fire ignitions, suppression response time, and the amount of acres burned?

7) How does changed access, including abandoned trails and historic sites, affect public and administrative use of the forest?

***ISSUE #4* - AQUATIC COMMUNITIES MAY HAVE BEEN CHANGED FROM REFERENCE CONDITIONS DUE TO THE INTRODUCTION OF NON-NATIVE SPECIES**

The introduction of fish to naturally fishless lakes may have effects on naturally occurring populations of amphibians and aquatic insects through competition and predation. Introductions of other non-native species such as bull frogs have also had effects on the native aquatic species.

Restoration of salmon, steelhead trout, and bull trout runs could also create some negative effects such as increased recreational impact in riparian areas and conflict between river users (specifically kayak and raft users) and in-channel structures.

ISSUE #4 KEY QUESTION

1) What are the effects of introduction of non-native species on native aquatic communities?

***ISSUE #5* - THE DIVERSION DAM FOR THE WILLAMETTE FISH HATCHERY HAS THE POTENTIAL TO FAIL, WHICH IN TURN, COULD DISRUPT OPERATIONS AT THE FISH HATCHERY**

The Fish Hatchery diversion dam is being undercut by Salmon Creek. Construction of a new diversion dam is scheduled to begin in the summer of 1996. The existing diversion is a barrier to resident fish populations.

ISSUE #5 KEY QUESTION

1) Should the new diversion dam be equipped with a fish passage structure?

***ISSUE #6* - THERE IS A CONCERN FOR PROTECTION OF WATER QUALITY FOR THE OAKRIDGE MUNICIPAL WATER SUPPLIES AND THE WILLAMETTE FISH HATCHERY**

Salmon Creek and its associated ground water areas are important sources of water for the City of Oakridge and the Willamette Fish Hatchery. Administrative facilities, recreational facilities, and management activities in the Salmon Creek watershed that could decrease surface and ground water quality are of a concern.

ISSUE #6 KEY QUESTIONS

1) What facilities and management activities could potentially contaminate the Oakridge Municipal wells, the emergency municipal water source (Salmon Creek) and Willamette Fish Hatchery water sources?

2) Do administrative and recreational facilities affect water quality?

REFERENCE & CURRENT CONDITIONS

CHAPTER III

REFERENCE / CURRENT CONDITIONS

PHYSICAL

GEOLOGY AND SOILS

The following discussion of soils found in the watershed requires the reader to have a working knowledge of the nomenclature of the Willamette National Forest Soil Resource Inventory (SRI). The original SRI was produced in 1973 and the maps revised in 1990 (USDA, 1994b). The map revision has not been field verified. To simplify analysis of the 1990 SRI soil mapping units within the watershed, they have been grouped into five categories based on similar soil properties and expected behavioral response to management activities.

Table 1: SRI Mapping Units by Soil Category

Soil Category	Definition of SRI Soil Category	SRI Mapping Units
Category 1	Nearly 100% clayey soils	25, 35
Category 2	At least 50% clayey soils	235, 335, 336
Category 3	Steep terrain and shallow soils	1, 2, 201, 203, 21, 3, 301, 310, 310U, 6, 601, 602, 61, 610, 610U, 8, 91, 910
Category 4	at least 50% steep terrain and shallow soils	212, 311, 313, 614, 615, 616, 714, 9, 914, 920, 941
Category 5	all others	

Category 1 consists of 1990 SRI mapping units 25, 35 and mapping unit complexes comprised of units 25 and 35, i.e. 255. Typically, these soils are on gentle to moderately hummocky sideslopes (5 to 40 percent), deep (from 6 to 12 feet), have a high clay content, and are occasionally associated with earthflow geomorphology.

Although this landform includes past large scale earth movements, it is usually stable in its current slope geometry, with the exception of localized areas such as road cuts and stream channels. In-place shear stress can be low to high depending on the moisture content, but the remolded strength (such as in road fills and subgrades) tends to be low. During construction, this requires that controlled compaction techniques are used and that the material is not allowed to become saturated. It is often necessary to exclude the surface and subsurface water from these soils to maintain a stable road prism. Due to the low permeability of the soils, these areas typically support hydrophitic vegetation and habitat for animals adapted to riparian and aquatic habitats.

Category 2 consists of SRI complexes which include at least 50 percent of the mapping units in Soil Category 1. The behavior of this category is similar to that outlined for Category 1 and are frequently associated with draws and swales on midslopes.

Category 3 is 100 percent of SRI mapping units and complexes characterized by steep terrain with shallow rocky soils. This category is more likely to have high surface and subsurface erosion potential and the highest number of road and harvest related slope failures. The sediments produced are typically coarse grained. The harvest related slope failures tend to be due to the loss of root strength after timber harvest or stand replacement wildfires. These slope failures most often occur where water is concentrated.

Category 4 consists of SRI complexes which include at least 50 percent of the mapping units described in Category 3. The behavior of these soil types is similar to those outlined in Category 3, but at a lower frequency.

Category 5 consists of the rest of the SRI units and complexes. This category represents a wide rage of geomorphic settings which tend to be more stable.

Figure 1 displays the location of the various soil categories mapped in the watershed. Figure 2 displays the relative area by subwatershed.

Figure 1: SRI Soil Categories

Salmon Creek Watershed Analysis

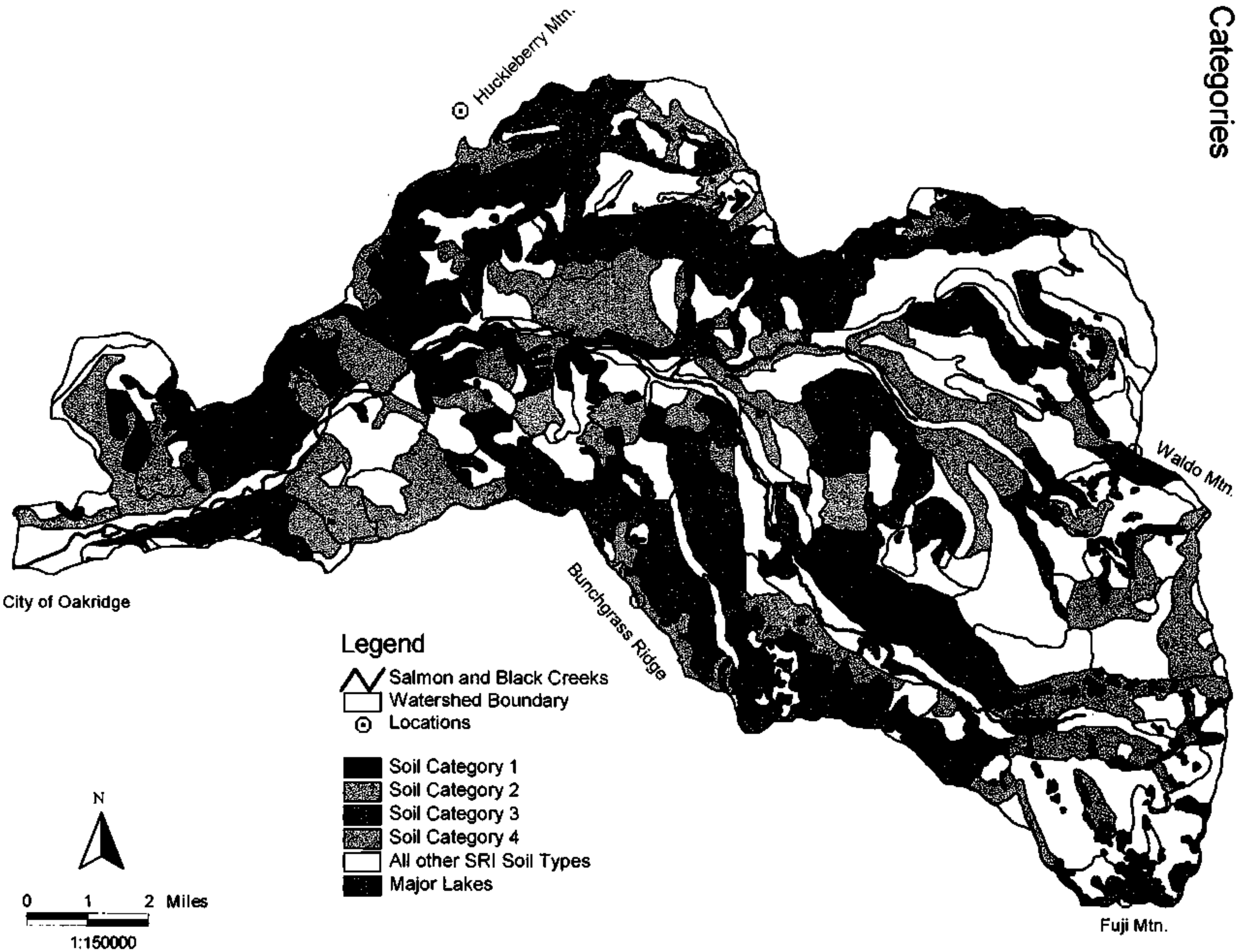
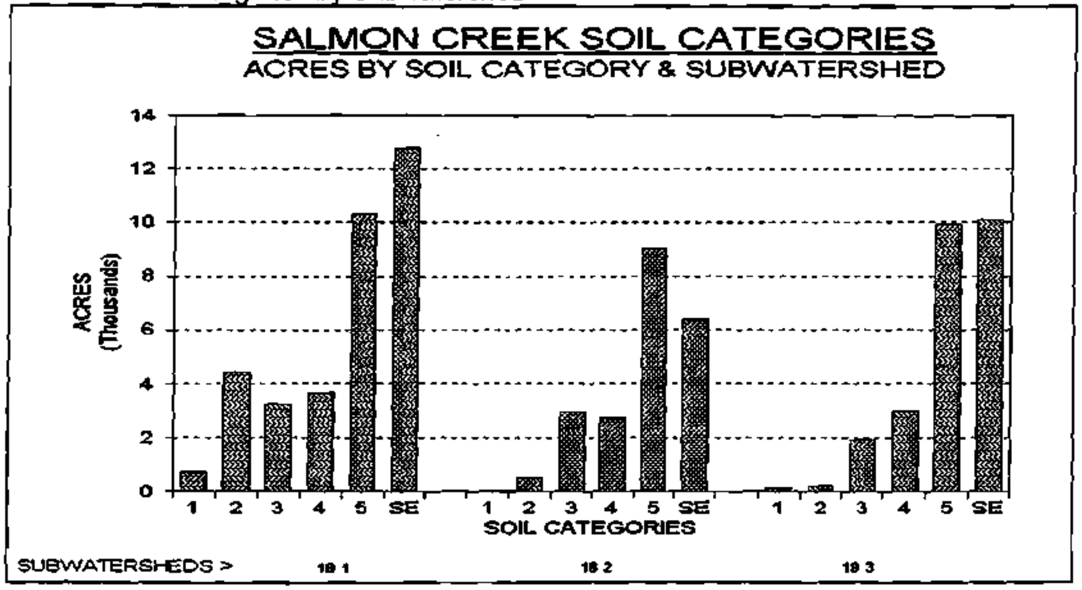


Figure 2: Acres of Soil Categories by Subwatershed



Mass Soil Movement

REFERENCE AND CURRENT CONDITION

Prior to logging and road building, slope failures were typically localized slope movements in steeper portions of areas with deeper soils, i.e., stream banks, and debris slides on steep slopes with thinner soils over shallow bedrock. The current age of these failures is unknown, but presumably the majority are hundreds of years old, judged by the age of the trees growing on top of these slope movements.

The erosion potential for each soil category was determined by averaging the surface and subsurface erosion potential of those SRI soils comprising the soil categories. Category 3 had the highest, followed by categories 4, 1, 2, with 5 having the least erosion potential. Based on the gradation of the SRI soils comprising the soil categories, 1 and 2 can be expected to yield the greatest volume of fine grained sediments (see Figure 3); categories 3 and 4 can be expected to yield the greatest volume of coarse grained sediments (see Figure 4), while category 5 produces a mixture of both at a relatively low rate. Figure 2 displays the area within each soil category by subwatershed.

In addition to the potential sediment source areas associated with the various soil categories, data from the Watershed Improvement Needs Inventory (WIN) was used to locate existing mass failures. Fifty-eight mass wasting sites were identified, the majority of these sites are associated with roads and to a smaller extent with timber harvest units. The highest concentration of these sites occur in subwatershed 18 1 (see Figure 5).

SURFACE EROSION

REFERENCE AND CURRENT CONDITION

Naturally occurring stand replacement wildfires are probably the closest comparison that can be made relating timber harvest (particularly clearcut harvesting) with pre-historic conditions. The variation in the recurrence interval of stand replacement fires within the watershed is discussed in the Vegetation/ Fire History section.

Loss of canopy closure and duff layers due to high and some medium intensity fires would allow relatively unimpeded rainfall upon bare soil. This can result in down slope movement of soil particles detached by raindrop impact and possibly by overland flow.

High intensity fires remove under brush and kill mature trees, creating abundant snags. Soil surface erosion can be high immediately after a fire and decreases as the vegetation recovers. Over time, as trees killed by the fire fall, they serve as energy dissipaters limiting the down slope movement of soil. Results from a study in the Oregon Coast Range can be used as an example of what could occur after a fire where a large portion of the organic material is burned (Brown and Krygier, 1971). After clearcutting and broadcast burning, there was a five fold increase in suspended sediment production. After a period of four years, suspended sediment production returned to near pretreatment levels.

Figure 3:

Landflows and Potential High Risk Sources of Fine Grain Sediments

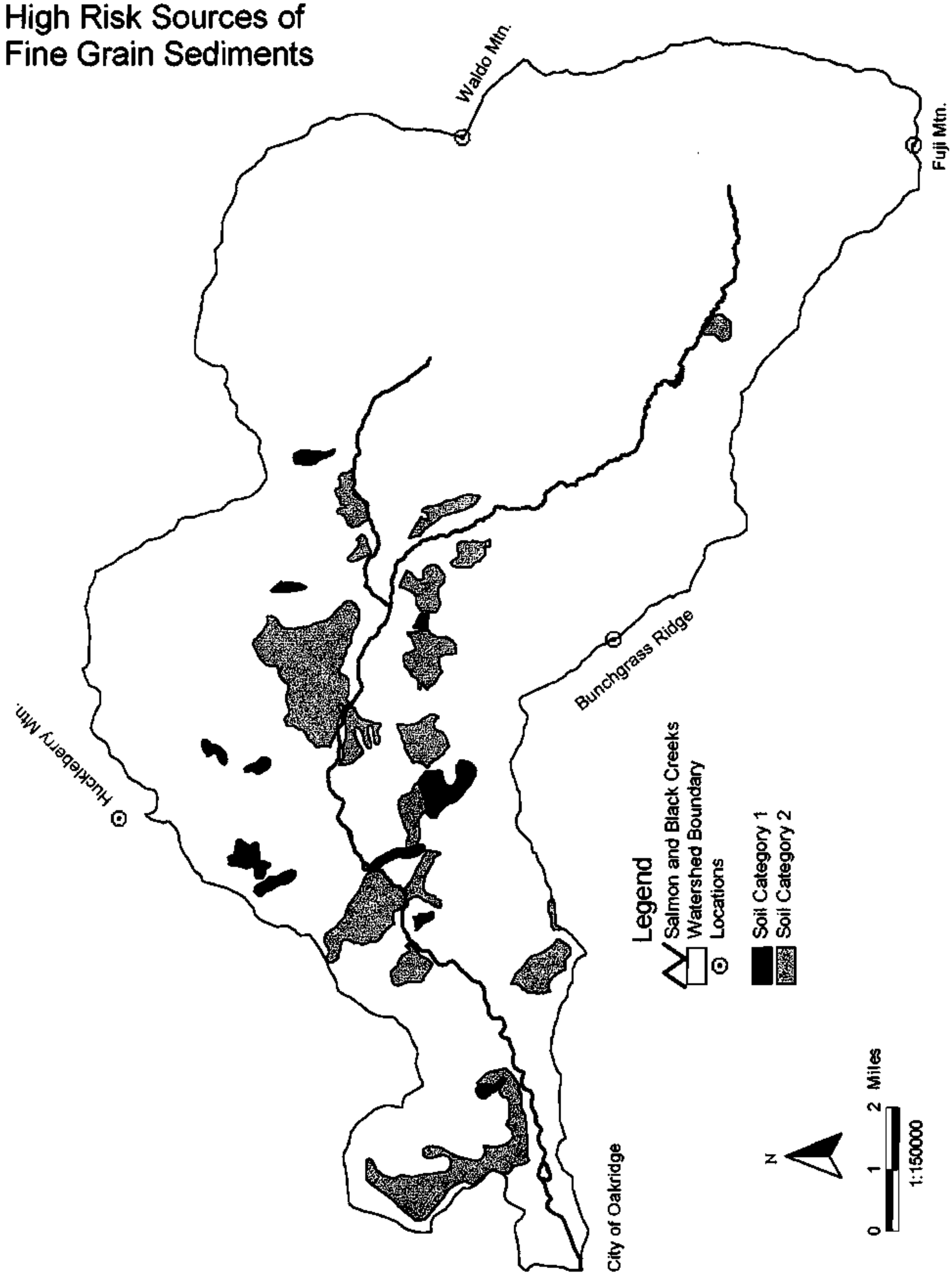


Figure 4:
Highest Risk Areas of Debris Failure and Potential Source of Coarse Grain Sediments

The Salmon Creek watershed contains approximately 8,600 acres that have been managed by stand replacement harvest on severely erosive soils as defined by SRI Landtype . Ninety-one percent of this harvest occurred on slopes greater than 30 percent. These severely erosive soils on relatively steep slopes would have the highest potential of contributing sediment to streams. Table 2 displays the acres of harvest on severely erosive soils on slopes greater than 30 percent by decade. Impacts to severely erosive soils were greatest during the time period from 1960 to 1989.

Table 2: Acres of Harvest on Severely Erosive Soils Greater Than Thirty Percent Slope

	Acres by Subwatershed			
Decade	18 1	18 2	18 3	Total
1900 - 1929	211	0	0	211
1930 - 1939	4	0	0	4
1940 - 1949	10	0	0	10
1950 - 1959	388	1	66	455
1960 - 1969	1278	221	662	2161
1970 - 1979	1499	267	474	2240
1980 - 1989	1065	461	1077	2603
1990 - 1995	32	8	135	175

Total = 7859 acres

Management practices relative to the retention of large woody material (LWM) have varied with time. Areas harvested during the period when most LWM was removed from harvest units (mid 1960's to mid 1980's) have the greatest potential for down slope movement of soil. As mentioned previously, the presence of LWM tends to reduce the down slope movement of soil. The greatest potential impact would be in the areas of severely erosive soils on steep slopes adjacent to stream channels.

Soil Compaction

REFERENCE CONDITION

There was very little compaction of soil prior to the beginning of timber harvest and road building in the 1920's. There was a small amount of very localized compaction caused by trails used by humans, wildlife, and livestock.

CURRENT CONDITION

Tractor yarding was used extensively prior to 1980 on gentle slopes (usually less than 35 percent). Data is currently not available to determine how many acres have been impacted by tractor yarding within the watershed. The majority of the known tractor yarded areas are located on slopes less than 40 percent in subwatershed 18 1.

Soils with a high clay content (Category 1 and 2) would be the most susceptible to compaction regardless of the harvest method. Approximately 3,200 acres have been impacted by stand replacement timber harvest on soils with a relatively high clay content. Eighty-five percent of this harvest is located in subwatershed 18 1. Although tractor yarding generally results in the greatest amount of compaction per unit area compared with other harvest methods, even with partial suspension cable logging systems, these areas would be prone to moderate to high impacts whether it be gouging or compaction.

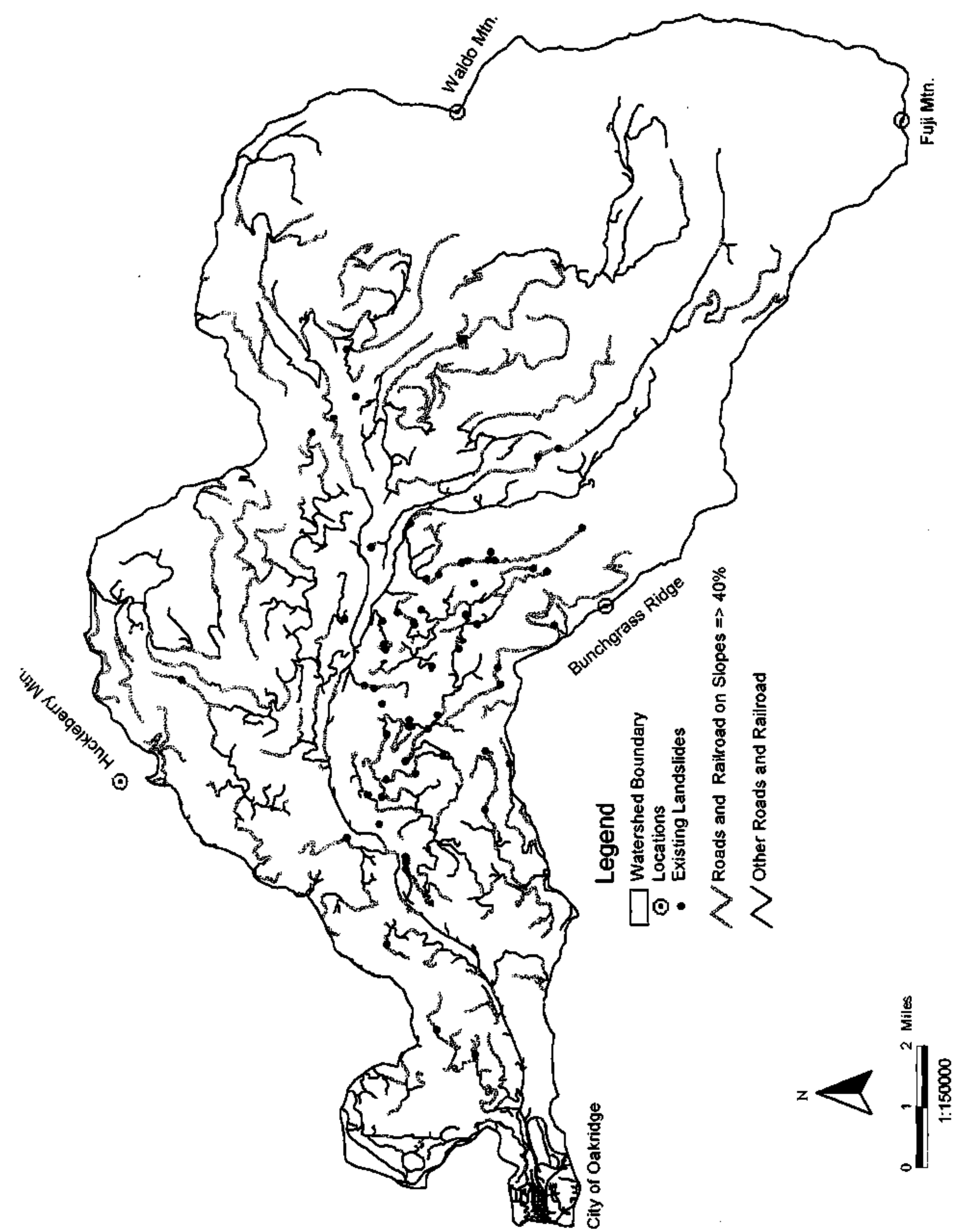
Sediment Associated with Roads

Studies have shown that roads with vehicle traffic produce up to six times the amount of sediment as roads where traffic is eliminated. Research has also shown that sediment can be reduced by 50 percent when using central tire inflation during commercial log hauling (Foltz 1991). Further, these studies show that as rutting occurred during use, sediment production increased 2.9 to 13.3 times. This effect can be reduced by timely maintenance, but maintenance can also produce increased levels of sediment.

Roads can contribute sediment to streams through runoff routed directly to streams from roadside ditches or by the formation of gullies below relief culverts, particularly on mid-slope roads. As the drainage area of each culvert and the culvert spacing increases, there is a greater potential of gully formation below the culvert outlet. As the volume of water discharged from the culvert increases, so does its erosive force on hill slopes below the culvert. In some situations these gullies may create surface flow paths for water and sediment directly to streams. In a study conducted in the western Cascades of Oregon (Wemple 1994), statistical analysis of gullying below culvert outlets indicated that the probability of gully formation below a

Figure 5:
Potential Management Related
Sediment Sources

Salmon Creek Watershed Analysis



relief culvert was significantly related to culvert spacing and hill slope steepness but not road grade.

The District Watershed Improvement Needs (WIN) database was used to determine the range of culvert spacing within the watershed. An analysis of WIN data from 25 sections of mid-slope roads indicates a range of culvert spacing of 361 feet to 1,056 feet and an averaging spacing of 605 feet. The culvert spacing above which gully formation is likely to occur will vary depending on factors such as slope steepness and drainage area. Many of the culverts within the Salmon Creek watershed have gullies below their outlets. There is a high probability that a portion of the existing gullies are linked to streams and are capable of routing sediment to stream channels particularly during high runoff events.

Gully formation is most likely to occur on slopes greater than 40 percent (Wemple 1994). Figure 5 displays a map of roads on slopes greater than 40 percent slope and existing management related mass wasting sites primarily associated with roads. These road segments and existing mass wasting sites are likely source areas of management related sediment.

The effect of both use and maintenance on the production of fine sediment can be reduced by the closure of roads when not in use for commercial, administrative or motorized recreation usage. Other factors that can reduce the amount of sediment from roads include the installation of additional relief culverts, out-sloping of roads, more frequent road maintenance, aggregate quality, and road surfacing type.

ROAD / STREAM CROSSINGS

There are 12 bridges within this watershed, all of which cross Class I perennial, fish bearing streams. Approximately 576 culverts have been installed within the analysis area where roads cross Class II through Class IV streams as currently identified. At least five times that amount exists when ditch relief culverts are considered. If any of the culverts were designed for fish passage many of them have lost that ability due to outlet scour or different velocity and distance design requirements than are currently used. In addition, most pipes were originally designed to carry a 50-year storm event. Others had no designed criteria. Inventory and analysis of 25 culverts within the analysis area indicates that 40 percent will overtop the fill during a 100-year flood event. This value is consistent with findings for 153 culverts analyzed on timber sale haul routes on Oakridge and Rigdon Ranger Districts.

Table 3: Stream Crossings by Stream Class

Subwatershed	Class I Stream	Class II Stream	Class III Stream	Class IV Stream
18 1 (roads)	7	47	64	259
(railroad)	2	1	0	3
18 2 (roads)	3	5	40	60
18 3 (roads)	0	15	36	52
Totals	12	68	140	374

Note: Class I crossings are all bridges

Table 4: Culvert Information from the WIN Database

	Number of Culverts			
Subwatershed	Totally Blocked	Partially Blocked	With other Problems	OK
18 1	36	298	89	454
18 2	12	117	16	175
18 3	20	169	27	240
Totals	68	584	132	869

AQUATIC

Streams

STREAM CLASSIFICATION AND DISTRIBUTION

REFERENCE AND CURRENT CONDITION

The distribution of streams vary across the watershed due to changes in site specific characteristics including soil properties and geology. Table 5 displays the number of mapped stream miles by class and stream density by subwatershed. Detailed mapping of all perennial and intermittent streams within the watershed has not been completed. The stream mileages appearing in Figure 5 under represent the true values for class III and IV streams.

Table 5: Length of Streams by Class and Subwatershed

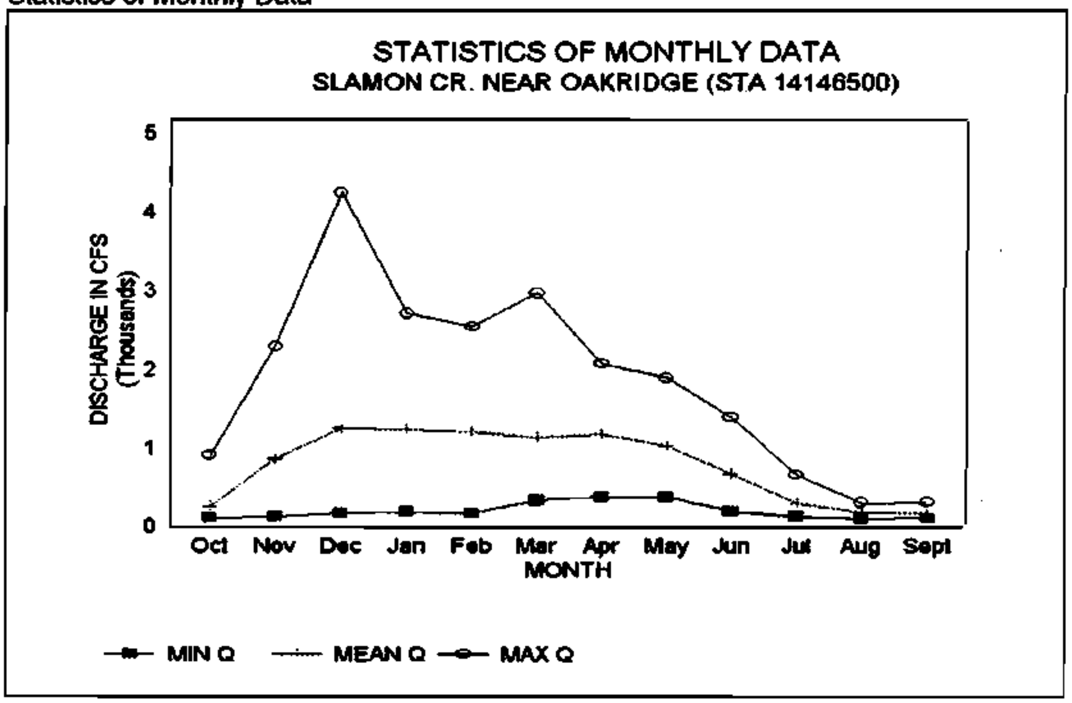
Stream Class	Miles by Subwatershed		
	18 1	18 2	18 3
I	14	12	5
II	35	4	20
III	40	34	23
IV	137	48	35
Total Miles	226	99	84
Stream Density (mi/sq mi)	4.1	2.9	2.1

STREAMFLOW

Stream discharge is a result of a combination of climatic and geologic conditions and can be influenced by natural events and management activities. Stand replacement wildfires and timber harvest can result in a temporary decrease in evapotranspiration resulting in higher stream flow and within the transient snow zone can increase the magnitude of peak flows under some conditions.

Flow measurement records from the US Geological Survey are available for a stream gauging station located near Salmon Creek Falls (station 14146500) at river mile 5.84. The period of record includes from October to November 1909, February 1913 to October 1919, October 1933 to September 1985, and October 1986 until it was discontinued in June of 1994. Statistics of mean monthly flow data is displayed in Figure 6 and a summary of data observations is presented below.

Figure 6: Statistics of Monthly Data



Data Summary for period of Record:

1. Annual mean discharge - 423 cfs
2. Highest annual mean discharge - 681 cfs in water year 1974
3. Lowest annual mean discharge - 217 cfs in water year 1941
4. Lowest average seven day minimum flow - 91 cfs in August of 1940

The variation in streamflow generally follows the pattern of precipitation. The lowest flow period during the year is typically August and September. The majority of the runoff occurs from November through May. High flow events during this time period often coincide with high rainfall events and may be associated with rapid snow melt. During the spring season, melting of the seasonal snow pack at high elevations in the watershed contributes a significant portion of the runoff.

A recurrence interval is the probability a certain magnitude flood event will occur over a given period of time. The following summarizes the results of two different methodologies for determination of a recurrence interval and corresponding flood magnitude utilizing Salmon Creek flow data. The first is an instantaneous peak flow recurrence interval, and the second is a Log-Pearson Type III Duration-Frequency Analysis for mean daily maximum flows. Instantaneous peak flow recurrence intervals were developed from data for this gauging station by Harris et al., 1979, and values are displayed in Table 6a.

Table 6a: Instantaneous Peak Flow Recurrence Intervals, USGS Station 14146500

Recurrence Interval	Discharge (cfs)
2 Year	3,150
5 Year	5,300
10 Year	7,020
25 Year	9,520
50 Year	11,600
100 Year	14,000

Table 6b: Mean Daily Maximum Flow Recurrence Intervals, USGS Station 14146500

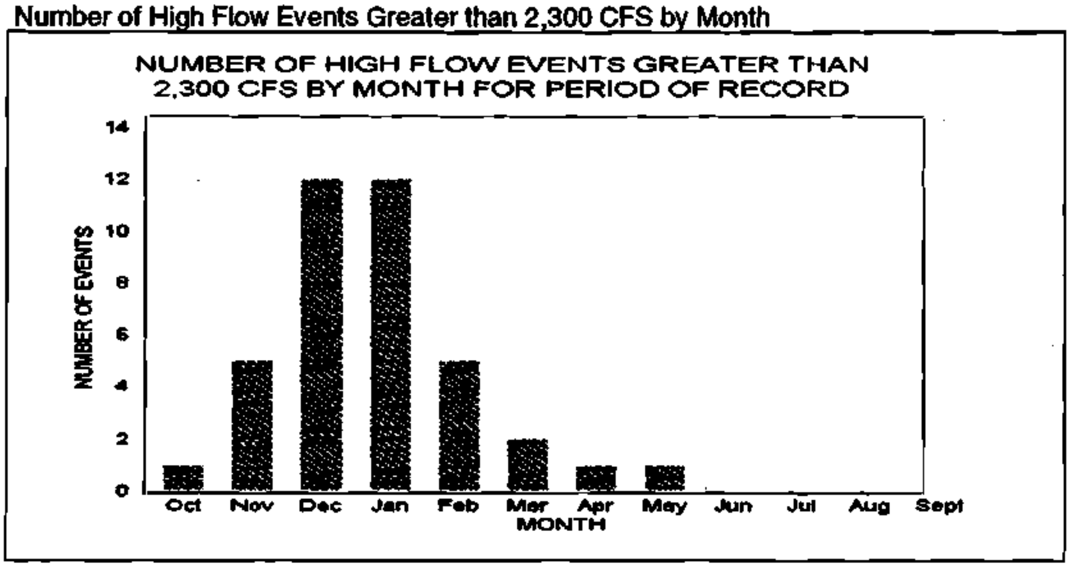
Recurrence Interval	Discharge (cfs)
2 Year	2,719
5 Year	4,278
10 Year	5,387
25 Year	6,855
50 Year	7,989
100 Year	9,153

A Log-Pearson Type III Duration-Frequency Analysis for the period of record up to year 1986 was completed based on USGS gauging station records (Welcher et al. 1991). This analysis provides a recurrence interval for mean daily maximum flows rather than instantaneous peak flows. These recurrence intervals are displayed in Table 6b.

Notable flood events within the Willamette River Basin prior to the period of record occurred in calendar years 1861 and 1890. The maximum discharge for the period of record was 11,700 cfs on December 22, 1964. Floods of smaller magnitude exceeding the 10 year recurrence interval but less than a 25 year event as displayed in Table 6b, occurred in December of 1942, 1945, and 1955. Floods of this magnitude also occurred in January of 1971 and February of 1986. A flood slightly greater than the magnitude of a twenty-five year event as displayed in Table 6b occurred in December of 1956.

The greatest frequency of high flow events occurs during the months of December and January. Figure 7 displays the number of recorded events with a mean daily discharge exceeding 2,300 cfs by month. This flow corresponds to an event with approximately a 1.5 year return interval under the Log-Pearson Type III Duration Frequency analysis for mean daily maximum flows.

Figure 7: Number of High Flow Events Greater than 2,300 CFS by Month



Hydrologic Recovery

REFERENCE AND CURRENT CONDITION

Variations in stream flow are influenced by the intensity, duration and type of precipitation, and the capacity of the watershed to store runoff. Peak stream flows are most likely to occur during storms delivering large quantities of precipitation in a short time. Some studies have linked increases in peak stream flow with timber harvest and attributed this change to an altered rate of snow accumulation and melt. Warm wind and rain storms on saturated snow packs have been shown to contribute runoff to flood events. Christner and Harr (1982) studied the effects of timber harvest and roading on peak flows for three paired basins. They attributed increases in peak flows to increased rate of soil water input during rain-on-snow events. The latter type of event is most common in the transient snow zone between the months of October and March. Increases in peak stream flow may result in an increase in stream bed and bank erosion and a corresponding increase in sediment production.

The vegetative condition of an area as it relates to snow accumulation and melt within the transient snow zone is termed hydrologic recovery. Prior to forest management, hydrologic recovery values probably varied widely through time due to stand replacement wildfires. The Salmon Creek watershed likely experienced long periods of relatively high hydrologic recovery punctuated with relatively short periods (depending on the rate of reforestation) of very low recovery levels (similar to the effects of clearcut harvesting) after infrequent, landscape level fire events mentioned in the Vegetation/Fire History discussion contained in Chapter II.

The Willamette National Forest Land and Resource Management Plan (USDA, 1990) states that an assessment of potential for cumulative effects of operating and scheduling practices on beneficial uses should considered the effects of management practices on hydrologic recovery (FW-093).

Hydrologic recovery can be quantified by the Aggregate Recovery Percent (ARP) method. Calculated ARP values were used as a measure of the risk of increased peak streamflow related to management activities. For a further discussion of ARP, see Willamette national Forest Land and Resource Management Plan FEIS Chapter IV, Section: Water and Appendix B of that document.

For planning purposes, the Willamette National Forest Land and Resource Management Plan (Forest Plan) describes the sensitivity of planning subdrainages based on overall slope of the drainage and the percent in the transient snow zone. Each planning subdrainage was assigned a midpoint ARP value as a reference point for assessment purposes. The mid-point ARP values provide a relative measure of drainage sensitivity (see Forest Plan Appendix E). These may be viewed as threshold values below which a more detailed assessment should be conducted to determine the potential for adverse effects associated with increases in peak stream flow. Current and mid-point ARP values by planning subdrainage are displayed in Appendix C. Mapped locations of planning subdrainages can be found in Appendix B. Table 7 displays the current calculated ARP values and a weighted mid-point ARP by subwatershed. Subwatershed 18 3 is currently the lowest, 18 2 is intermediate, and 18 1 has the highest current value.

All subwatersheds are currently above a weighted mid-point ARP value calculated from Forest Plan values assigned to planning subdrainages. The weight assigned to each planning subdrainage was based on the area it contributes to the total subwatershed area.

Table 7: Aggregate Recovery Percentages by Subwatershed

Subwatershed	ARP Value	Weighted Mid-Point ARP Value
18 1	88	72
18 2	86	66
18 3	81	68

Roads contribute to an increase in peak flows above the change in vegetative condition primarily due to the reduced permeability of the road surface, more rapid routing of water to streams in roadside ditches, interception and conversion of sub-surface flow to more rapid surface flow, and in some circumstances through the formation of gullies below relief culverts (see discussion in Geology Sediment Associated With Roads). A study utilizing a stream network simulated for Lookout Creek and Blue River drainage's (Wemple 1994) indicated drainage density may increase by as much as 36 percent to more than 60 percent due to the road network. Appendix D lists the current road densities by subwatershed, planning subdrainage and streamsheds.

Jones and Grant (1996) studied the same basin pairs as Christner and Harr (1982) using 150 to 200 paired storms with a period of record greater than 55 years. The results of this study indicate a significant increase in peak discharge associated with cumulative percent of the basin harvested in all three basin pairs. The results of this study indicate no difference in the peak flow response for rain verses rain-on-snow events. They speculated that the trend of increasing peak flows could be several interacting mechanisms including changes in water routing by roads. The regression model used by Jones and Grant (1996) in the North

Fork of the Middle Fork of the Willamette and Salmon Creek pair, indicated that on the average, the basin with an additional five percent of its area harvested increased peak flows by an amount equivalent to 25 to 34 percent of an event with a one year recurrence interval.

Water Yield

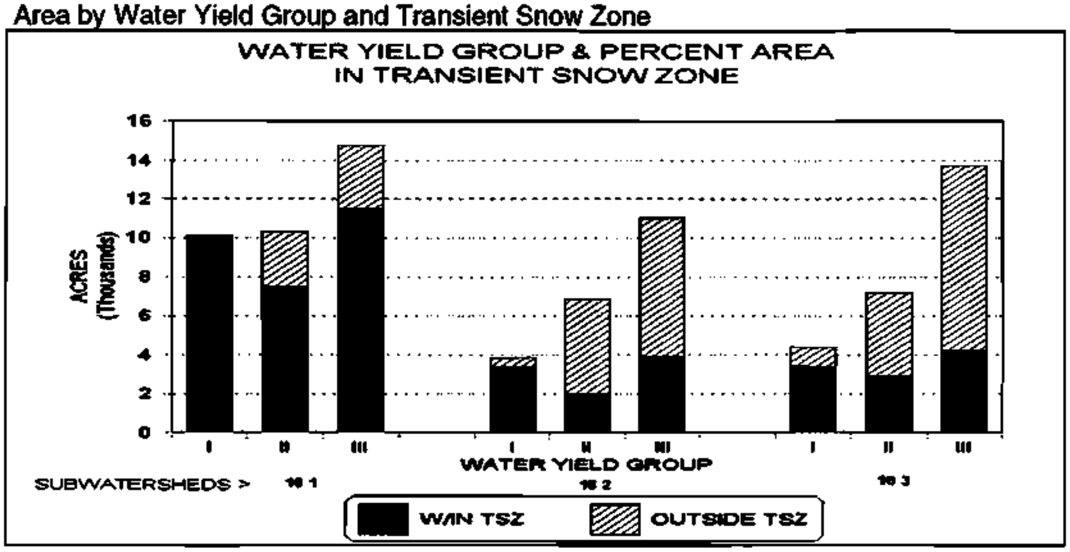
The water yield of an area is a product of the amount of precipitation it receives, combined with the soil and landform properties. The vegetative condition of an area also affects water yield due to changes in the rate of evapotranspiration. Water yield increases have been observed following stand replacement wildfires (Potts et. al., 1989) and after clearcut harvesting (Moring 1975, Harr 1983).

Groundwater storage capacity is directly related to the type of soil and its depth. Relatively shallow soils have a lower ability to store water and have the potential to be the greatest contributors to increased stream flow during high runoff events. Deep soil areas have the ability to store more water and release this water at a slower rate and contribute to baseflow. Soil water yield classification from the Willamette National Forest Soils Resource Inventory (USDA, 1994b) was used as an indicator of the water storage capacity of the soil and the rate at which water would be transmitted through the soil contributing to streamflow. Soil water yield class definitions used in this analysis are as follows:

I. Soils with a low runoff rate and high water detention capacity, given that the soils are not saturated or frozen. Important in sustaining high base flows.
II. Soils with a moderate runoff rate and moderate water detention capacity. Water contributes to both peak flow and base flow.
III. Soils with a high runoff rate and low water retention capacity. The storage capacity is low and easily exceeded with most of the water contributing to peak stream flow.

Landtypes identified in the Soils Resource Inventory were aggregated into high, moderate of low water yield classifications. Figure 8 displays the relative area of each water yield class by subwatershed and the relative proportion of each subwatershed within the transient snow zone. Those subwatersheds that have a high proportion of their area in water yield class III and a high proportion of their area in the transient snow zone would be most susceptible to increases in peak stream flow during rain on snow events. Subwatershed 18 1 would likely contribute the largest volume of runoff during peak flow events due to the large proportion in water yield class III and a high proportion within the transient snow zone.

Figure 8: Area by Water Yield Group and Transient Snow Zone



Water Quality

BENEFICIAL USES

The Oregon Department of Environmental Quality has identified beneficial uses in Oregon Administrative Rules 340-41-442. Beneficial uses for Salmon Creek include resident fish and aquatic life, water contact recreation and aesthetic quality. The Salmon Creek watershed is a secondary municipal water supply for the City of Oakridge and is a source of water for the Oakridge Fish Hatchery operated by the Oregon Department of Fish and Wildlife. Water quality parameters of concern include stream water temperature and sediment.

WATER TEMPERATURE

REFERENCE CONDITION

The water quality within the Salmon Creek watershed during prehistoric times would have been considered high quality by today's standards the majority of the time. Stand replacement wildfires would have had the potential to significantly affect stream temperatures by removing stream side vegetation. After large scale fires or large magnitude flood events, stream temperatures would likely be elevated for a period of time as the stream side vegetation recovers. This recovery period would vary depending on site specific factors. The recovery period could extend to twenty years or more before shading reached pre-disturbance levels.

Limited stream temperature data is available to indicate the range of stream temperatures within the watershed before extensive timber harvesting and road building occurred within the watershed. Table 8 displays the known stream temperature data during this time period. In the summer of 1917 water temperatures were found to be six to eight degrees Fahrenheit colder in Salmon Creek near the mouth when compared to temperatures in the Middle Fork Willamette near the mouth of Salmon Creek.

Table 8: Historic Salmon Creek Temperatures: Year 1917 (from Johnson D.R. 1917)

Location	Month	Maximum Temp. (°F)	Minimum Temp. (°F)
Salmon Creek: near mouth at river mile 1	July	56.0	46.0
	August	57.0	46.0
	September	58.0	46.0

Table 9: Historic Stream Temperatures (from McIntosh et al. 1996)

Location	River Mile	Date	Time	Temperature (°F)
Salmon Creek:				
near mouth		9/1/37	5:15 p.m.	56
bridge at ranger station	1.6	9/1/37	5:00 p.m.	55
Salmon Creek Falls	5.4	9/1/37	4:00 p.m.	52
Mouth of Wall Creek	10.0	7/12/38	1:45 p.m.	56
Mouth of Black Creek	13.5	7/12/38		56
Mouth of Furnish Creek	17.7	7/17/38	4:30 p.m.	49
Black Creek:				
4.0 miles from confluence with Salmon Creek	4.0	7/17/38	2:00 p.m.	50

CURRENT CONDITION

Oregon State water quality temperature standard (OAR Chapter 340):

Seven day moving average of the daily maximum shall not exceed the following values unless specifically allowed under a Department of Environmental Quality approved basin surface water management plan-

- 64 degrees F (17.8 degrees C)
- 55 degrees F (12.8 degrees C) during times and in waters that support salmon spawning, incubation and fry emergence from the egg and from the gravel.
  [except when the air temperature exceeds the 90th percentile of the 7-day average daily maximum air temperature for the warmest 7-day period of the year]

Water quality limited criteria:

Rolling seven day average of the daily maximum exceeds the standard listed above. In cases where data was not collected in a manner to calculate the rolling seven day average of the daily maximum, greater than 25 percent (and a minimum of at least two excedences) of the samples exceed the standard based on multi-year monitoring programs that collect representative samples on separate days for the season of concern (typically summer) and time of day of concern (typically mid to late afternoon).

Time period:

Rearing > June 1 through September 30

Spawning through fry emergence > October 1 to May 31

Stream temperatures within the Salmon Creek watershed vary greatly by season of the year. The highest daily maximum temperature for a given year can occur any time between June through September. The highest average of the daily maximum temperatures occurs during the month of July and the lowest temperatures in December and January.

MAINSTEM SALMON CREEK

Stream temperature data for lower Salmon Creek is available for the critical summer months from the Oakridge fish hatchery located at river mile 1.0. A nearly continuous data record of daily maximum and minimum stream temperatures exists for years 1955 through the present. Figure 9 displays a monthly average of the daily maximum and daily minimum stream temperature at this location for the period of record. For this analysis, recorded daily maximum stream temperatures during the months of June, July and August were used to determine compliance with current standards and determine if any trends are apparent. Figure 10 shows the maximum stream temperature recorded for each summer season and the maximum of the seven day rolling average for this time period.

Figure 9: Average Monthly Stream Temperatures for Salmon Creek Near Mouth

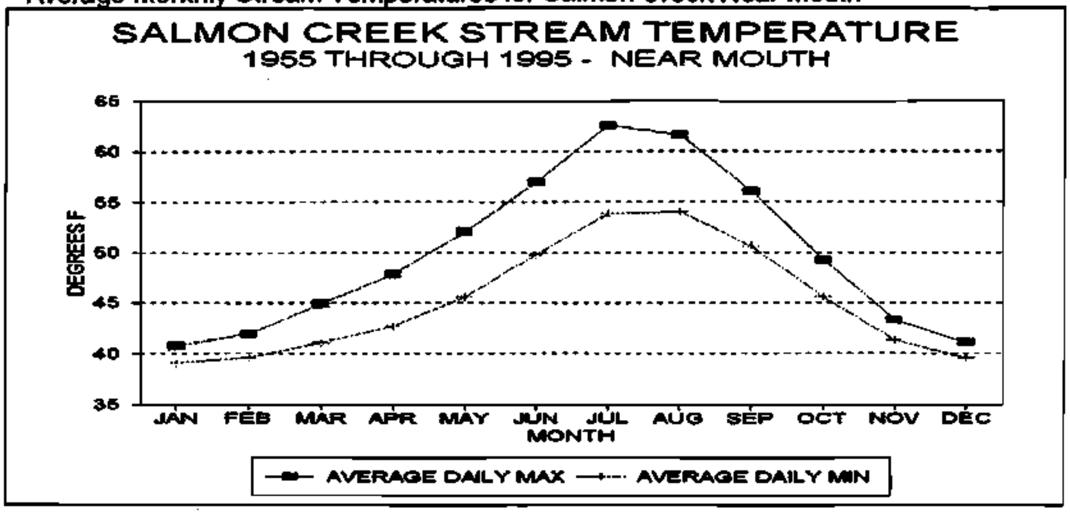
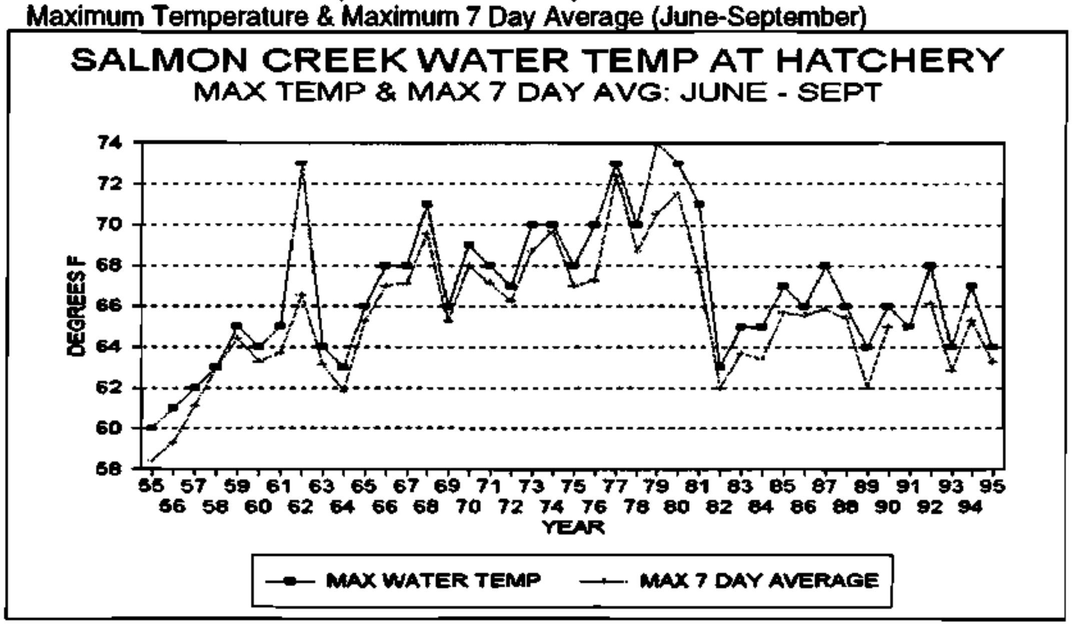


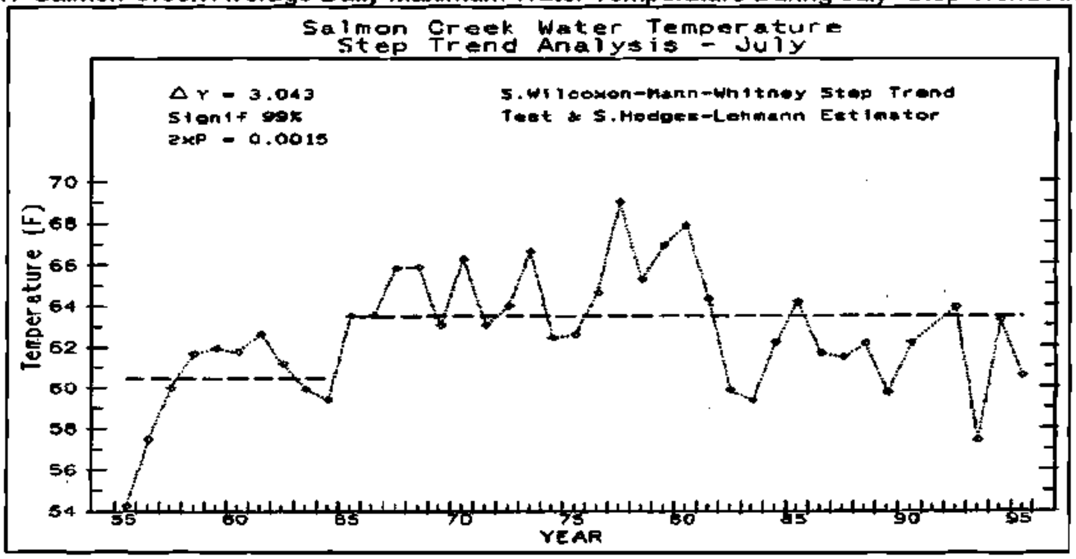
Figure 10: Salmon Creek Water Temperature at Hatchery; Maximum Temperature & Maximum 7 Day Average (June-September)



For the period from the beginning of the record through 1981, the maximum stream temperature and the maximum of the seven day rolling average tends to increase. After 1981, the temperatures tend to be lower. However , they do not reach the cooler temperatures measured during the summer season at the beginning of the period of record (1955-1957) or the lower temperatures indicated during the reference period.

The increase in stream temperature coincides with the time period when stand replacement timber harvest and road building was occurring at a faster rate within the watershed. Logging practices implemented during the 1960's and 1970s typically would remove the majority of stream side vegetation and frequently included the removal of in-channel large woody material. Studies have demonstrated these practices can result in increased temperatures in streams (Moring 1975). Another factor which could have contributed to the apparent increase in stream temperatures is damage to stream side vegetation during high flow events such as the flood of December 1964. Figure 11 displays an analysis of the average daily maximum stream temperatures for the month of July before and after this flood event. Analysis of the average daily maximum stream temperature during July indicated a significant increase in the mean of the maximum stream temperatures from the period before the 1964 flood to the period after the flood ($p<0.01$).

Figure 11: Salmon Creek Average Daily Maximum Water Temperature During July- Step Trend Analysis



A study completed by Beschta and Taylor (1988), reported a highly significant ($p<0.01$) correlation between a cumulative index of timber harvest and maximum stream temperatures. They also noted that stream temperatures tend to increase following damage to streamside vegetation from large magnitude peak flow events and associated mass movements. Their study utilized a forward step wise multiple regression to confirm the occurrence of a highly significant ($p<0.01$) time trend in maximum stream temperatures in Salmon Creek over the study period of 1955 to 1984. Regression analysis for this study indicated the effect of streamflow upon stream temperature was considerably less than the time trend effects. They found that the majority of the explained variance was associated with "year". Only eight percent of the variance was accounted for by "streamflow". Analysis of air temperature data for the 30 year period of record covered by the study indicated a slight decrease in air temperatures during the same time period that stream temperatures were increasing.

The data record studied by Beschta and Taylor (1988) included relatively large magnitude peak flow events in the Salmon Creek watershed in years 1956, 1964, and 1971. They noted that increased water temperatures would be expected to decrease as streamside vegetation recovers. In the Salmon Creek watershed however, summer water temperatures continued to increase after the 1964 flood (the highest on record) for several years after this event. During the 1960's and 1970's, extensive salvage and "stream cleaning" operations were conducted throughout much of the watershed. These activities could have damaged streamside vegetation and contributed to a reduce rate of recovery. Beschta and Taylor speculated that the lower stream temperatures observed after 1981 could be due to several factors including (1) a reduction in timber harvest and road building after 1972, (2) the absence of a large peak flow event since 1971, which would allow for streamside vegetation to recover, and (3) changes in forest management practices. Data displayed in Figure 14 suggests that the lower stream temperatures after 1981 may be more closely associated with the latter two factors listed above.

LONGITUDINAL VARIATION IN TEMPERATURE

During the summer of 1976, the Oakridge Ranger District placed recording thermometers in Salmon Creek at various locations that measured maximum and minimum stream temperatures. Temperature was recorded on approximately a weekly basis. This data indicates a decreasing trend in stream temperature from the mouth to headwater reaches. Maximum water temperatures in the lower reaches of Salmon Creek are likely lower in the current decade when compared to those displayed in Figure 12.

Figure 12: Salmon Creek July through August 1976; Average of Maximum Weekly Stream Temperatures

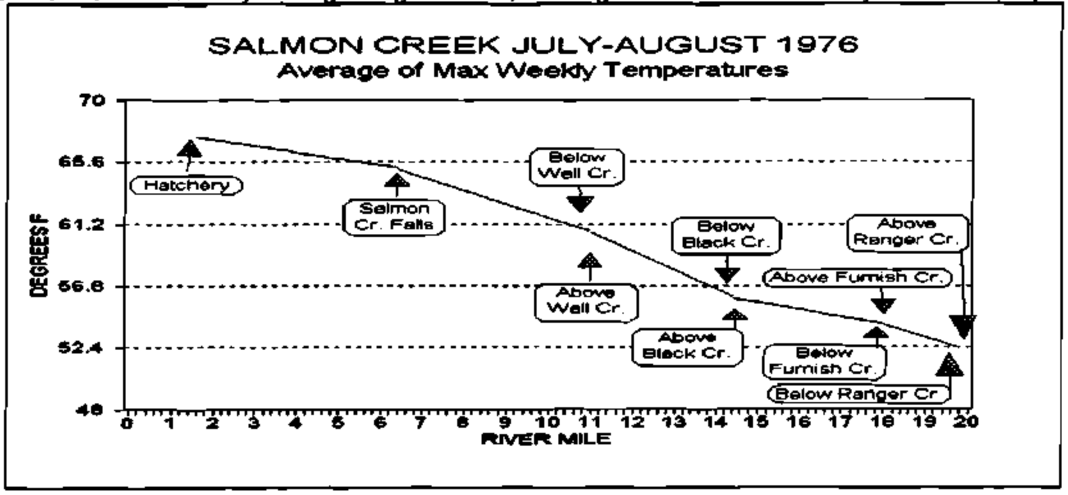


Table 10 below summarizes additional information on temperatures at various locations along the mainstem of Salmon Creek from the 1960's to the present.

Table 10: Salmon Creek Maximum Summer Water Temperatures

Date	Location	Temperature(s)	Data Source
June - October 1964	Near mouth	44.0 - 52.0	1964 survey
September 1965	Near mouth	56.0	1965 survey
Summer 1992 & 1993	Near mouth	59.9 - 67.1	Data recorder
July 1995	Near mouth	60.0	USFS stream survey
July 1995	Fish Hatchery Rd Bridge	55.0	USFS stream survey
July 1995	Near Diversion Dam for Hatchery	58.0	USFS stream survey
July 1995	Near Salmon Creek Falls	55.0	USFS stream survey
July 1995	Near Pollalie Creek	50.0	USFS stream survey
July 1995	Approximately river mile 12.5	51.0	USFS stream survey
July 1995	Between Black Creek and Furnish Creek (river miles 14.2 and 17.8)	52.0	USFS stream survey

TEMPERATURES OF STREAMS TRIBUTARY TO SALMON CREEK

Some small streams tributary to Salmon Creek have likely experienced increases in stream temperatures from the 1960's to the present due to stand replacement timber harvest and other management activities such as the removal of large wood from channels. The effect of the warmer water from these small streams would be partially offset by mixing with cooler water from ground water and other tributary sources. The available data indicates that streams tributary to Salmon Creek are generally relatively cool. Table 11 below summarizes stream temperature information of several tributaries of Salmon Creek.

Table 11: Temperatures of Streams Tributary to Salmon Creek

Stream Name	Date	Location	Maximum Temperature	Data Source
Wall Creek	June-October, 1964	Near mouth	43 - 56	1964 survey
	June - Sept., 1976	Near mouth	55 - 61	USFS data
	Sept., 1995	Above warm springs	48	USFS stream survey
Kelsey Creek	July 1992	Mouth to Headwaters	50 - 54	USFS stream survey
	Oct. - Sept. 1994	Near mouth	34 - 63	USFS data recorder
	Oct. - Sept. 1995	Near Mouth	35 - 60	USFS data recorder
Black Creek	June - Oct., 1964	Near Mouth	43 - 50	1964 survey
	Sept. 8, 1965	Near Mouth	49	1965 survey
	July 19, 1992	Near Mouth	51	USFS stream survey
	June - Sept., 1992-94	Near Mouth	52 - 57	USFS data recorder
	August 1995	Near river mile 10 (reach 12)	47 - 49	USFS stream survey
	August 1995	Near river mile 11 (reach 13)	45	USFS stream survey
Mule Creek	Sept., 1995	Reach 3	43	USFS stream survey
Furnish Creek	June - Sept. 1991	Near mouth	55 - 47	USFS data recorder
	August, 1990	Mouth to headwaters	45 - 52	USFS stream survey
	June - Sept. 1991,92,94,95	Road crossing 2417-266	49 - 57	USFS data recorder
Ranger Creek	July, 1995	Reach 2	54	USFS stream survey
	July, 1995	Reach 4	62	USFS stream survey

COMPLIANCE WITH CURRENT STATE WATER QUALITY STANDARDS FOR TEMPERATURE
The mainstem of Salmon Creek has exceeded the state water quality standard for temperature at the mouth of the watershed for at least a portion of the summer season (June 1 through September 30) in the majority of years data is available. Although stream water temperatures near the mouth of Salmon Creek have been lower since 1981 when compared to the time period of the mid-sixties through the seventies, the water temperature currently is above the state standard in some years during the critical summer season. The limited amount of data available indicates that water temperatures in the mainstem of Salmon Creek are likely maintained below the maximum allowed by state standards above river mile 10 (down stream of the confluence of Wall Creek). The majority of streams tributary to Salmon Creek are relatively cool and within state water temperature standards. However, it is likely some tributary streams that are recovering from stand replacement timber harvest within the riparian reserves are currently above the state standard.

STREAM SEDIMENT AND TURBIDITY
REFERENCE CONDITION
Prior to management activities in the Salmon Creek watershed, elevated turbidity was probably associated with high runoff events, particularly after large and infrequent wildfires, or disturbance such as a debris torrent. The majority of the time, Salmon Creek and its tributaries would have been clear with low levels of suspended sediment and turbidity.

CURRENT CONDITION
Studies indicate the ability of salmonids to find and capture food may be impaired at turbidity values in the range of 25-70 NTUs, growth reduced and gill tissues damaged after 5-10 days of exposure to turbidity of 25 NTUs, and some species may be displaced at 50 NTUs (MacDonald et al. 1991). Salmon Creek generally has low turbidity values (typically less than 5 NTUs) except during winter high flow conditions.

Shallow rapid mass movements in the form of debris torrents can result in dramatic short-term changes in turbidity. Chronic sources of fine sediment contributing to increases in turbidity include road and hill slope surface erosion, and stream bank cutting where banks are composed of unconsolidated material and vegetation has been disturbed.

The degree to which specific drainages contribute chronic sources of sediment varies by management history combined with soil type and geologic structure. See Physical/ Geology and Soils section, this chapter for a related discussion and identified management related sediment source areas.

Bank instability was noted during stream surveys in Warble Creek, Kelsey Creek, Wall Creek, and Mule Creek in subwatershed 18 1. Wall Creek, Mule Creek, and Kelsey Creek had the highest number of mass wasting and bank cutting sites in this subwatershed (18, 9, and 10 sites respectively). Subwatershed 18 2, consisting primarily of Black Creek, had 21 sites of bank cutting and mass wasting, with some of the mass wasting sites being quite large (100 feet long by 50 feet high). Subwatershed 18 3 containing Furnish Creek and Ranger Creek had relatively few sites of bank instability. Subwatersheds 18 1 and 18 2 which have numerous areas of bank instability are likely to be source areas of sediment for stream channels as well as potential sediment sources for the mainstem of Salmon Creek. The mainstem of Salmon Creek itself also had reaches with evidence of bank instability. Reaches 4, 5, 7 and 9 had the highest frequency of unstable areas (see Figure 15).

GROUNDWATER
REFERENCE AND CURRENT CONDITION
The Safe Drinking Water Act requires the Oregon Health Division to identify community water supply systems utilizing groundwater sources under direct influence from surface waters. To meet this requirement, the city of Oakridge contracted with a consulting engineering firm to conduct a hydrogeologic assessment to evaluate whether surface water has a direct hydrologic connection with the wellfield groundwater from which the City extracts its water. The following information was taken from the consulting engineers report prepared for the City of Oakridge (Barry 1993).

The available geologic information indicates no laterally continuous low permeability zone that would isolate surface water (Salmon Creek) from the aquifer that supplies the City's wellfield. In addition, it appears there is a hydrologic connection between the wellfield and Salmon Creek and that there is a potential for surface water to influence the wellfield. The estimated surface water contribution to the Oakridge wellfield over a six month time period is approximately 60 percent. The travel time of ground water from Salmon Creek to the wellfield is estimated to range from less than three months to more than one year. Actual travel time of the water is probably greater however because the preceding estimates do not include the time required for the surface water to infiltrate vertically downward from Salmon Creek to the open interval of the wells.

Large Woody Material

Large Woody Material (LWM) is an important component on most stream reaches within the Salmon Creek watershed. This material influences the form and structure of stream channels by affecting stream profile, pool formation, and channel pattern and position. The rate at which sediment and organic matter are transported downstream is controlled in part by LWM. The features formed by LWM affect the formation and distribution of in-stream habitat, provide cover and complexity, and act as a substrate for biological activity.

REFERENCE CONDITION

Due to the affects of floods and debris torrents, LWM would have been distributed non-uniformly, existing in large debris jams in and adjacent to stream channels and as isolated logs or trees. Amounts of LWM in stream channels likely varied across the watershed. Some areas that experience repeated fire (see discussion of re-burning in the Vegetation/Fire History Section) may have had low amounts of in-stream LWM.

CURRENT CONDITION

Past management activities such as salvage logging and stream cleaning projects have reduced the current amount of LWM present in and adjacent to stream channels when compared to pre-management conditions. The 1964 flood event combined with extensive timber salvage within the riparian area of Salmon Creek likely had significant impacts to the stability of gravel and cobble bars, stream banks, and riparian vegetation. The loss of LWM is likely in part responsible for reduced channel complexity including a reduction in the number of pools and the number and length of side channels (see the channel condition discussion later in this chapter).

Large woody material for streams originates directly from the adjacent riparian area, from tributaries, and from hill slopes. Past timber management activities have significantly affected this source area of LWM within the riparian areas. Stand replacement timber harvest and salvage logging has reduced the amount of LWM currently available and the potential recruitment of LWM in the future (Figures 13 and 14). Many decades will be required for riparian areas to recover and provide LWM of similar sizes and amounts as would have been available under pre- management conditions.

Riparian Reserves

CURRENT CONDITION

Approximately 31 percent of the total area of the Salmon Creek watershed is within areas identified as riparian reserves. The proportion of the watershed in riparian reserves will likely increase as more detailed stream mapping is completed. Figure 13 of this chapter displays the acres of mapped riparian reserves by subwatershed and the area by harvest category within these reserves. Subwatershed 18 1 has had the highest percentage of harvest in riparian reserves.

The area impacted by management activities within riparian reserves has varied over time. Harvest impacts within riparian reserves increased during the decade beginning in 1960 and remained relatively high through the decade ending in 1990. Figure 14 and Table 12 of this chapter display the acres of riparian reserves harvested by decade and subwatershed.

Table 12: Acres Harvested in Riparian Reserves

	Decade of Harvest								
Subwatershed	< 29	30-39	40-49	50-59	60-69	70-79	80-89	90-95	Total Acres by Subwatershed
18 1	195	0	152	413	1388	1438	831	36	4463
18 2	0	0	0	45	337	431	303	64	1180
18 3	0	0	1.5	137	527	361	511	40	1577.5
Total Acres by Decade >>	195	0	153.5	595	2252	2230	1645	140	Total = 7210.5

Figure 13: Acres of Riparian Reserves and Amount Impacted by Harvest

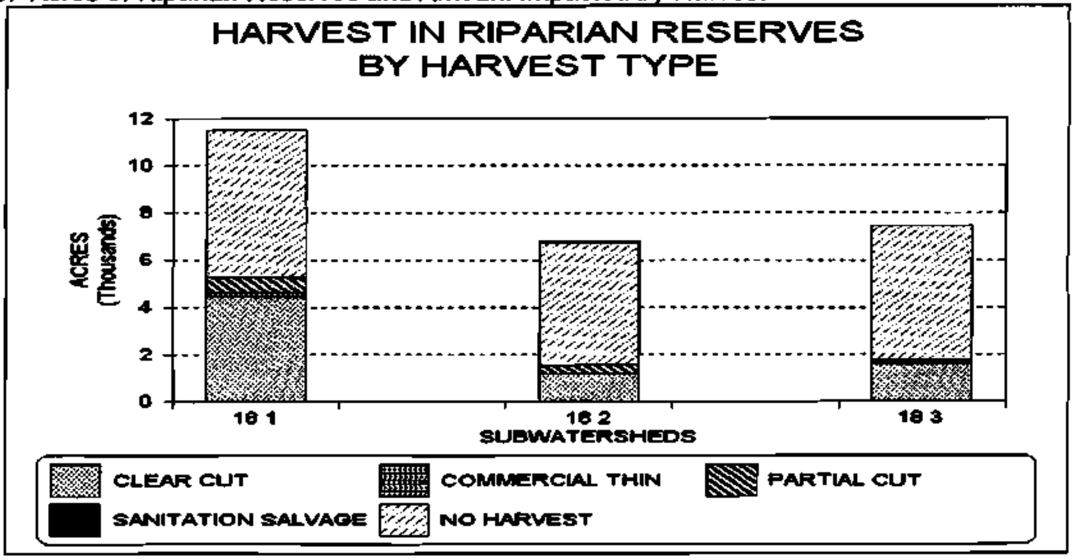
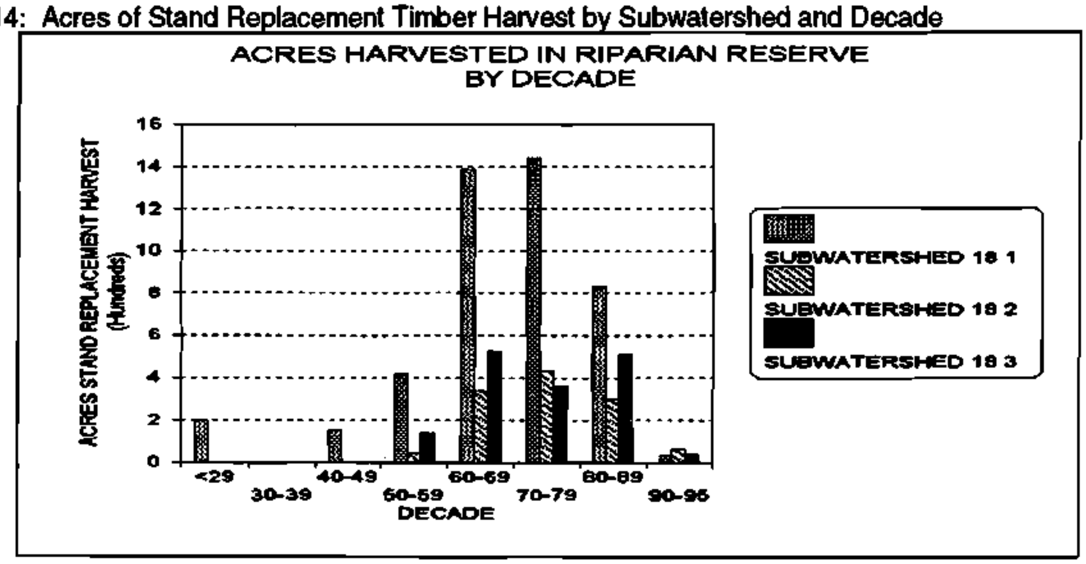


Figure 14: Acres of Stand Replacement Timber Harvest by Subwatershed and Decade



Channel Condition

REFERENCE CONDITION

Channel conditions in general are heavily influenced by the presence and distribution of large woody material (see above section on large woody material). Overall channel conditions prior to management probably varied substantially by stream type and due to the influence of varying amounts of large woody material. It is likely that most stream reaches had relatively high amounts of large woody material before management impacts occurred, as historic stream survey data indicates. Streams located in areas of high fire frequency and high elevation areas may exhibit a natural condition of low amounts of large woody material.

CURRENT CONDITION

Channel conditions were analyzed by subwatershed, except for the main stem of Salmon Creek which was analyzed separately because it flows through more than one subwatershed. Physical and biological characteristics of each subwatershed, as well as the main stem of Salmon Creek, were determined from stream survey data. Many of these characteristics can be compared to objective values to aid in determining the current condition of the watershed (Table 13). A total of 64.1 miles of streams have been surveyed in the Salmon Creek watershed (Table 14).

Assessing channel condition and predicting channel response requires identification of functionally similar portions of the channel network. On the Willamette National Forest, the identification of Valley Segment Types has been incorporated into the stream survey methodology to stratify stream segments based on similar drainage morphology. Tables 16 and 17 of this chapter outline the valley segment types delineated within the Salmon Creek watershed.

Table 13: Objectives for Aquatic Variables

Habitat Variable	Definition or Range	Objective	Source
Large Pools	<2% Gradient	1 pool/5-7 channel widths	Willamette NF Plan
Large Pools	2-8% Gradient	1 pool/3-5 channel widths	Willamette NF Plan
Large Pools	Channel Width	See below (*)	PACFISH
Large Wood	Undefined	80 pieces over 24" dbh & 50' length per mile	PACFISH
Large Wood	Low Gradient Streams	105 pieces longer than stream width w/pieces >25' per mile	Willamette NF Plan (Appendix E)
Large Wood	High Gradient Streams	50% of channel length should be influenced	Willamette NF Plan (Appendix E)
Width:Depth Ratio	All Streams	<10	PACFISH
Temperature	Streams (salmonids)	Meet state standards (58 degrees F)	State Standards

(*) PACFISH Objective for Pools per Mile by Wetted Stream Width in feet (USDA, USDI, 1994c)

Wetted Stream Width	10	15	20	25	50	75	100	125	150	175	200
Pools/Mile	96	70	56	47	26	23	18	14	12	10	9

Table 14: Streams Surveyed in the Salmon Creek Watershed

Stream	Subwatershed	PSUB	Miles Surveyed	Year Surveyed	Method*
Salmon	NA	NA	12.3, 21.8	1990, 1995	GP, Reg
Warble	Lower Salmon (18 1)	182	.9	1990	GP
Salmon Trib	Lower Salmon (18 1)	183	.34	1990	GP
Wall	Lower Salmon (18 1)	18E	5.36, 7.01	1991, 1995	GP, Reg
-Tributaries		18E & F	3.08	1991	GP
Mule	Lower Salmon (18 1)	18I	3.49	1995	Reg
Kelsey	Lower Salmon (18 1)	18Z	5.73	1992	Reg
-Tributaries		18Z	1.5	1992	Reg
Black	Black Creek (18 2)	18X	8.99, 3.25	1992, 1995	Reg
Ranger	Upper Salmon (18 3)	18T	3.28	1995	Reg
Furnish	Upper Salmon (18 3)	18K	4.68	1990	GP

*GP - Gifford Pinchot, Reg - USFS Region 6

Relatively high gradient streams associated with Steeply Incised Valley/Steep and Moderate Channel Gradients (types 2, 3, V1, V2, V3, H1, H2, and H3) are generally high debris transport streams with channel features including frequent vertical drop scour pools and infrequent log jams. Lower gradient streams associated with valley segment types such as U-Shaped Glacial Trough and alluviated mountain valleys (types 7, 10, M2, V4, U2, and U3) will have depositional features such as point bars, and under natural conditions would be expected to have abundant log jams. Channel stability ratings are an indication of sediment source areas often from stream bank and stream bed erosion. Areas indicated as having a poor stability rating may be particularly susceptible to adverse impacts during high flow events. It should be noted that valley\headwall tributaries are probably under represented since many of these are Class IV streams which are not surveyed under current stream survey methodology. The following is a synopsis of the stream surveys conducted in the Salmon Creek watershed.

Main Stem of Salmon Creek

VALLEY SEGMENT TYPES

The main stem of Salmon Creek is composed of several different valley segment types and Rosgen types (Table 17 and Figure 15 of this chapter). The first reach of Salmon Creek flows through an alluvial/colluvial fan area. The reaches just above this area flow through alluviated slope bound valleys and alluviated mountain valleys before entering a bedrock canyon about 8.8 miles upstream from the confluence with the Middle Fork of the Willamette River. Above this bedrock canyon Salmon Creek again flows through an alluviated mountain valley until the confluence with Black Creek. Above this point, the valley changes to a v-shaped valley with a moderate gradient bottom until the confluence with Ranger Creek, when the gradient of the V-shaped valley gets steeper. The total number of miles for each valley segment type is shown in Table 18 of this chapter.

Figure 15:
Valley Segment Types
and Rosgen Types

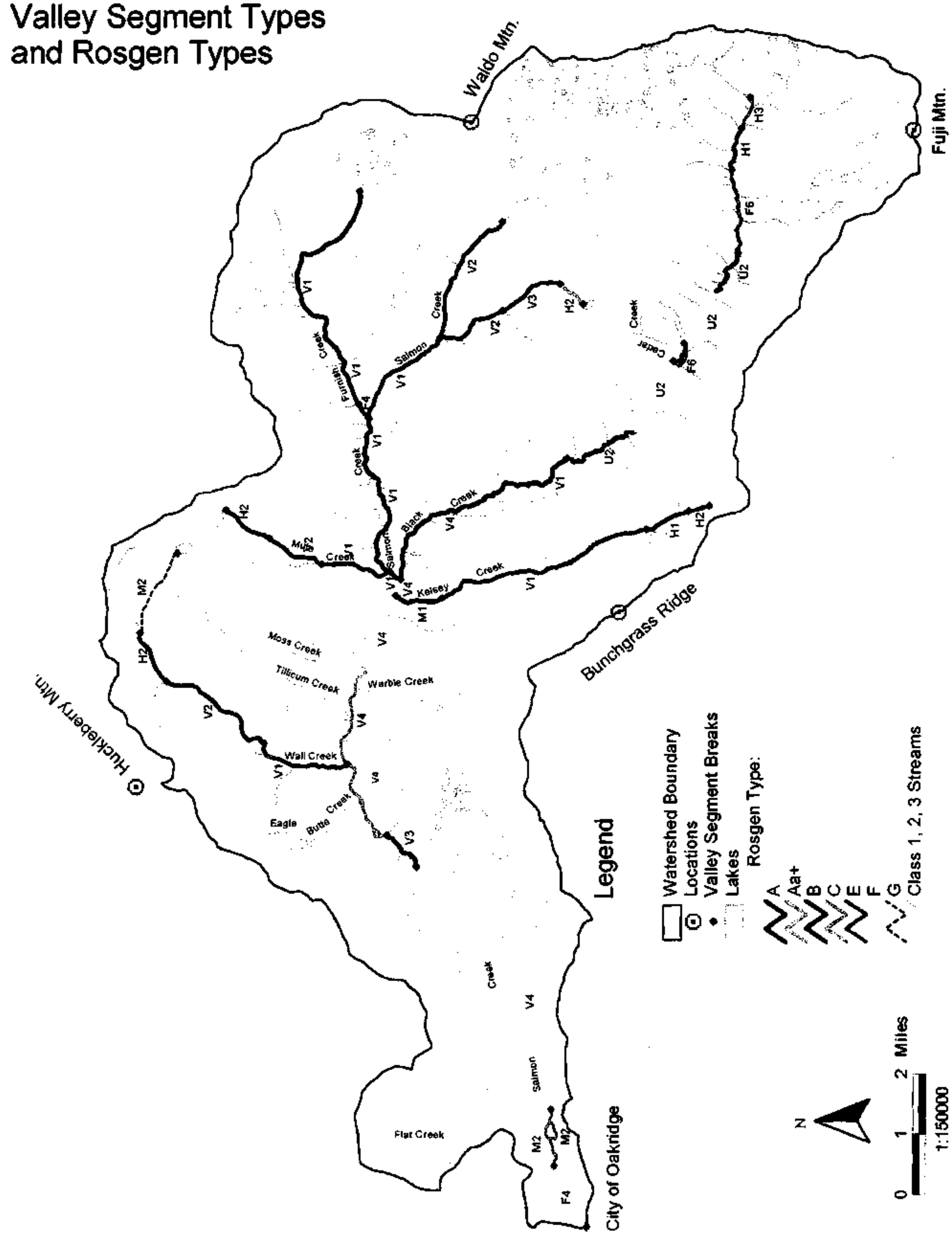


Table 15: Valley Segment Types in the Salmon Creek Watershed

Valley Segment Type	Valley Bottom Gradient	Side Slope Gradient	Valley Bottom Width	Channel Pattern	Stream Order	Landform & Geographic Features
F4- Alluvial / Colluvial Fan	1-3%	<=10%	>3X	Variable;generally unconstrained	1-4	Occurring where tributary streams enter low gradient valley floor; alluvial /colluvial fan deposition overlaying floodplains of larger, low grade stream; may actively downcut through alluvial fan deposition
F6-Palustrine Spring fed Meandering Flats	<2%	<5%	75X	Unconstrained; high sinuosity	>=2	Associated w/lakes, wetland outlets; often high elevation; fine sediment storage; grass/forb riparian communities
M1-Moderate Slope Bound	2-5%	10-30%	<2X	Constrained; infrequent meanders	1-4	Constrained, narrow floodplain bounded by mod. gradient sideslope; typically found in lowlands/foothills, may occur on broken mountain slopes and volcano flanks
M2-Alluviated Moderate Slope Bound	<=2%	<5% gradually increase to 30%	2X-4X	Unconstrained; moderate to high sinuosity	1-4	Active floodplain & alluvial terraces bounded by moderate grade hillslopes; typically found in lowlands & foothills, may occur on broken mountain slopes and volcano flanks
V1-V-Shaped Moderate Gradient Bottom	2-6%	30-70%	<2X	Constrained	>=2	Incised drainage w/steep competent sideslopes; very common in uplifted mountainous topography; also glacial outwash terraces in lowlands
V2-V-Shaped High Gradient Bottom	6-11%	30-70%	<2X	Constrained	>=2	Same as V1, but valley bottom longitudinal profile steep with pronounced stairstep characteristics
V3-Bedrock Canyon	3-11%	>=70%	<2X	Highly constrained	>=2	Canyonlike stream corridors with frequent bedrock outcrops, stairstepped profile; associated with faulted or volcanic landforms
V4-Alluviated Mountain Valley	1-4%	Channel adjacent slopes <10%; increases to 30%	2X-4X	Unconstrained; high sinuosity; with side channels and braids common	2-5	Deeply incised drainage with relatively wide floodplains; distinguished as "alluvial flats" in otherwise steeply dissected mountainous terrain
U2-Incised U-Shaped Valley, Moderate Gradient Bottom	2-5%	Steep channel adjacent slopes, decreases <30% then increases to >30%	2X	Moderately constrained by unconsolidated material; infrequent short flats w/braids and meanders	2-5	Downcuts through deep valley bottom glacial till, colluvium glaciofluvial deposits; cross sectional profile variable, but generally weakly U-shaped w/active channel vertically incised into valley fill deposits; immediate sideslopes composed of unconsolidated & often unsorted coarse grained deposits
U3-Incised U-Shaped Valley, high Gradient Bottom	6-11%	Same as U2	<2X	Same as U2	2-5	Same as U2
H1-Moderate Gradient Valley Wall / Headwater	3-6%	>30%	<2x, may be >2X in headwater cirques	Constrained	1-2	Small Drainage w/channels slightly to moderately entrenched into mountain toeslopes or headwater basins
H2-High Gradient Valley Wall / Headwater	6-11%	>30%	<2X	Constrained; stairstepped	1-2	Small drainage w/channels moderately entrenched into high gradient mountain slopes or headwater basins; bedrock exposures & outcrops common; localized alluvial/ colluvial terrace deposition
H3-Very High Gradient Valley wall / Headwater	>11%	>60%	<2X	Constrained; stairstepped	1-2	Small drainage w/channels moderately entrenched into very steep mountain slopes or headwater basins; bedrock exposures & outcrops frequent

Table 16: Valley Segment Types- Gifford Pinchot Stream Survey Methodology

Valley Segment Type	Stream Order	Sideslope	Channel Pattern	Land Form Features	Channel Type	Channel Gradient	Large Woody Material
Lower Alluvial Valley (1)	Any	0-10%	unconstrained, highly sinuous	on lower large river floodplain/ lacustrine terrace, elevated glacial valleys	alluvial	0-5%	abundant large jams on channel margins
Alluvial Fan (2)	2-4	flat-moderate	sinuous, generally unconstrained	occurs where tributaries enter low gradient streams	alluvial	1-6%	frequent large jams and individual pieces
Steeply Incised Valley Moderate Channel Gradient (3)	2-4	steep	constrained, slightly sinuous	downcutting steep hillsides, often vertical canyon walls	bedrock, alluvial in short reaches	3-6%	infrequent large jams
Steeply Incised Valley /Steep Channel Gradient (4)	2-4	steep, often vertical	constrained, slightly sinuous	downcutting steep hillsides, often vertical canyon walls	bedrock, big boulder	>6%	infrequent large jams
Incised Glacial Till/Incised Colluvium Deposits (5)	2-4	steep w\ flat to steep upper slopes	straight-slightly sinuous	downcutting through glacial deposits or colluvium substrate - high potential bank failure	boulder / rubble	2-5%	abundant single pieces and occasional jams
Moderate-Slope Bound Valley (6)	1-3	flat - moderate	straight-slightly sinuous	lower foothill sand minor fault block areas as well as upper drainage areas	alluvial, short sections of bedrock	1-5%	small debris jams & single stems common
U-Shaped Glacial Trough (7)	1-3	flat	moderate-high meanders	located in bottoms and lower side slopes of U-shaped glacial valleys	alluvial	0-3%	abundant small jams and single pieces
Valleywall/Headwall Tributary (8)	1-2	moderate-steep	straight; stairstep profile	small tributaries flowing over moderate/steep hillsides	bedrock or boulder	1-5 %	variable, creates stairsteps
Lava Flow/Spring Fed Meadow (9)	1-2	0-10%	slight meander	low gradient slopes and slight downcutting	alluvial or boulders	0-3%	infrequent large jams, beaver important
Alluviated Mountain Valley (10)	2-4	flat w\ steep upper slopes	high meanders and braiding	wide annual floodplain, continual alluvial deposits	alluvial	0-3%	frequent jams and single pieces create pools
Moderately Incised Valley (11)	2-3	steep w\ flat upper slope	straight - slightly sinuous	steep, bedrock banks with broad flat upslope areas	bedrock, boulder and rubble	3-5%	infrequent channel width jams, few single pieces

Table 17: Valley Segment Types for Salmon Creek

Reach Number	Reach Length (miles)	Cumulative Miles	Valley Segment Type	Reference Point for Start of Reach
1	1	1	Alluvial/Colluvial Fan (F4)	Confluence with Middle Fork
2	1.1	2.1	Alluviated Moderate Slope Bound (M2)	Fish Hatchery Road bridge
3	1.5	3.6	Alluviated Mountain Valley (V4)	Diversion Dam for Fish Hatchery
4	2.2	5.8	Alluviated Mountain Valley (V4)	
5	2.3	8.1	Alluviated Mountain Valley (V4)	Salmon Creek Falls
6	.7	8.8	Bedrock Canyon (V3)	Bedrock Canyon
7	3.9	12.7	Alluviated Mountain Valley (V4)	Top of Bedrock Canyon
8	1.7	14.4	Alluviated Mountain Valley (V4)	Moss creek
9	3.6	18.0	V-Shaped Moderate Gradient Bottom (V1)	Black Creek
10	1.8	19.8	V-Shaped Moderate Gradient Bottom (V1)	Furnish Creek
11	1	20.8	V-Shaped High Gradient Bottom (V2)	Ranger Creek

Table 18: Total Miles for Valley Segment Types for Salmon Creek

Valley Segment Type	Miles	%
Alluvial/Colluvial Fan (F4)	1	5
Alluviated Moderate Slope Bound (M2)	1.1	5
Alluviated Mountain Valley (V4)	11.6	56
Bedrock Canyon (V3)	.7	3
V-Shaped Moderate Gradient Bottom (V1)	5.4	26
V-Shaped High Gradient Bottom (V2)	1	5

LARGE WOODY MATERIAL

Given the valley segment types present in the main stem of Salmon Creek, large woody material would be expected to be present in the form of frequent jams and single pieces in the alluvial reaches, such as the alluviated mountain valleys. Steeper gradient reaches, such as those flowing through V-shaped valleys, would be expected to have less frequent, large debris jams. Figure 16 of this chapter shows the current levels of large woody material along the longitudinal profile of the main stem of Salmon Creek. All reaches of the main stem of Salmon Creek, including those in which large wood would be expected to be abundant, are below large woody material objective values (Figure 17). Large wood is most abundant in the upper reaches of Salmon Creek, although current levels of wood are lower than objective and historic values. During the 1995 survey, a total of 22 log jams were noted with the majority occurring in reach 9 (above the confluence with Mule Creek. Notes from a 1938 stream survey (McIntosh et al., 1992) reported that Salmon Creek "was full of log jams above the falls, a number of which" were thought to "present impassable barriers to salmon." The highest levels of large wood were located above the confluence with Black Creek according to the same 1938 survey.

Figure 16: Longitudinal Profile for Mainstem Salmon Creek (1995)

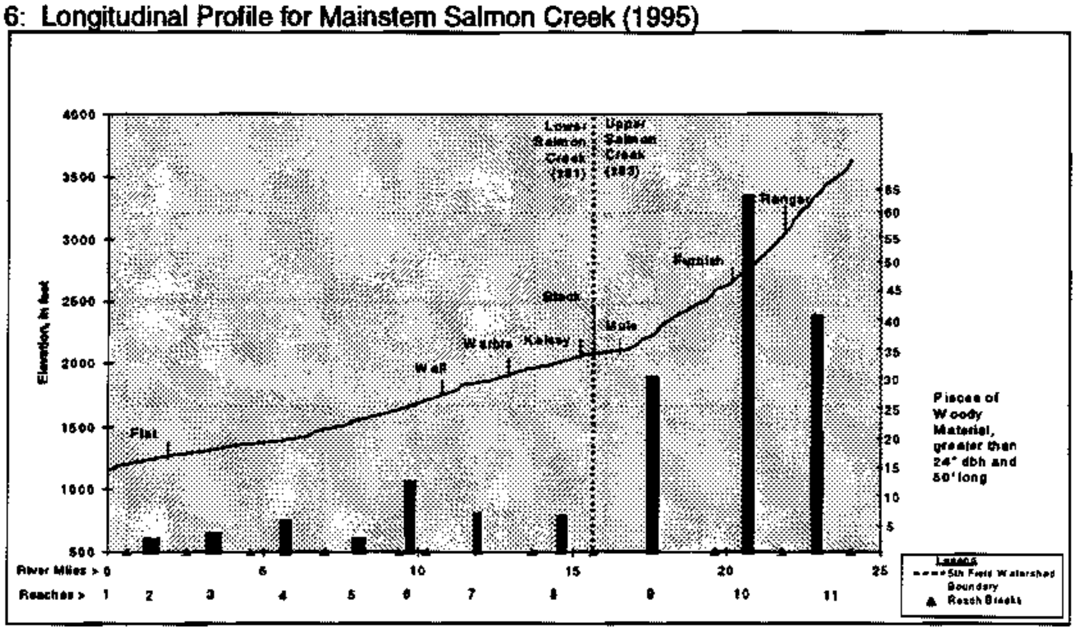
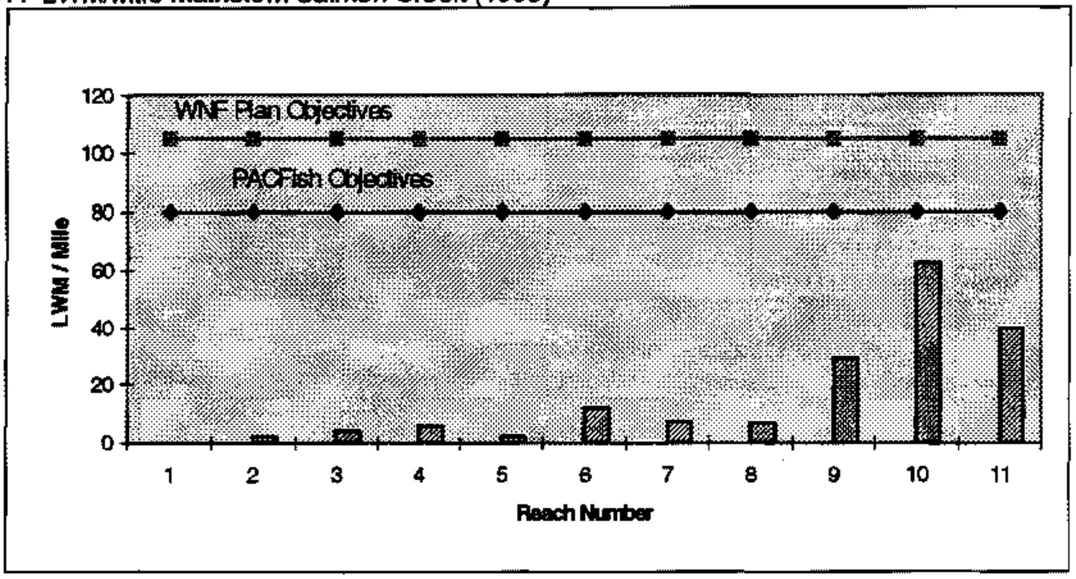


Figure 17: LWM/Mile Mainstem Salmon Creek (1995)



LARGE POOLS AND SIDE CHANNELS

In alluvial reaches, large woody material and scour at meander bends are major components in the formation of large pools. In higher gradient, boulder dominated reaches, pools are typically associated with large log jams or occur as pocket pools associated with large boulders. Figure 18 shows the riffle and pool percentages for the mainstem of Salmon Creek. Pools make up a larger percentage of the total habitat in the lower reaches of Salmon Creek and are less common in the upper reaches. The number of large pools/mile nears or exceeds the Forest Plan objective values, but not PACFISH objective values, in the lower reaches of the mainstem of Salmon Creek (reaches 1-7) (Appendix E). Since there is very little large woody material in this section of Salmon Creek, the majority of pools are probably scour pools at meander bends with very little cover. Although there are higher amounts of large woody material in the upper reaches of Salmon Creek (reaches 9-11) the number of large pools per mile is lower than both Forest Plan and PACFISH objective values.

Figure 18: Mainstem Salmon Creek Riffle/Pool Percentages (1995)

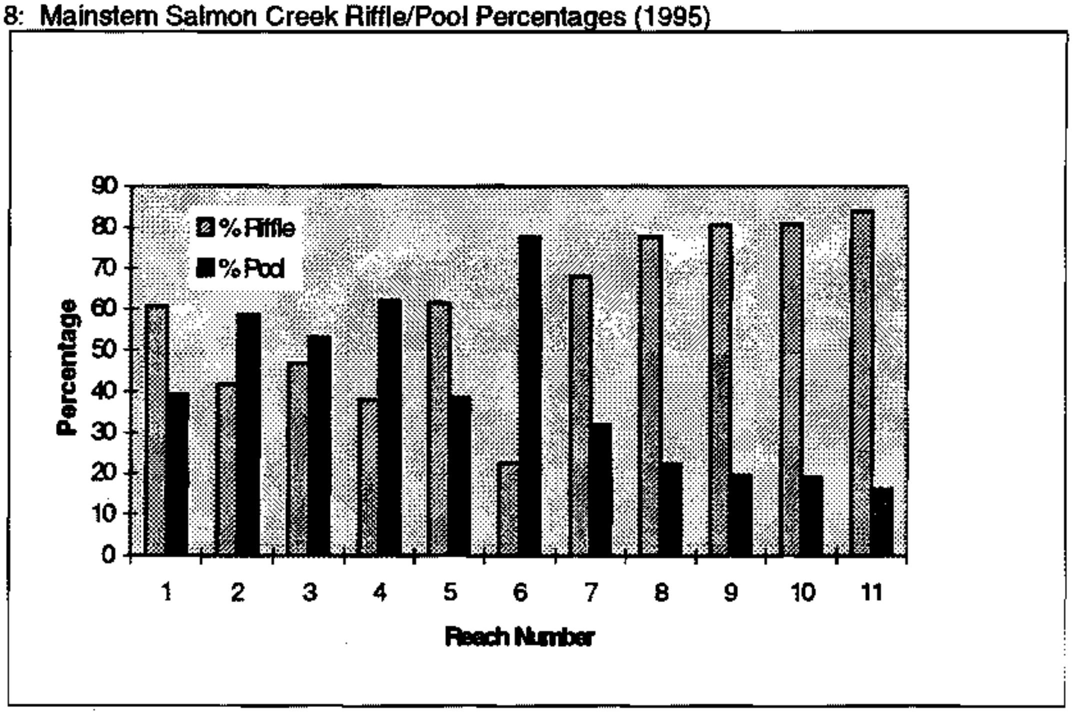


Table 19: Changes in the Number of Pools/Mile in the Mainstem of Salmon Creek from 1938 to 1995

1938 Survey*		% Difference from	1995 Survey**	
Location	pools/mile	1938 to 1992	pools/mile	Reaches
Mouth to Fish Hatchery Rd. Bridge	9.4	+1.1	9.5	1
Fish Hatchery Rd. Bridge to Salmon Ck. Falls	12.1	-9.1	11	2 to 4
Salmon Creek Falls to Wall Creek	14.3	-13.9	12.3	5 to 7
Wall Creek to Black Creek	17.7	-49.7	8.9	8
Black Creek to Furnish Creek	7.6	+122.7	16.9	9
Furnish Creek to end of Survey	20	+0.5	20.1	10

* McIntosh et al. 1992

** Oakridge Ranger District stream surveys 1995

(Note: location description was used rather than river miles for the mainstem Salmon Creek comparisons.)

Comparisons of the large pools/mile from the 1991 stream survey with the survey completed in 1938 (McIntosh et al. 1992) shows that large pools were not numerous in reaches 9 and 10 even in 1938 before intensive land management activities impacted this area (Table 19). The fact that we see an increase in the number of large pools may simply be a factor of differing definitions of "large pools" between the two different survey methods. This is to be expected in these smaller, headwater reaches. A large pool in the 1995 survey methodology simply meant that the pool spanned the entire channel width and would not necessarily be seen as "large" by the 1938 methodology. This difference in large pool definitions between the two survey methods should not be as great in the lower reaches where a "large pool" is actually expected to be large in size. In the lower and middle reaches (2-8) there was a decline in the number of large pools per mile from 1938 to 1995. The highest decline was in reach 8, the section of Salmon Creek that extends from Wall Creek to Black Creek. The 1938 survey indicated that the area above Wall Creek (the stream section above reach 7 during the 1995 survey) had "no signs of human habitation" so this section could be considered as being in reference conditions during the 1938 survey. The number of pools in this reach declined nearly 50 percent from 1938 levels. Reach 1, from the mouth of Salmon Creek to the Fish Hatchery Road bridge did not change between 1938 and 1995. This area was already impacted by the time of the 1938 survey, however. Therefore, 1938 conditions should not be considered to be the reference conditions for this reach.

Side channel habitat is also an important aspect of channel condition. Figure 19 shows that side channels are common throughout the mainstem of Salmon Creek especially in reaches 1, 3, and 7.

Figure 19: Mainstem Salmon Creek Habitat (1995)

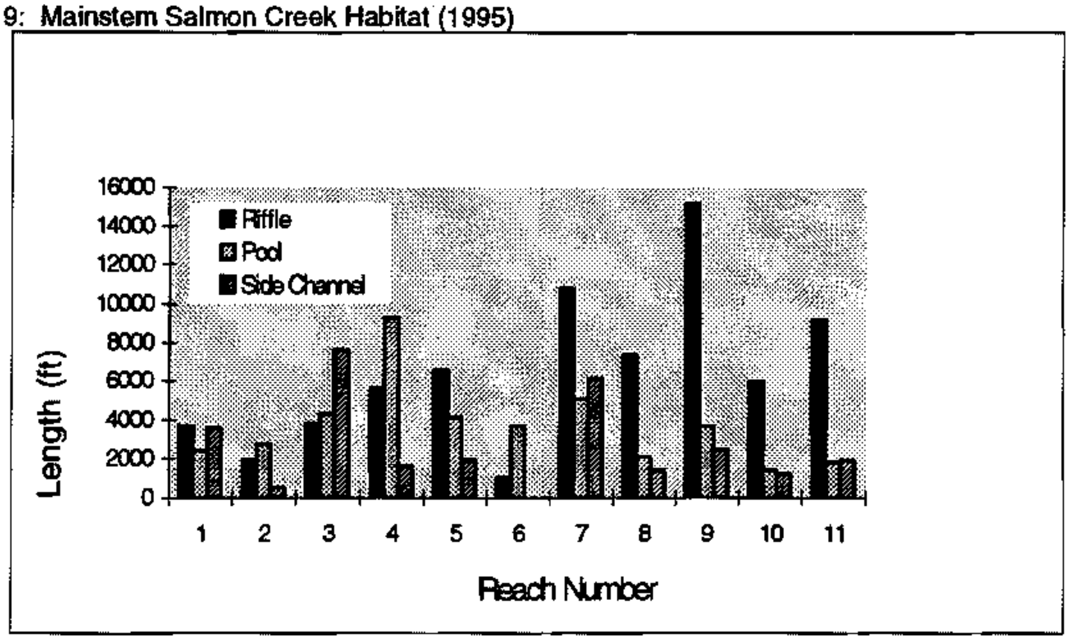


Table 20: Changes in the Average Channel Width in the Mainstem of Salmon Creek from 1938 to 1995

1938 Survey*		% Difference from 1938 to 1992	1995 Survey**	
Location	width (ft)		width (ft)	Reaches
Mouth	55	-20.0	44	1
Fish Hatchery Rd. Bridge	49	+32.7	65	2
Salmon Creek Falls	80	-28.8	57	5
Wall Creek	68	+1.5	69	7
Black Creek	58	-1.7	57	9
Furnish Creek	43	+18.6	51	10

* McIntosh et. al. 1992

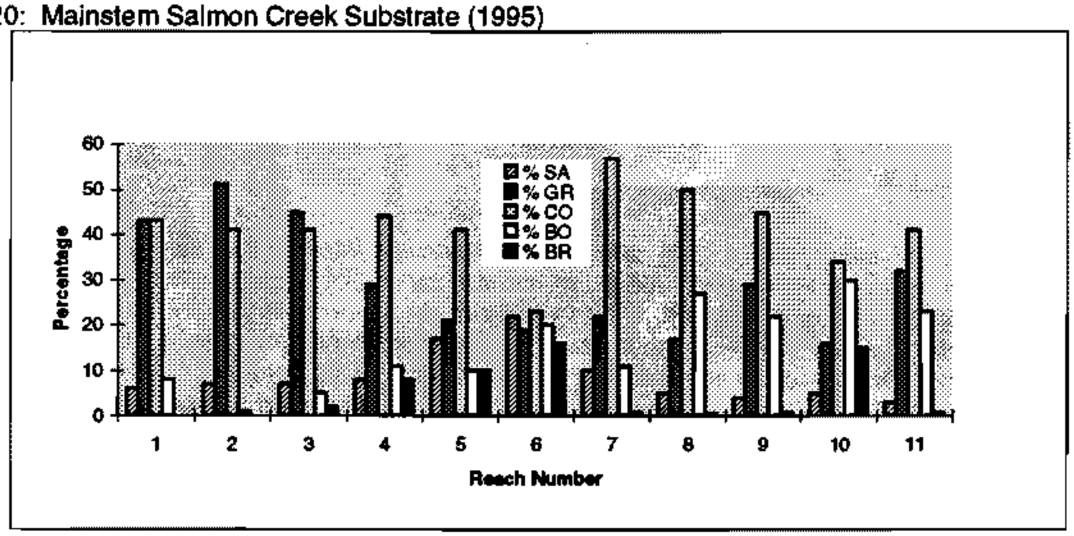
** Oakridge Ranger District stream surveys 1995

(Note: location description was used rather than river miles for the mainstem Salmon Creek comparisons.)

CHANNEL WIDTH

Channel width is another component of channel conditions for which data exists on conditions in 1938 (McIntosh et al. 1992). These can not be considered reference conditions for the lower reaches of Salmon Creek as human impacts were already evident by this time. Comparison of this 1938 data with data collected from the 1995 survey indicates that channel width has changed from 1938 to 1995 (Table 20). It should be noted that the 1938 measurement of channel width was taken from one specific point and the 1995 width is an average channel width for the reach, which contained the 1938 measurement point. The channel width near the mouth of Salmon Creek (reach 1) has decreased by 20 percent since the time of the 1938 survey. This may be due to the levees placed along this reach to protect the city of Oakridge from flooding. Channel width near the Fish Hatchery Road bridge (reach 2) has increased since the 1938 survey. It is possible that the widening of the channel in this location is due to the Fish Hatchery diversion dam. Channel width near Salmon Creek Falls (reach 5) has decreased, but 1995 channel widths near Wall Creek (reach 7) and Black Creek (reach 9) have remained nearly identical to widths measured in 1938. Notes from this 1938 survey indicate that there was no sign of human habitation above Wall Creek (above reach 7). Channel width near Furnish Creek (reach 10), however, has increased by 18 percent over channel width measured in 1938.

Figure 20: Mainstem Salmon Creek Substrate (1995)



SUBSTRATE

Substrate is also an important component of channel condition. Figure 20 shows the percentage breakdown of substrate observed in the mainstem of Salmon Creek during the 1995 stream survey. This survey showed that there are high percentages of gravel and cobble throughout most of the reaches of Salmon Creek. Data on substrate size was also collected during the 1938 stream surveys (McIntosh et al. 1992). To compare this data to that collected in 1995, some assumptions were made in the categorization of substrate size. Substrate called small rubble, medium rubble, and large rubble during the 1938 survey were assumed to be of similar size to those called gravel, cobble, and small boulder respectively during 1995 stream surveys.

Table 21: Changes in Substrate Size Classes in the Mainstem of Salmon Creek from 1938 to 1995

1938 Survey* Location	1995 Survey** Reaches	% small rubble 1938	% gravel 1995	% med. rubble 1938	% cobble 1995	% large rubble 1938	% small boulder 1995
Mouth to Fish Hatchery Rd. Bridge	1	37.6	43	41.1	43	17.7	8
Fish Hatchery Rd. Bridge to Salmon Creek Falls	2 to 4	27.8	41.7	38.8	42	28.6	5.7
Salmon Creek Falls to Wall Creek	5 to 7	22.1	20.7	26.6	40.3	43.7	13.7
Wall Creek to Black Creek	8	11.3	17	19.6	50	67.6	27
Black Creek to Furnish Creek	9	17.4	29	19.9	45	57.3	22
Furnish Creek to end of Survey	10	13.2	16	18	34	62.6	30

* McIntosh et al. 1992

** Oakridge Ranger District stream surveys 1995

(Note: location description was used rather than river miles for the mainstem Salmon Creek comparisons.)

Table 21 shows that in the section of Salmon Creek that extends from the mouth to the Fish Hatchery Road bridge (reach 1), the size of substrate has changed very little between 1938 and 1995. In the section of Salmon Creek from the Fish Hatchery Road bridge to Salmon Creek Falls (reaches 2-4), there was a higher percentage of gravel and a lower percentage of small boulders observed during the 1995 survey than was seen during the 1938 survey. In the segment from Salmon Creek Falls to Black Creek (reaches 5-8) the percentage of gravels was essentially unchanged, but the percentage of cobbles increased and the percentage of small boulders decreased between 1938 and 1995. The 1995 surveys of the upper reaches of Salmon Creek above the Black Creek confluence (reaches 9-10) there was a slightly higher percentage of gravels and cobbles and a lower percentage of small boulders than were seen in the 1938 surveys.

CHANNEL STABILITY

Channel stability for the mainstem of Salmon Creek was rated as good overall, although there were individual reaches in which bank instability was noted. Reaches with the highest degree of instability include reach 4 (5 unstable areas consisting primarily of eroding terraces), reach 5 (5 unstable areas where bank cutting was occurring), reach 7 (5 unstable areas consisting of both bank cutting and some bank sloughing), and reach 9 (9 unstable areas consisting of small rock slides, eroding banks, and cutbanks). Eroding banks are not a new condition in the lower reaches of Salmon Creek. 1938 surveys indicate that bank erosion was common below Salmon Creek Falls (reaches 1-4) (McIntosh et al 1992).

Lower Salmon Creek Subwatershed (18 1)

VALLEY SEGMENT TYPES

Streams that were surveyed in this subwatershed include Warble, Kelsey, Wall and Mule Creeks. Table 22 of this chapter shows the miles of stream by valley segment type for the tributaries of the lower Salmon Creek subwatershed. The majority of the streams in this subwatershed flow through steep, high gradient valley segment types, such as high gradient valley wall (headwater), very high gradient valley wall (headwater), v-shaped high gradient bottom , and v-shaped moderate gradient bottom. Other valley segment types found in this subwatershed include alluviated moderate slope bound valleys, steeply incised valley with a steep channel gradient, and alluvial fans.

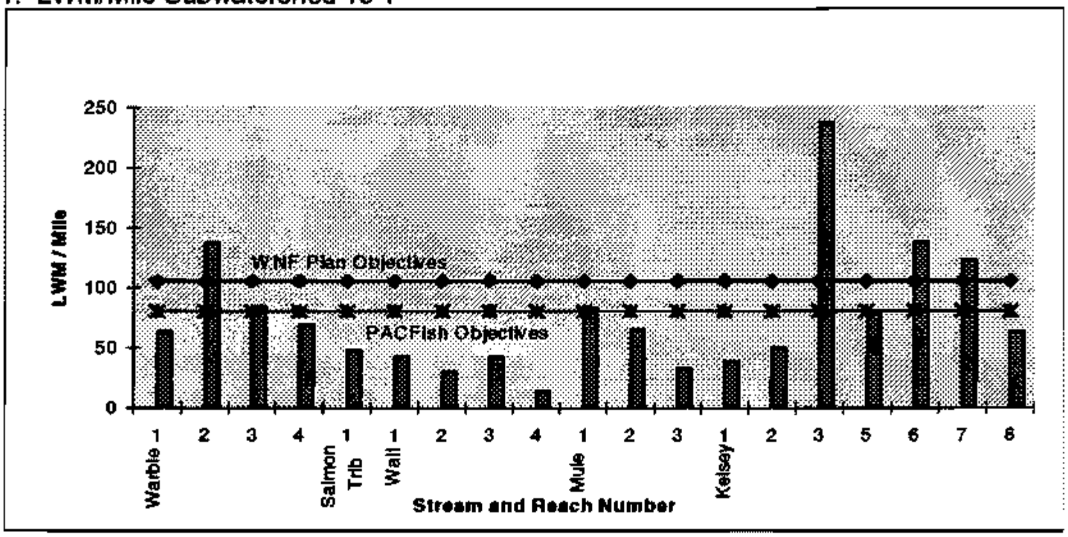
Table 22: Valley Segment Types for Tributaries in Lower Salmon Creek (Subwatershed 18 1)

Valley Segment Type	Miles	%
Alluvial Fan (2)	.6	5
Steeply Incised Valley / Steep Channel Gradient (4)	.3	2
Alluviated Moderate Slope Bound (M2)	1.7	14
V-Shaped Moderate Gradient Bottom (V1)	1.9	16
V-Shaped High Gradient Bottom (V2)	2.4	20
High Gradient Valley Wall / Headwater (H2)	2	17
Very High Gradient Valley Wall / Headwater (H3)	3.2	26

LARGE WOODY MATERIAL

Given the dominant valley segment types in this subwatershed, large amounts of woody material would be expected in the form of small debris jams and single pieces in the alluvial reaches with a few large jams in the higher gradient reaches. There were 75 debris jams of various sizes in this subwatershed. Stream surveys indicate that 72 percent of streams in this subwatershed did not meet PACFISH minimum objectives for the number of pieces of large woody material per mile and 83 percent of the streams surveyed in this subwatershed did not meet objective values outlined in the Appendix E of the Willamette National Forest Plan (Figure 21).

Figure 21: LWM/Mile Subwatershed 18 1



LARGE POOLS

In reaches dominated by boulders, pocket pools would be expected to make up the majority of pool habitat while in alluvial reaches composed primarily of cobbles and gravels, wood becomes an important component in the formation of channel spanning pools. The lack of large wood, especially in the alluvial reaches of this subwatershed, may explain the low numbers of large pools. Large pool habitat is currently lacking in the entire subwatershed (see Appendix E). None of the streams in this subwatershed meet minimum objective values outlined in Appendix E (page E-8) of the Willamette National Forest Plan or PACFISH.

SUBSTRATE

Dominant substrate types in this subwatershed varied by stream (see Appendix E). Wall Creek substrate was primarily composed of gravel, cobble, and boulders except for reach 3 which also contained a high proportion of bedrock, and reach 4 which had a relatively high percentage of sand. Mule Creek had a very diverse range of substrate consisting of sand, gravel, cobble, boulder, and bedrock. The dominant substrate in Warble Creek was rubble, although cobble, gravel, sand and boulders were also present. Cobble and small boulders were the dominant substrates for Kelsey.

CHANNEL STABILITY

Channel stability was rated as good for the majority of the subwatershed. There were 42 documented sites of mass wasting and bank cutting, with the majority occurring in reaches 1 (11 sites) and 2 (4 sites) of Wall Creek, reach 2 of Mule Creek (7 sites), Warble Creek (4 sites) and Kelsey Creek (10 sites) (see Appendix H).

Black Creek Subwatershed (18 2)

VALLEY SEGMENT TYPES

Black Creek is the only stream surveyed in this subwatershed. The numerous small tributaries to Black Creek were not surveyed. Tables 23 and 24 of this chapter shows the miles of stream by valley segment type for the Black Creek Subwatershed. This subwatershed is composed of several different valley segment types and Rosgen types (Figure 15 of this chapter). The first three miles (reaches 1-3) flow through an alluviated mountain valley. Black Creek then flows through a v-shaped, moderate gradient bottom for a short time before entering an incised, U-shaped valley with a high gradient bottom. This valley segment type continues until the first swamp, which begins at river mile 6.5. After the first swamp, Black Creek flows through another u-shaped valley with a high gradient bottom until it reaches the second swamp beginning at approximately river mile 8.8. Above this second swamp Black Creek enters a moderate gradient valley wall (headwater) and then a very high gradient valley wall (headwater).

Table 23: Valley Segment Types for Mainstem Black Creek (Subwatershed 18 2)

Reach #	Reach Length	Cumulative Miles	Valley Segment Type	Reference Point for Start of Reach
1	1.8	1.8	Alluviated Mountain Valley (V4)	Confluence with Salmon Cr.
2	.1	1.9	Alluviated Mountain Valley (V4)	Unit Boundary in Sec 9
3	1.2	3.1	Alluviated Mountain Valley (V4)	End of Unit
4	.7	3.8	V-Shaped Moderate Gradient Bottom (V1)	Valley Type Change, Side Slopes Steeper
5	1.2	5	Incised U-Shaped Valley, High Gradient Bottom (U2)	Valley Type Change
6	.5	5.5	Incised U-Shaped Valley, High Gradient Bottom (U2)	Habitat Complex Change, More Large Pools
7	.5	6	Incised U-Shaped Valley, High Gradient Bottom (U2)	Habitat Complex Change, Riffles Dominant
8	.5	6.5	Incised U-Shaped Valley, High Gradient Bottom (U2)	Valley Type Change, Wider Valley Floor
9	.4	6.9	Palustrine Spring fed Meandering Flats (F6) .	Beginning of First Swamp, Section 26
10	1	7.9	Incised U-Shaped Valley, High Gradient Bottom (U2)	End of First Swamp
11	.9	8.8	Incised U-Shaped Valley, High Gradient Bottom (U2)	Habitat Complex Change, Larger Substrate
12	1.7	10.5	Palustrine Spring fed Meandering Flats (F6)	Beginning of Second Swamp
13	.9	11.4	Moderate Gradient Valley Wall/Headwater (H1)	Edith Creek
14	.6	12	Very High Gradient Valley Wall/Headwater (H3)	Class III Tribe

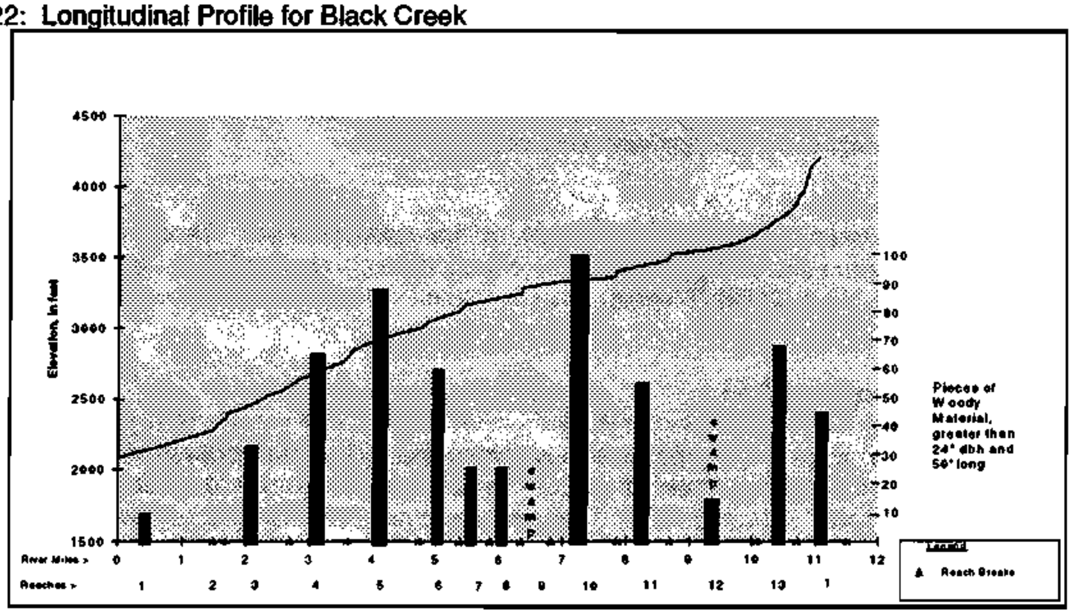
Table 24: Total Miles by Valley Segment Type for Mainstem Black Creek (Subwatershed 18 2)

Valley Segment Type	Miles	%
Alluviated Mountain Valley (V4)	3.1	25.8
V-Shaped Moderate Gradient Bottom (V1)	.7	5.8
Incised U-Shaped Valley, High Gradient Bottom (U2)	4.6	38.3
Palustrine Spring fed Meandering Flats (F6)	2.1	17.5
Moderate Gradient Valley Wall / Headwater (H1)	.9	7.5
Very High Gradient Valley Wall / Headwater (H3)	.6	5.0

LARGE WOODY MATERIAL

Given the dominant valley segment types in this watershed, infrequent large jams and more frequent small jams as well as individual pieces of wood would be expected in this subwatershed. Large wood appears to have historically been an important part component of the channel conditions in Black Creek. 1938 surveys indicate that Black Creek "was full of log jams" (McIntosh et al 1992). At the time of the 1992/1995 stream survey, there were 59 debris jams, many of them fully spanning the channel, located in the mainstem of Black Creek. In addition to this there were many beaver dams and sign of recent beaver activity in both of the swamp areas. Figure 22 shows the longitudinal profile for Black Creek along with

Figure 22: Longitudinal Profile for Black Creek



the pieces of large woody material per mile. Although Black Creek is currently below PACFISH large woody material minimum objective values for 81 percent of its length and below Forest Plan objective values throughout (Figure 23), it comes closer to meeting these values than many other streams in the Salmon Creek watershed. Reaches 1,2, 3,7,8, and 12 are currently most lacking in large woody material (although it should be noted that reach 12 is a swamp section that has many beaver dams throughout to provide habitat.)

Figure 23: LWM/Mile Mainstem Black Creek (1992 & 1995)

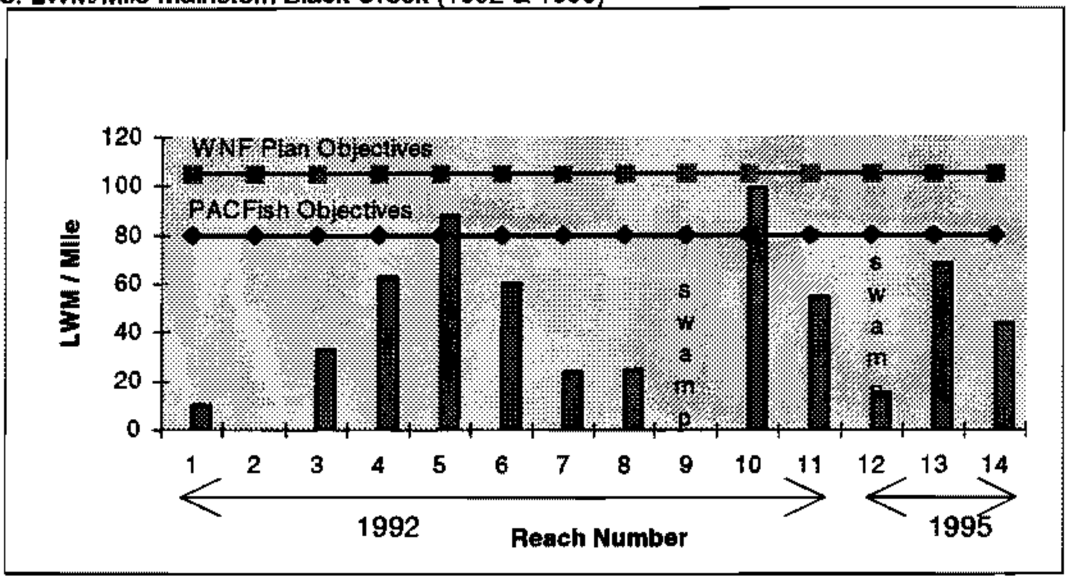
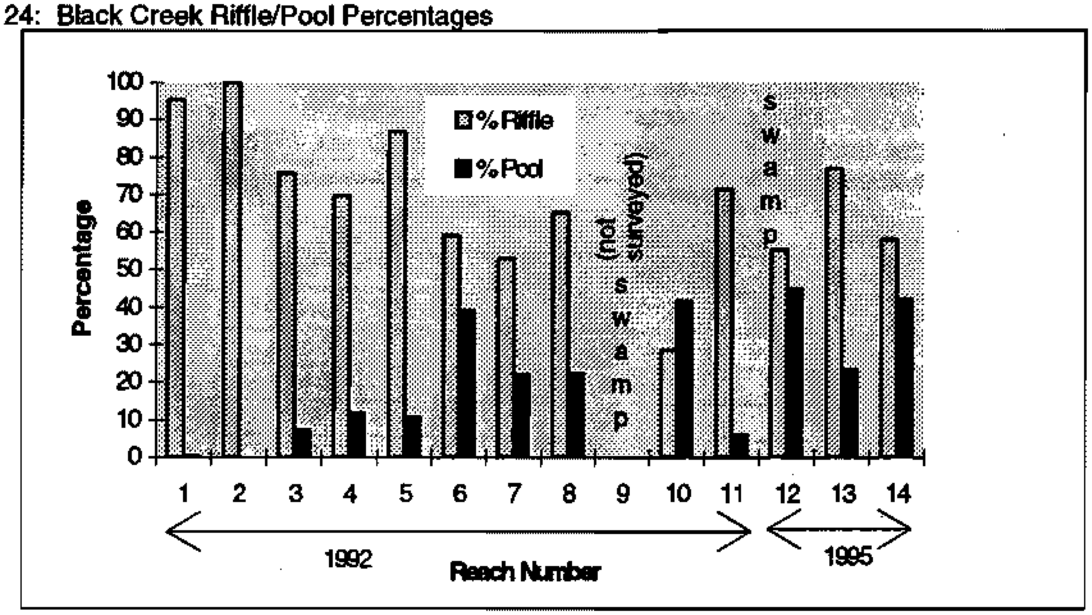


Figure 24: Black Creek Riffle/Pool Percentages

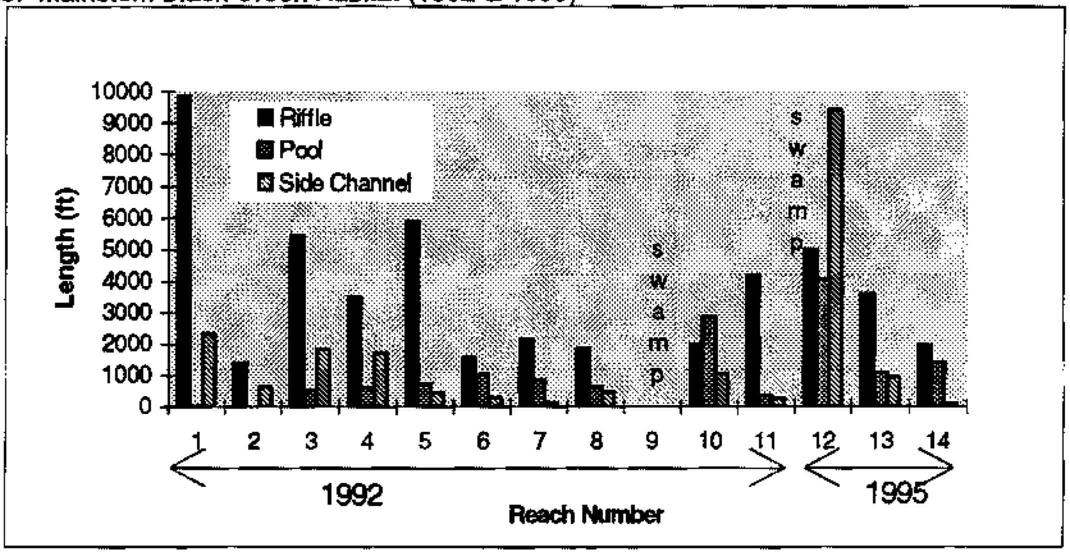


LARGE POOLS AND SIDE CHANNELS

In reaches dominated by small boulders, the most prevalent pools would be expected to occur as pocket pools. In the alluvial reaches, large woody material would be expected to be a component in large pool formation. Large pool habitat in this subwatershed is currently lacking in many reaches of the mainstem of Black Creek. All streams within this subwatershed are below the recommended objective values for the number of pools per mile (see Appendix E). Figure 24 shows that there are very few large pools in the lower reaches of Black Creek. Large pools are more common in the upper reaches. The lack of large wood may explain the low numbers of large pools, especially in the lower reaches of the subwatershed which are also lacking in large woody material.

Side channel habitat is common throughout the mainstem of Black Creek, especially in the lower reaches, which may help to make up for a lack of large pool habitat (Figure 25). Reach 12, which encompasses the second swamp, has a large amount of side channel habitat. Stream surveys indicate that much of the length of reach 12 was braided with ample amounts of overhanging vegetation and numerous beaver dams to provide fish habitat. Presumably reach 9, which was not surveyed, has similar habitat, as it appears in aerial photos to be similar to the swamp of reach 12.

Figure 25: Mainstem Black Creek Habitat (1992 & 1995)



CHANNEL WIDTH

Comparison of channel width from the 1992 stream survey with data collected in 1938 (McIntosh et al 1992) indicates that channel width has increased. It should be noted that the 1938 measurement of channel width was taken from one specific point and the 1995 width is an average channel width for the reach which contained the 1938 measurement point. Table 25 shows that channel widths have increased 20 to 61 percent in the nearly all of the lower reaches of Black Creek. The only exception to this was reach 4 which stayed about the same.

Table 25: Changes in Channel Width in Black Creek from 1938 to 1992

1938 Survey*		% Difference from 1938 to 1992	1992 Survey**		
River Mile	Width (ft)		Width (ft)	River Mile	Reaches
0 to 1	29.4	+ 20.7	35.5	0 to 1.8	1
1 to 2	27.9	+ 27.9	35.7	0 to 1.9	1 and 2
2 to 3	22.5	+61.3	36.3	1.9 to 3.1	3
3 to 4	27	- 2.7	26.3	3.1 to 3.8	4
4 to 5	25.2	+61.5	40.7	3.8 to 5.0	5
5 to 6	21	+ 51.9	31.9	5.0 to 6.0	6 and 7

* McIntosh et al. 1992

** Oakridge Ranger District stream surveys 1992

SUBSTRATE

The substrate in the lower reaches (1-8) of Black Creek is composed primarily of cobble and gravel. Sand and cobble are the dominant substrates in the first swamp (reach 9) (Appendix E). Gravel, sand, cobble, and small boulders are prevalent in reaches 10 and 11. Reach 12, the second swamp, is primarily composed of gravel, although sand and cobble are also present. The substrate in the upper reaches (13-14) consists of gravel, cobble, boulders, and sand.

CHANNEL STABILITY

Channel stability in Black Creek varies by reach from fair to good. There are a total of 32 sites of bank instability including bank cutting as well as sites of mass wasting. The areas that have the most sites of instability are reaches 3, 5, 6, and 12 (see Appendix E). Reach 3 has five sites that average 100 feet in length and 20 feet high. Reach 5 has five sites that average 100 feet long by 50 feet high. The average size of bank instability sites in reach 6 is 60 feet long by 30 feet high. Instability in reach 12 consists primarily of bank cutting with an average length of 45 feet and an average height of 6 feet.

Upper Salmon Creek Subwatershed (18 3)

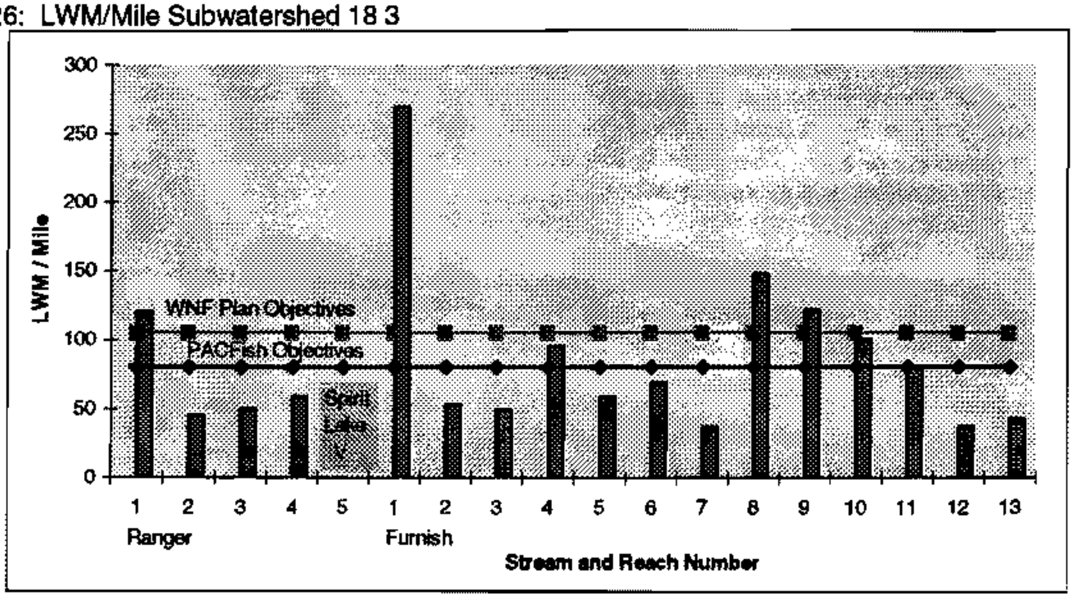
VALLEY SEGMENT TYPES

Streams that were surveyed in this subwatershed include Ranger Creek and Furnish Creek. The predominant valley segment type in this subwatershed is the V-shaped valley with a moderate gradient bottom (Table 26). Other valley segment types include V-shaped valley with a steep gradient bottom, incised U-shaped valley with a high gradient bottom, moderate slope-bound valley, as well as moderate and high gradient valley wall headwater.

Table 26: Valley Segment Types for Tributaries in Upper Salmon Creek Watershed (Subwatershed 18 3)

Valley Segment Type	Miles	%
Moderate Slope Bound (M1)	.8	9
V-Shaped Moderate Gradient Bottom (V1)	3.8	42
V-Shaped high Gradient Bottom (V2)	1.2	13
Incised U-Shaped Valley, High Gradient Bottom (U3)	1.3	14
Moderate Gradient Valley Wall / Headwater (H1)	.9	10
High Gradient Valley Wall / Headwater (H2)	1	11

Figure 26: LWM/Mile Subwatershed 18 3



LARGE WOODY MATERIAL

There were 62 debris jams in this subwatershed. Although it is difficult to know the amount of large wood in the stream channels prior to human activities in this subwatershed, the 1938 surveys indicated that Furnish Creek "was choked with log jams at regular intervals" (McIntosh et al 1992). Presently, 63 percent of the total stream miles surveyed do not meet PACFISH objective values and 70 percent do not meet WNF Plan minimum objective values for large woody material (Figure 26). Although large woody material objectives are not met for a large portion of the subwatershed, large woody material is relatively abundant and is nearing those objective values in many reaches. In some reaches, these objective values are exceeded.

LARGE POOLS

Large pools, while abundant in some stream reaches in this subwatershed, do not meet PACFISH or WNF Plan objective values for the number of large pools per mile (Appendix E).

CHANNEL WIDTH

Comparison of 1938 channel width (McIntosh et al 1992) with 1990 stream surveys indicates that channel width has increased from 13 to 25 percent in Furnish Creek since 1938 (Table 27). It should be noted that the 1938 measurement of channel width was taken from one specific point and the 1995 width is an average channel width for the reach, which contained the 1938 measurement point.

Table 27: Changes in Channel Width in Furnish Creek from 1938 to 1990

1938 Survey*		% Difference from 1938 to 1990	1990 Survey**		
River Mile	Width (ft)		Width (ft)	River Mile	Reaches
0 to 1	30.9	+13.3	35	0 to 1.2	1 and 2
1 to 2	25.8	+20.2	31	1.2 to 1.9	3 and 4
2 to 3	24.6	+25.6	30.9	1.9 to 2.8	5, 6 and 7

* McIntosh et al. 1992 ** Oakridge Ranger District stream surveys 1990

SUBSTRATE

Substrate in this subwatershed varied by stream. Ranger Creek substrate was composed of sand, gravel, cobble, boulders, and some bedrock. Dominant substrate in Furnish Creek was primarily boulder and rubble, with some cobble.

CHANNEL STABILITY

Stream channels in this subwatershed are relatively stable. There are only five sites of bank instability in this subwatershed. The majority of these sites (3) are located in reach 3 of Ranger Creek. Furnish Creek has two sites, one in reach 3 and another in reach 13 (see Appendix E).

Lakes

REFERENCE CONDITION

The Salmon Creek watershed contains hundreds of lakes and ponds located primarily within and adjacent to the Waldo Lake Wilderness area. The majority of lakes were formed by glacial scour. Nearly all of the lakes are located above 4,500 feet in elevation and are primarily in the Black Creek subwatershed (18 2) and the Upper Salmon Creek subwatershed (18 3). Nearly all lakes within the watershed had no naturally occurring populations of fish. The lakes in this watershed presumably contained high quality water prior to management activities and recreational use.

CURRENT CONDITION

Very little is known about the limnological and biological parameters of lakes within the watershed, with the exception of the following lakes, which were surveyed in 1995: Upper and Lower Salmon Lakes, Zircon Lake, Fig Lake, Photo Lake, Spirit Lake, and Blair Lake.

Information from lakes surveyed in 1995 is displayed in Table 28. All of the lakes surveyed were located in the subalpine ecoregion and were classified as being either oligotrophic (Zircon, Upper Salmon, Fig, and Photo Lakes) or oligo-mesotrophic (Lower Salmon , Spirit, and Blair Lakes). The coldest lake was Upper Salmon, which had many shoreline springs providing water to the lake. The levels of dissolved oxygen for this lake was higher than any of the other lakes that were surveyed. In contrast, Fig Lake and Photo Lake had very low levels of dissolved oxygen. This, combined with the low (acidic) pH values, indicates that these lakes may have limited refugia for fish and other vertebrates (WATER Environmental Services Inc., 1996). In addition, both Fig and Photo Lakes have a relatively low alkalinity. This indicates a low buffering capacity, and therefore a lower capacity to resist changes in pH, compared to the other lakes surveyed in 1995. Zircon Lake also has a relatively low buffering capacity. With the exception of phosphorous rich Upper Salmon Lake, the surveyed lakes appeared to be phosphorous and nitrogen limited (WATER Environmental Services Inc., 1996). Of the lakes surveyed, Blair Lake, Spirit Lake, and Lower Salmon Lake had the highest levels of chlorophyll A , an indication of the phytoplankton productivity in those lakes. Blair Lake and Fig Lake also had relatively high algal densities.

Many lakes have been stocked with brook trout, rainbow trout and cutthroat trout. Some lakes contain naturally reproducing populations of trout, while others are stocked regularly by ODFW. Appendix E shows the stocking records for lakes surveyed in 1995. Fish captured from surveyed lakes were in generally good condition (Table 28). Fish species fed primarily on aquatic insect larvae and terrestrial adults during the time of the survey. However, in Upper Salmon Lake, freshwater clams (*Pelycypoda sphaeridae*) were also a major component of the diet (Appendix E).

With the exception of Spirit Lake and Blair Lake the majority of the lakes are located within wilderness areas, and thus have only minor impacts from management activities. Due to the concentration of recreational use associated with several of the lakes including some within wilderness areas, water

quality could be affected due to the loss of shoreline vegetation and/or impacts from livestock use within riparian areas.

Table 28: Data from 1995 Lake Surveys

	Zircon Lake	L.Salmon	U.Salmon	Spirit Lake	Fig Lake	Photo Lake	Blair Lake
Trophic Status	Oligotrophic	Oligo-Mesotrophic	Oligotrophic	Oligo-Mesotrophic	Oligotrophic	Oligotrophic	Oligo-Mesotrophic
Elevation (ft)	5620	4784	4833	4749	5550	5500	4749
Basin Acreage	37	70	469	158	62	119	394
Max Depth (ft)	34	5	28	22	19	23	22
Sechii Depth	34	5	28	22	19	23	22
Surface Temp. Bottom Temp.	64.6 62.4	66.97 63.84	58.6 47.0	64.27 63.84	65.66 64.24	64.29 63.95	65.37 64.2
Surface DO Bottom DO	6.84 6.59	6.65 6.9	9.16 11.42	7.36 7.31	6.02 5.68	7.08 6.92	7.49 7.1
Surface pH Bottom pH	7.68 6.0	6.7 6.8	7.76 7.72	7.38 7.45	6.70 5.96	6.50 6.01	7.31 7.29
Nitrates (mg/l)	.003	.002	.001	.001	.016	.001	.001
Conductivity (umho/cm)	5.7	35.2	54.7	32.6	5.7	3.5	16.8
Alkalinity (ueq/l)	60.45	346.58	558.16	314.46	62.47	50.38	176.5
Total Phosphorus (ug/l)	5	15	66	12	4	3	6
Dissolved NA (mg/l)	.42	2.21	2.72	1.41	.29	.3	.89
Dissolved K (mg/l)	.14	.6	1.58	.34	.14	.09	.12
Dissolved CA (mg/l)	.28	3.29	4.5	3.01	.28	.16	1.4
Dissolved Mg (mg/l)	.095	.801	1.559	.973	.075	.054	.511
Chl a (ug/l)	.6	1.2	.7	1.7	.9	.6	1.7
Dominant Substrate	Silt	Silt	Silt	Silt	Silt	Silt	Silt
Subdominant Substrate	Talus/Lg BO	Silt	Gravel	GR/Cobble	Silt	Boulder	Boulder
Outlet	Intermittent	Intermittent	year-round	year-round	Intermittent	Intermittent	year-round
Inlet	Intermittent	year-round	3 year-round	year-round	intermittent	Intermittent	Intermittent
Zooplankton Biomass	Calanoid Copepods (59%)	Cladocerans (62%)	Cladocerans (87%)	Cladocerans (77%)	Calanoid Copepods (59%)	Calanoid Copepods (55%)	Cladocerans (52%)
Zooplankton Density	Rotifers (70%)	Rotifers (96%)	Rotifers (60%)	Rotifers (95%)	Rotifers (76%)	Rotifers (93%)	Rotifers (60%)
Algal Densities (cells/ml)	100-400 x 10³ Low-Moderate	10 Low	100-400 x 10³ Low-Moderate	400-750 Mod.-High	400-750 Mod.-High	100-400 x 10³ Low-Mod.	2300 High
Fish Species Stocked	BT & RB	BT, RB, CT	BT & RB	BT & RB	BT & CT	BT, RB, CT	BT, RB, CT·
Fish Species captured	NONE	NONE	BT (n=6)*	BT (n+5)*	CT (n=3)*	RB (n=1)*	BT (n=1)*
Fish Diet	--	--	Megaloptera (45%) Pelycypoda Sphaeridae (48%)	Aquatic Macros, Very Opportunistic	Ephemeroptera (83%) Diptera (12%)	Ephemeroptera (69%) Diptera (31%)	Hymenoptera (88%) Odonata Anisoptera(9%)
Mean X Factor	--	--	1.29 (n=2)	1.16	1.223 (n=1)	2.286 (n=1)	.932 (n=1)
Total Length (mm)	--	--	231-257	204-266	262-347	134	289
Age of Fish	--	--	3+	2+-4+ (n=4)	3+-5+	1+	3+
Amphibians	--	Pseudacris regilla	Bufo Boreas (thousands!)	Pseudacris regilla, Taricha granulosa	--	Pseudacris regilla	Ambystoma macrodactylum Taricha granulosa
Dominant Veg. Species	Pac. Silver Fir	Mt. Hemlock	DFir/Willow	Mt. Hemlock	Mt. Hemlock	Mt. Hemlock	Mt. Hemlock
Recreation Impacts	Low - camp	Low-no camp	High-3 camps, trail	High-3 camps, trail	Low-2 camps	Low-2 camps	High-FS campground

***Fish Measurements bases on (n=x) for next 4 rows unless otherwise noted**

BIOLOGICAL

VEGETATION

Age Class/Successional Stage Distribution

Vegetation is always changing, and is difficult to typify as a result of its dynamic nature. To a large extent the following discussions compare two snap shots in time, one before large scale harvesting began in this watershed, and one that exists after 55 years of timber harvesting. It should be kept in mind that these two periods of comparison are not absolute. There may have been times when a majority of the watershed was occupied by young stands after very infrequent, regional scale wildfire (as discussed in the Vegetation/Fire History section of the Characterization chapter). Central to the following comparisons is that under natural conditions, the vegetation was occasionally heavily disturbed and recovered over periods of time that may have been centuries long on a given site. Under current and past management regimes, disturbance has been chronic: frequent and at low levels over short periods of time such that certain structural and age classes have or may become relatively more rare than they were in between natural fire occurrences.

REFERENCE CONDITION

Two hundred years ago (before European influence at least in terms of the vegetation and fire frequency), about 12 percent of this watershed was occupied by early-successional, or stand initiation stage forests. There was relatively little edge between early and late-successional forests in this historic landscape. The early-successional forest and edge were created by wildfire that burned large areas, both as stand replacement fire and as underburns. The amount of forest fragmentation before fire suppression and timber management can be seen in Figure 28 of this chapter.

Conversely, approximately 45 percent of this watershed was composed of late-successional forest. Mid-successional forests, those representing the stem exclusion and understory reinitiation stand development stages, occurred on about 37 percent of the area.

The watershed probably had more non-forested acres due to repeated fire that created and maintained large meadow complexes along ridge tops, but this percentage was probably not much larger than it is today. Aboriginal burning was probably also responsible for a greater amount of meadows along the river bottom. In some areas, likely south slopes near main campsites, the forest was very open and park-like due to repeated underburning. The Fisher and Long Prairie system is a probable example where the practice of burning would have occurred.

CURRENT CONDITION

Approximately 24 percent of the watershed is composed of early-seral stands in the stand initiation stage of development. This percentage is twice as large as what existed 200 years ago and it is distributed quite differently across the watershed. Nearly all the current early-successional forest occurs in the western two thirds of the watershed while two hundred years ago there was a much higher percentage of early-successional forests in the eastern portion of the watershed. Current early-successional forests are for the most part the result of dispersed regeneration harvest activities, and as such, create much more edge and associated fragmentation of interior habitat than in reference conditions (see Figure 29 of this chapter). Stand initiation acreage is currently three to four times greater in Douglas-fir/western hemlock plant associations than in reference conditions. Conversely, less than half of the initiation stage acreage occurs in true fir/mountain hemlock associations.

Currently, 9 percent of the mid-seral habitat across the watershed is in the stem exclusion stage and 28 percent is in the understory reinitiation stages. Stem exclusion acreage, as a percent of total, is not much different in Douglas-fir/western hemlock stands than in reference conditions, however, the distribution pattern of these acres is significantly different. Stem exclusion acreage is approximately four times less in true fir/mountain hemlock associations. Understory reinitiation stage acreage is slightly less in Douglas-fir/western hemlock associations and approximately double in true fir/mountain hemlock than what existed in reference conditions.

About 34 percent of the watershed currently consists of late-seral forests, which is about 75 percent of what existed before forest management began. As with early-successional habitat, this late-successional forest is more scattered throughout the watershed and much more fragmented than it once was. Current late-seral stand acreage in Douglas-fir/western hemlock plant associations is about one third less than in reference conditions. Current late-seral acreage in true fir/mountain hemlock plant associations is approximately one third more than in reference conditions.

This watershed has a very diverse set of age classes (as shown in Table 29), resulting from five decades of timber harvesting and the incidence of wildfire, as discussed in Chapter I. Most of the current acreage of younger, early-successional forests shown in Table 29 have been created after harvesting. Forest management policy has changed considerably in the years since the first clearcut was implemented in the watershed. The first harvesting occurred as large, clustered clearcuts. Subsequent public concern with large clearcut areas resulted in law and agency policy directing management to avoid the creation of large openings in the forest. After about 1950, regeneration harvesting was limited in size, and dispersal was increased, without a concurrent reduction on harvest volumes, resulting in widespread fragmentation of the previously unfragmented forest. Widespread partial harvest also occurred from the 1950's to the 1980's. The objectives of the partial harvest areas were to salvage expected mortality in mature and old-growth stands and to minimize the openings created by harvest. This partial harvesting may have imitated somewhat the effects of low intensity fire in terms of canopy closure and numbers of live trees per acre. However, it removed stems that would have remained on site after low intensity fires, and it resulted in compaction of soil from tractor yarding. These are two results that do not have an analog in the natural system.

Table 29: Reference vs. Current Seral Stage Distribution by Plant Association

		Reference Condition								Current Condition							
		Sixth Field (Acres / % of sum total)								Sixth Field (Acres / % of sum total)							
Plant	Seral	18 1		18 2		18 3		Total		18 1		18 2		18 3		Total	
Assn.	Stage	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
DF/WH	SI	3,506	10	414	2	856	4	4,776	6	9,900	28	2,916	13	4,163	16	16,978	21
	SE	2,111	6	2,074	10	1,432	6	5,617	7	3,786	11	699	3	941	4	5,427	7
	UR	4,488	13	4,289	20	2,809	11	11,586	14	5,709	16	2,524	12	2,357	9	10,590	13
	LS/OG	19,321	55	5,310	24	7,429	29	32,061	39	10,057	29	5,948	27	5,066	20	21,072	26
sub total		29,425	83	12,087	56	12,527	49	54,039	66	29,463	83	12,087	56	12,527	49	54,067	66
TF/MH	SI	857	2	630	3	3,729	15	5,215	6	914	3	385	2	984	4	2,283	3
	SE	818	2	3,619	17	2,549	10	6,986	8	179	0.5	433	2	1,048	4	1,660	2
	UR	684	2	2,499	11	3,134	12	6,316	8	1,722	5	4,536	21	6,366	25	12,625	15
	LS/OG	1,223	3	1,369	6	2,062	8	4,654	6	766	2	2,763	13	3,075	12	6,605	8
sub total		3,581	10	8,117	37	11,474	45	23,172	28	3,581	10	8,117	37	11,474	45	23,172	28
SHAB		1,231	3	1,429	7	1,199	5	3,859	5	1,231	3	1,429	7	1,199	5	3,859	5
WX		32	0.1	97	0.4	199	0.8	328	0.4	32	0.1	97	0.4	199	0.8	328	0.4
XFOR		1,002	3	14	0.1	18	0.1	1,034	1	974	3	14	0.1	18	0.1	1,006	1
Sum Total		35,271	100	21,744	100	25,417	100	82,432	100	35,271	100	21,744	100	25,417	100	82,432	100

Table legend: DF/WH = Douglas fir/western hemlock TF/MH = true fir / mountain hemlock
SHAB = special habitat WX = water XFOR = non forested
SI = stand initiation (0-30 year old stand) SE = stem exclusion (31-80 year old stand)
UR = understory reinitiation (81-200 year old stand) LS/OG = late-successional / old-growth (201+ year old stand)

The numbers in Table 29 reflect the amount of various age and structural classes but not their distribution. The following section on Terrestrial Wildlife Habitat discusses the extent and implications of the fragmentation and structural changes which have occurred in these forests.

Overall Diversity of Vegetation

REFERENCE CONDITION

The pattern and timing of fire on this landscape created a relatively diverse complex of vegetation assemblages and structural conditions. Fire periodically created new early-successional communities, and areas that did not frequently burn gradually developed late-successional characteristics that in some areas persisted for centuries before stand replacement fire eventually returned. Many meadow complexes were created and maintained on ridge tops and on the north edge of the river bottoms as a result of repeated fire, some of which was the result of aboriginal burning.

CURRENT CONDITION

While certain types of plant communities are not as widespread as they once were (for example late-successional forest, or dry meadows), they still exist in fairly large percentages compared to 200 years ago. No plant communities have been eliminated from this watershed as a result of fire suppression or timber harvesting. However, fire suppression has resulted in a reduction in the acreage of meadows and timber harvest has resulted in a reduction in the acres of late-successional forests.

The structural diversity of some young stands regenerated after harvest may be less complex than natural young stands. Some young managed stands were planted with mostly Douglas-fir. Pre-commercial thinning was often designed to select against trees other than Douglas-fir. However, dense, predominantly Douglas-fir stands can also be found in natural young stands regenerating after fire. Young managed stands often contained little in terms of residual structure (snags and large wood material) especially those created by harvest between 1960 and 1990. Furthermore, natural young stands sometimes reburned, resulting in low structural diversity.

The main effect that management activities have had on vegetational diversity is an increase in stand edge (fragmentation) as mentioned above. Harvesting and associated road construction has increased the amount of edge habitat (discussed in a following section on wildlife habitat), decreased the amount of late-successional habitat, changed the distribution of late-successional habitat, accelerated the establishment of non-native plants, and may have created non-forest vegetation types that would not have existed otherwise. The vegetation may be more diverse now than it was prior to management in terms of early-successional herb/shrub communities created by harvest. However, these communities are relatively ephemeral as shrubs and sapling trees tend to dominate such sites quickly. Fire suppression has decreased the extent of meadows, and may have resulted in some areas of late-successional forest that would not have persisted otherwise.

Special and Unique Non-Forested Habitats (SHABs)

REFERENCE CONDITION

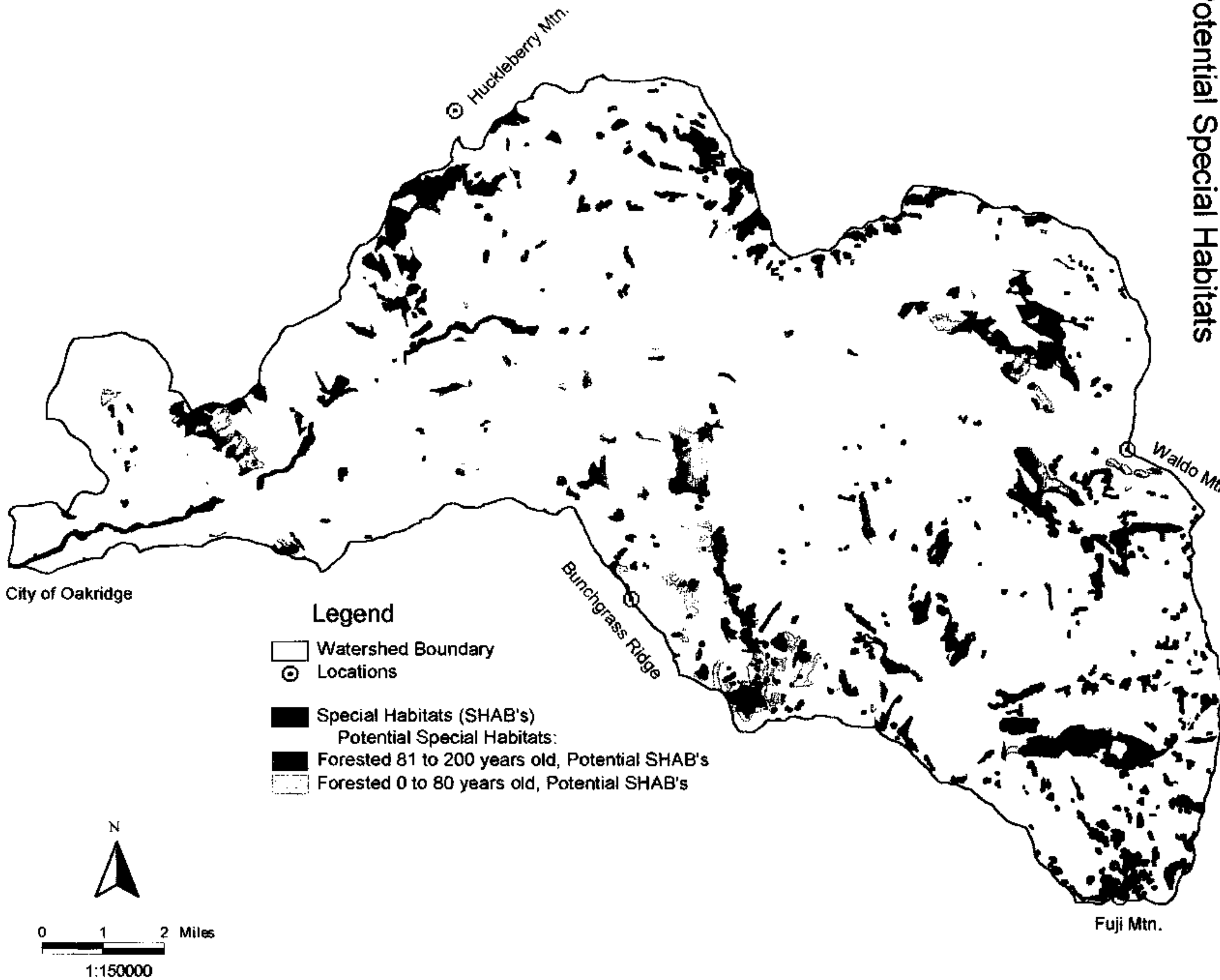
It is suspected that prior to European settlement, Native American populations used fire as a tool to create or perpetuate meadow habitat in order to maintain early seral conditions for longer periods than natural fire intervals. As a result, vigor and productivity increased for berries, roots and associated wildlife use. Forested areas were also probably underburned in places to provide more productive animal forage and to facilitate travel. Several non-forested meadows and prairies in the watershed have undergone past modifications to habitat diversity in the form of post-settlement use. A representation of potential non-forested openings on fire prone soils (Figure 27 of this chapter), in stands less than 80 years of age, and in stands 81+ years was compared with a current map of non-forested special habitats (also Figure 27 of this chapter) and with a fire history map (Figure 2 of the Characterization chapter). The comparison suggests that fire events could have contributed towards the development of a larger amount of non-forested acres than what might have developed with fire suppression. Past livestock grazing, logging history, and fire suppression all contributed to changes in the diversity, composition and function of the plant communities.

Several meadows and prairies were included in major grazing allotment ranges on the district. The effects of grazing contributed to maintaining more open conditions in meadows. It is assumed that the total meadow acreage was higher around the turn of the century, prior to the cessation of grazing. Historical records indicate that cattle were grazed in the mid 1860's. District records show cattle and sheep were grazed in the late 1800's and early 1900's.

CURRENT CONDITION

Meadow opening size and abundance in the watershed may have been influenced by a reduction in the fire maintenance regime, caused by 70 to 80 years of natural fire suppression activities. Subsequent conifer invasion has since been occurring, being particularly prevalent on ridge line meadows where repeated lightning ignited burns may have maintained meadow conditions. *Vaccinium embranaceum /Xerophyllum tenax* communities present in the upper elevations of the watershed are examples where fire is thought to have played a key role in producing non-forested openings in drier mountain areas (Franklin and Dyrness, 1988). Spirit meadow is an example of where tree encroachment has been taking place and is contributing to loss of meadow habitat. The watershed has not yet been extensively surveyed for SHAB types and associated floristic inventories. Sampling is usually accomplished when associated with site specific projects.

Figure 27:
Special Habitats and Potential Special Habitats



Sensitive and Rare Plant Species

REFERENCE CONDITION

The historic distribution of sensitive and rare plant populations is assumed to be generally similar to that of today with the exceptions discussed in the following narrative. Areas prone to higher frequency, stand replacing fires may have contributed to a higher abundance of non-forested patches and underburned areas maintained by more frequent fire events, as suggested by Figure 2 of the Characterization chapter.

CURRENT CONDITION

Several types of natural openings and forested lands found in the watershed are habitat for plants currently listed as sensitive by the Region 6 Regional Forester's TES Plant List. See Appendix F for a list of potential habitats for sensitive plants. No plants on the sensitive list are documented as occurring within the watershed.

Succession, in the form of tree encroachment into meadows and tree canopy closure (possibly increased by fire suppression), is occurring where low intensity natural ground fires contributed to more open understory conditions. The result may be the exclusion of the Umpqua swertia (*Frasera umpquaensis*) from its meadow and forest edge habitat and may be a long-term concern (USDA, USDI, 1993). The germination of woodland milkvetch (*Astragalus umbraticus*) and branching Montia (Montia diffusa) is influenced by fire. Both species may have occurred more frequently in reference conditions, following closely after fire events. No occurrence of woodland milkvetch has been discovered in the watershed to date. However, it may be that this plant extended its currently known range into the watershed prior to fire management activities, based on recent documentation of its occurrence in the Warner Creek Fire area in 1993. The central range of this species is in the Umpqua NF, just to the south of the Willamette National Forest. An assumption is made that the North Fork of the Middle Fork of the Willamette River, the Middle Fork of the Willamette River, Salmon Creek, and the Umpqua River watersheds may have contained connected populations. The branching Montia, documented south of the Salmon Creek watershed, could have existed in similar habitat in greater abundance in the watershed.

Additional rare plant species occur in the watershed. Some, like most sensitive plants in this ecosystem, are found within non-forested habitats while others occur in forested habitats. Four species listed on the Willamette National Forest Watch and Concern Lists are located within the watershed. These species are usually located and tracked along with sensitive plant and other botanical inventories conducted in Wilderness Areas, Special Interest Areas, and other non-timber production land allocations. See Appendix F for a listing of rare and unique plants in the watershed.

Survey and Manage Species: Fungi, Bryophytes, Lichens, and Vascular Plants

REFERENCE CONDITION

In the western half of the watershed, prior to extensive logging and fire suppression, large old-growth tracts of forest developed with patchy fire occurrences, as suggested by the representation of the watershed fire history pattern (see Figure 2 of the Characterization Chapter). Since fire suppression was introduced, longer intervals have occurred between large scale fire events. Species diversity and richness in old-growth and riparian dependent communities, where these survey and manage species tend to occur, would have had more time to develop before increases in early seral stages were brought about by extensive timber harvesting.

In the eastern half of the watershed, residual patches of old-growth occurred in a more isolated pattern, due to a higher frequency of stand replacing fires. Old-growth associated species there were relegated to riparian areas and refugia such as basins, valley bottoms, and ridge line breaks where a higher level of down woody material and snag development remained.

CURRENT CONDITION

Late-successional species habitat in the watershed has declined due to extensive harvest of old-growth stands and associated road building. The remaining old-growth in the watershed is concentrated at higher elevations or in relatively small areas associated with previously designated spotted owl reserves. In many areas, the old-growth stands are highly fragmented. Many Survey and Manage Species have limited dispersal capabilities, thus gene flow may be restricted between populations in fragmented habitat areas. Management for single species plantations after harvest in riparian forests along with adjacent upland stands has contributed to a simplification of species richness in plant communities.

Several sites have been documented in the watershed for candy stick (*Allotropa virgata*). Candy stick is a non-green species dependent upon a mutual association with several conifer species and fungal species such as Matsutake.

Survey and Manage Species have not yet been systematically inventoried in this watershed. The Regional Ecosystem Office species location information and survey protocols are expected to be released in 1996. Existing biological and ecological information is minimal for most of these species. However, it is reasonable to assume that if systematic surveys were conducted for old-growth dependent species, a much larger number would be found in the watershed. See Appendix F for a list of potentially occurring Survey and Manage Species.

Noxious Weeds and Other Non-Native Invasive Plant Species

REFERENCE CONDITION

Non-native plant species legally designated as "noxious", are "any weed designated by the Oregon State Weed Board that is injurious to public health, agriculture, recreation, wildlife, or any public or private property" (ODA Noxious Weed Policy and Classification System, 1995). Several detrimental effects are included in the criteria for rating and classifying weeds as noxious. One such effect 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). Most northwest weeds are originally native to Europe or Asia and were introduced intentionally or by accident. Noxious weeds and other invasive non-natives have the potential to alter native plant communities, as they are able to displace and out compete native species. They are opportunists with broad ecological tolerances, can grow under a wide range of climatic and soil conditions, and have excellent reproductive capabilities (Taylor, 1990).

No noxious weeds were present prior to European colonization. Non-native plant species have been introduced into Oregon since settlers began bringing them in accidentally or for various uses. The advent of large-scale logging and road building in the 1930's produced a large increase in the spread of non-native plants. Livestock grazing also contributed to the spread of some noxious weeds.

CURRENT CONDITION

Weed competition with native plant species is occurring in conifer plantations; wildlife use areas (including small wetlands and river flood plains); and road, railroad, and power line right-of-ways. It has also been noted that some weeds are extending into natural dry and moist meadow openings and rock garden communities. In many areas, non-desirable weed species are excluding native plants to the point of forming dense weed patches and thickets.

Non-native plant species play a significant role in influencing changes to native plant communities. Many noxious weed species and other non-native invasive plants are found in the watershed. Many of these species are firmly established, and have been for some time now. Some are currently increasing in extent largely due to logging and road building practices, which act as dispersal mechanisms. See Appendix F for a list of noxious weeds present in the watershed.

Invasion of non-native plants in the watershed is a serious threat to native plant abundance. The Willamette National Forest Integrated Weed and Management Environmental Assessment, April 1993, lists 7 site types where a potential exists to harbor noxious weeds already established on the forest and potential invader weeds. All of these site types are found within the watershed. Site types range from bare, rocky, gravely ground, such as road beds and quarries, to floristically diverse areas such as meadows, sensitive plant habitat, and wetlands (refer to the Environmental Analysis for full descriptions).

Major forest roads and other corridors, such as right-of-way clearances, serve as noxious weed dispersal pathways and establishment sites. Salmon Creek Road (FS Road 24) is a well used travel corridor by which vehicular, mechanical, and wind-born weed seed transport and spread has occurred. Timber sale units, associated roads and landings, trails, and other disturbed openings have seral conditions which typically support weed populations. Other spread mechanisms in the watershed include bird and mammal seed dispersal, livestock and their feeds, and weed seed contamination of forage and erosion control seeding mixes.

Roadside inventories on the Oakridge Ranger District of noxious weeds were conducted by the ODA in 1988 and again in 1993. The results of these inventories have shown that some noxious weed species have spread at an alarming rate. For instance, scotch broom (*Cytisus scoparius*) is estimated to have infested an additional 35 percent of the area since the 1988 survey and the number of roads infested has increased to 51 percent (Glen Miller, personal communication).

Special Forest Products

REFERENCE CONDITION

Special Forest Products have long been gathered for traditional native American and folk use.

CURRENT CONDITION

A forest-wide programmatic special forest product environmental assessment was completed in 1993 that provides the framework for decisions on the collection of special forest products. Willamette Forest Plan Amendment No. 23 allows commercial collection in all lands open to commercial timber harvest.

Many miscellaneous non-convertible special forest products (SFPs) found in the watershed are frequently requested by local and non-local collectors for personal and commercial use. There is a growing interest in the SFP industry as a source of alternative income. These plants will continue to be an important part of future forest resource use.

No formal SFP inventories have been done on the district for species with economic potential. Therefore, information that provides specific locations, quantities, qualities, and accessibility for these species is limited. Several types of plant communities in the watershed contain products of marketable quality, such as ornamental cuttings, transplants, boughs, and floral greenery products. The following is a preliminary list of those products identified in the watershed that may occur in quantities sufficient for commercial collection rates, while remaining abundant enough to maintain plant populations as prescribed in the Willamette NF SFP Program standards and guidelines: mushrooms, floral greens (salal, sword fern, dwarf Oregon grape, beargrass, scotch broom), landscape transplants (vine maple, rhododendron, manzanita, etc.), huckleberries, nuts, ornamental cuttings/crafts (willow, vine maple, ceanothus, madrone, chinquapin, Pacific yew), boughs, pitchwood, cones, conks, botanicals (such as prince's pine, wild ginger, wildflowers, etc.) Lichens and moss are not currently being offered for commercial collection on the Oakridge District. "Vine maple moss", a collective term used for several species that are collected, has been harvested on the district. Several thousands of pounds of moss were sold in the late 1980's. Records are no longer available to indicate precisely how much of that amount came from the Salmon Creek watershed. The demand for boughs and their collection riparian areas has heightened concern for riparian dependent lichens, mosses, liverworts and hornworts, many of which may be rare and for which biological information is lacking.

FUEL ACCUMULATION

Determining dead fuel accumulation is necessary to define potential fire behavior and suppression difficulty in the event of a fire. Once dead fuel loading is determined, it can be characterized into standard fuel models for predictive purposes.

REFERENCE CONDITION

This watershed is typical of a high-severity fire regime as described by Agee (1981). Fires in this regime are very infrequent on a given piece of land within the watershed (more than 100 years between fires). They are usually high-intensity, stand replacement fires. Fires are associated with drought years, east wind synoptic weather types with lower humidity, and an ignition source such as lightning (Huff and Agee, 1980, Pickford et al, 1980). Accurate fire return intervals have never been calculated in these forests because the interval between fires are long and may not be cyclic (Agee and Flewelling, 1983). Fahnestock and Agee (1983) estimated that dryer sites may burn again after 100 years. Following a fire event, the forest then would develop through the seral stages.

The following conditions were found in this watershed:

Subwatershed 18 1

A very large fire event occurred around 1790 in the western end of the area nearest to Oakridge. It appears that other fires occurred in this subwatershed approximately every 50 years. In the northern part of this subwatershed outside of the area just described above, no large fires have occurred since around 1910, but the fire return interval prior to 1910 was approximately 50 years. Approximately 51 percent of this subwatershed has burned in the last 200 years.

Subwatershed 18 2
A very large fire event occurred around 1790 with a large amount of reburning in 1840 (50 years). Other large fires around 1900 and 1930 occurred within the 1840 fire area (100 years). Nearly all of these fires occurred above 4,000 feet in elevation. Approximately 47 percent of this subwatershed burned in the last 200 years.

Subwatershed 18 3
A very large fire event occurred around 1790 with a large amount of reburning in 1840 (50 years), 1900 (60 years), and 1930 (30 years). There has been very little fire disturbance the last 50 years. Nearly all of these fire acres were above 4,000 feet in elevation, with 75 percent to 85 percent of them above 5,000 feet in elevation. Approximately 62 percent of this subwatershed has burned in the last 200 years.

Wilderness
In subwatershed 18 2, the majority of fire activity occurred between 100 and 150 years ago.
In subwatershed 18 3, the majority of fire activity occurred between 50 and 100 years ago.
For both areas, the majority of fire events appear to be reburns. Approximately 70 percent of all wilderness acres have burned within the last 200 years.

For the total watershed, fire history was broken down into 50 year intervals as shown in Table 30 below.

Table 30: Fire History for the Salmon Creek Watershed

Time Period	Acres Burned	% of Total Watershed
1790 to 1840	21,396	26
1850 to 1890	6,042	7
1900 to 1940	12,608	15
1950 to Present	4,051	5

Approximately 54 percent or 44,169 acres of this watershed has burned in the last 200 years. In most cases the lack of large woody material on the ground and fire boundaries are not typical of a single fire event. This leads one to postulate that many of the fires of the 1790 decade were reburns. This pattern holds true for most of the remaining events with most of the fire activity occurring in the same general topographic areas of previous fires and within 30 to 100 years. Given a fire start, this would be expected due to large accumulations of large dead material on the ground combined with young stands of brush and trees. Stand age determination is difficult, but when a variance of 5 to 10 years is applied, the majority of these events correspond well to drought years and or abnormally dry winters (Hemstrom and Franklin, 1982). Using data from 72 natural stand plots, an attempt was made to identify trends in fuel loading. Fuel loading was then classified into one of the Northern Forest Fire Laboratory (NFFL) fuel models (FM) used to predict fire behavior. Table 31 shows the fuel models used in this analysis.

Table 31: Fuel Models

Fuel Model >>	FM4	FM5	FM8	FM10	FM12
Total fuel load, <3-inch dead and live, tons/acre	13	3.5	5.0	12.0	34.6
Dead fuel load, 1/4-inch tons/acre	5.0	1.0	1.5	3.0	4.0
Live fuel load, foliage, tons/acre	5.0	2.0	0	2.0	0
Fuel bed depth, feet	6.0	2.0	0.2	1.0	2.3

No direct correlation could be found between fuel loading versus aspect and elevation. Fuel loading conditions expected after an event are shown in Table 32.

Table 32: Post Fire Event Fuel Loading

Years after event >	0-30 years	31-80 years	81-200 years	200 plus years
1st event fire	FM5	FM12	FM10	FM10
2nd event fire	FM5	FM4	FM10	FM8

With this sequence of events, a determination of reference conditions would require looking at each 50 year period of time to determine fuel loading conditions for that period only. FM4 was not used when determining reference conditions even though it existed and exists now.

Table 33: Reference Condition of Fuel Loading for Burned Areas of the Salmon Creek Watershed

Period	Subwatershed 18 1 (35271 acres) Acres Burned	Subwatershed 18 2 (21747 acres) Acres Burned	Subwatershed 18 3 (25417 acres) Acres Burned	Fuel Model with one Fire Event	Fuel Model with Reburn Fire Event
1790-1840	6269--18%	7165--33%	7962--31%	10	8
1850-1890	4859--14%	567--3%	617--2%	10	8
1900-1940	4263--12%	1374--6%	7043--28%	12	10
1950-present	2768--8%	1179--5%	105--1%	4	5

Most of these fire events were determined to be reburns. The total fuel loading by fuel model is shown below.

- FM8 represents 38 percent of those acres that burned 100 to 200 years ago.
- FM10 represents 18 percent of those acres that burned 50 to 100 years ago.
- FM5 represents 6 percent of those acres that burned 0 to 50 years ago.

Stands greater than 200 years old total 38,263 acres or 46 percent of watershed. Table 34 shows the breakdown of fuel loading by subwatershed.

Table 34: Fuel Loading by Subwatershed

Fuel Model	Subwatershed 18 1	Subwatershed 18 2	Subwatershed 18 3
FM8--47%	4082 acres	5387 acres	4554 acres
FM10--53%	9069 acres	6075 acres	5136 acres

Table 35 shows the reference fuel models and percentages of each for this watershed. Wilderness acres are included in Table 35 information. Table 36 shows fuel models specific to the wilderness.

Table 35: Reference Fuel Models

Fuel Model	Percent of Watershed
FM8	55
FM10	40
FM5	5

Table 36: Wilderness Fuel Models

Fuel Model	Percent of Wilderness
FM8	70
FM10	40
FM5	5

CURRENT CONDITION

Given the above reference conditions prior to timber harvest and with fire suppression, it is necessary to determine current fuel loading. The same percentages were used for acres not harvested. Table 37 shows harvest acres categorized by fuel model using the same NFFL fuel models used to determine reference conditions. Treated (T) acres are units that were either broadcast burned, underburned, or machine piled and burned. No treatment (NT) includes all acres that do not meet treated unit requirements.

Reference fuel conditions for last 200 years with fire suppression and no timber harvest compared with current conditions with timber harvest and with fire suppression are shown in Table 38.

Table 37: Harvest Acres by Fuel Model

Time Period	Treated?	Fuel Model and %
1960 to present	Not Treated (NT)	FM4 = 17%
1960 to present	Treated (T)	FM5 = 15%
Pre 1960	Not Treated (NT)	FM12 = 1%
Pre 1960	Treated (T)	FM10 = 2%

Table 38: Reference and Current Fuel Conditions

Fuel Model	Reference Conditions	Current Conditions
4	none	17%
5	5%	20%
8	55%	29%
10	40%	33%
12	none	1%

As shown in Table 30, 150 to 200 years ago 26 percent of this watershed was FM5. 50 to 100 years ago 15 percent was mostly FM5. The point here is that caution is needed when comparing current and reference conditions for fuel accumulations. We are currently near conditions that existed 50 to 100 years ago for FM4 and FM5 and below conditions that existed 150 to 200 years ago for the same fuel models. Of most concern should be FM4 and FM12. Most of the historic burns appear to be reburn events that occurred 30 to 100 years after the first event. If history were to repeat itself, these stands would be most at risk. A comparison of reference and current condition shows that early seral stage stands are most at risk due to their high flammability. Only seral stages SI and SE will be considered since they represent stands less that 100 years of age.

The following three tables (Table 39, 40, & 41) present the reference condition data in several different ways. Table 39 shows the reference condition (percent of acres burned by subwatershed over the last 200 years) for acres in seral stages SI and SE without timber harvest but with fire suppression.

Table 39:

Subwatershed 18 1	Subwatershed 18 2	Subwatershed 18 3
31%	13%	26%

Table 40 shows the reference condition (percent of acres burned by subwatershed excluding fire activity since 1920) for acres in seral stages SI and SE without timber harvest or fire suppression.

Table 40:

Subwatershed 18 1	Subwatershed 18 2	Subwatershed 18 3
20%	31%	34%

Table 41 shows the reference conditions (percent of acres burned by subwatershed over the last 200 years) in 100 year blocks of time. The same data used to produce this table was used for Table 30.

Table 41:

Time Period	Subwatershed 18 1	Subwatershed 18 2	Subwatershed 18 3
present to 100 years ago	20%	11%	29%
50 to 150 years ago	26%	9%	30%
100 to 200 years ago	32%	36%	35%

Table 42 shows the current conditions (percent of acres burned by subwatershed) with fuels treatment on harvest acres and suppression of wildfires included in the data.

Table 42:

Subwatershed 18 1	Subwatershed 18 2	Subwatershed 18 3
42%	20%	28%

Numerous conclusions can be made from this information. In subwatershed 18 3 for example, 100 to 200 years ago 35 percent of the acres burned, 50 to 150 years ago 30 percent burned, and within the last 100 years 29 percent has burned (from Table 41). Subwatershed 18 3 current conditions with timber harvest and fire suppression is estimated to be 28 percent (Table 42). Given the difference of 20 years between 80 and 100 years in the comparison, the current level of seral stages SI and SE are about the same as the historic conditions (Table 40). When compared to reference conditions prior to timber harvest and fire suppression the numbers are further apart. However they do not account for any large fires that have occurred in the last 50 years even though we have had fire suppression. Basically current fuel accumulation conditions in the subwatershed are about the same as historic conditions.

For subwatershed 18 2, depending on which 100 year interval you choose to use, current conditions are either much lower or much higher than reference conditions.

For subwatershed 18 1, current conditions are as much as 10 to 22 percent higher than reference conditions, again depending on which period of time you choose to use.

Fire Occurrence Since 1940

Table 43: Fire Occurrence Since 1940 by Elevation

Elevation Band	Human Caused Events	Lightning Caused Events
1000 to 2999 ft.	5% of acres or 26% of events	12% of acres or 5 % of events
3000 to 3999 ft.	11% of acres or 6% of events	11% of acres or 9% of events
4000 to 4999 ft.	20% of acres or 4% of events	3% of acres or 9% of events
5000 ft. plus	29% of acres or 10% of events	9% of acres or 31% of events

A total of 13,056 acres burned during this period. There were 398 events.

An event is any fire activity in that elevation range. The 9,000 acre Warner Creek fire is counted as an event in each of the elevation ranges that it burned.

Table 44: Percent of the Watershed Burned by Elevation Since 1940

Elevation Band	% of Acres Burned
1000 to 2999 ft.	3
3000 to 3999 ft.	3
4000 to 4999 ft.	4
5000 ft. plus	6

Due to small patch harvesting practices, the likelihood of dry weather conditions occurring each year, the heat generated by a fire in the uncut natural stands, plus the untreated and treated harvested units, a very large stand replacement event could occur in this watershed if an ignition occurred in the right place and at the right time. Units where fuel accumulations were treated may act as buffers or areas where fire intensity would be greatly reduced, but would be at risk of also being destroyed. Harvesting of timber may have been timely to duplicate large fire return interval by removing timber rather than destroying it by fire, but the method of cutting and fuel treatment in no way duplicates history. The patches of remaining late-successional and old-growth stands become significant given this sequence of events due to the fact that as they become older, fuel loadings will and have increased, increasing their vulnerability to wildfire. Areas most vulnerable to fires are any stand less than 80 years of age (seral stages SI an SE), especially those created by harvest without a subsequent fuels reduction treatment. This is about 21 percent of the watershed. Stands with a FM10 are also at risk.

James Agee states in "Fire Effects on Pacific Northwest Forest: Flora, Fuels, and Fauna", 1981, "The impact of effective fire control in western Hemlock/Douglas-fir type has not been nearly as significant as in forest types where fire was frequent. Suppression has been effective for only a fraction of a normal fire return interval in this type."

LOOKOUTS

CURRENT CONDITION

There is one lookout facility on the boundary of this watershed. Waldo Lookout is staffed during high fire danger or lightning activity. This lookout is within the Waldo Wilderness. Two primary concerns for this lookouts are to maintain its 360° view and the need for creation of fuel breaks. Since this facility is ground based, vegetation growth is threatening this view as well as the risk of burning given a fire event. The area surrounding the lookout was once kept clear of brush and vegetation for a distance of 50 to 100 feet. Vegetation now grows within 5 feet of the lookout. Response time by district fire crew to Waldo Lookout is one hour by foot and 30 minutes driving time. Smoke jumpers, if available, take about 30 minutes

Site Productivity

REFERENCE CONDITION

Prior to management activities, site productivity was lowered only by repeated wildfire (reburns) where most of the sites organic material was removed.

Management practices relative to the retention of large woody material (LWM) have varied with time. Most LWM was removed from harvested units from the mid 1970's to mid 1980's. The amount of large woody debris and snag habitat in the historic landscape probably varied within the watershed. In some areas, reburning of previously burned areas tended to remove many of the snags and logs that remained after the original fire. Repeated burning tends to decrease the amount of snags and down wood on the forest floor, particularly on steep south and west facing slopes. Large wood typically would have been retained at higher levels within riparian and aquatic habitats. In other fire areas reburning did not occur and natural levels of snags and logs was high.

CURRENT CONDITION

As mentioned previously, about 28 percent of this watershed has been more or less severely disturbed as the result of regeneration harvesting. Approximately 15 percent of this harvest was accomplished by ground-based skidding machinery that has the potential to compact soils. Past harvesting has most certainly had some affect upon the long-term site productivity.

The amount of large woody debris and snag habitat is variable within the watershed. Some areas, particularly within several hundred feet of roads, and most areas with gentle topography, have been heavily salvaged. In some cases most of the snags have been removed and woody debris has been reduced, both on the forest floor and within riparian and aquatic habitats. In other areas salvage has not occurred and natural levels of snags and logs are present. In managed stands, large woody debris and snag levels vary with the type of harvest and the time frame within which harvest occurred. Some of the older (pre-1950) harvested stands have trees that were retained as seed sources. These residual trees contribute to diversity within these otherwise young stands and ultimately provide a source for snag and large wood recruitment. Many of the areas logged prior to 1970 also have very large logs remaining from the original harvest, due to merchantability standards of the time. Later, utilization became an issue and slash treatment became standard practice between 1970 and 1989. Harvested areas were often left with little or no snags, large woody debris, or residual trees big enough to offer recruitment for these habitat structures. As YUM (yard unmerchantable material) and PUM (pile unmerchantable material) requirements were used less and Forest Plan standards for snag and large woody debris retention were adopted (1990), the amount of wildlife tree and down log habitat within harvested areas began to increase. Table 47 of this chapter displays the acreages within the watershed that were treated with intensive harvest treatments prior to 1970, from 1970 to 1989, and from 1990 to 1995.

The spatial and temporal distribution of non-vegetated areas on erosive soils in the watershed has been altered, compared to the historic fire pattern. Stand replacement fires tended to be larger, localized blocks rather than the dispersed patchwork of clearcuts in varying stages of vegetative recovery currently exhibited.

This change in patterns may or may not be beneficial to the system. Larger stand replacement fires would tend to have a high impact to a few drainages until vegetation is reestablished. The dispersed patchwork of clearcut units would tend to have a lower impact, but would be distributed over a larger area.

In contrast to past management practices, the recent change toward the retention of more trees, snags and large woody material comes closest to mimicking historical fire impacts. The residual root strength from the trees and the energy dissipating effect of large woody material on overland flow tend to retain more soil on the hillside.

WILDLIFE

Terrestrial Wildlife Habitat

REFERENCE CONDITION

A historical representation of what was thought to be the pattern of seral stages on the watershed landscape is provided in Figure 28 this chapter (page 48). This can be compared to the current pattern of seral stages presented in Figure 29 of this chapter (page 49).

As described in the Vegetation (Fire History) section of the Characterization chapter, portions of the watershed were exposed to a series of extensive and overlapping stand replacement fires. A majority of the watershed was burned within the past 200 years. In much of the central portions of the watershed however, stand replacement fires within the past 200 years have been in relatively small patches, relatively much less frequent, or absent altogether.

It is surmised that stands in the upper portions of subwatershed 18 1 and the lower portions of 18 2 and 18 3 may have been exposed to stand replacing fires relatively less frequently than stands elsewhere in the watershed, and thus may have been more likely to develop into large tracts of old-growth forest. Stands in the lowest portions of subwatershed 18 1 and the upper reaches of 18 2 and 18 3, being exposed to more frequent stand replacing fires, may have included relatively more extensive tracts of mid seral range forests between major fire events, with relatively small patches of old-growth developing mainly in sheltered areas such as basins, valley bottoms and patches associated with topographic breaks.

Edge Habitat

Species guilds include those groups of species with various home range sizes that prefer specific types and arrangements of habitat. Appendix A (pages 1 through 5) provides lists of species guilds and their habitat associations. Contrast guilds include those species that prefer distinct edges between open areas or early seral stands, and late seral or old-growth forests.

Salmon Creek Watershed Analysis

Figure 28:
Historic Seral Stages by Plant Association

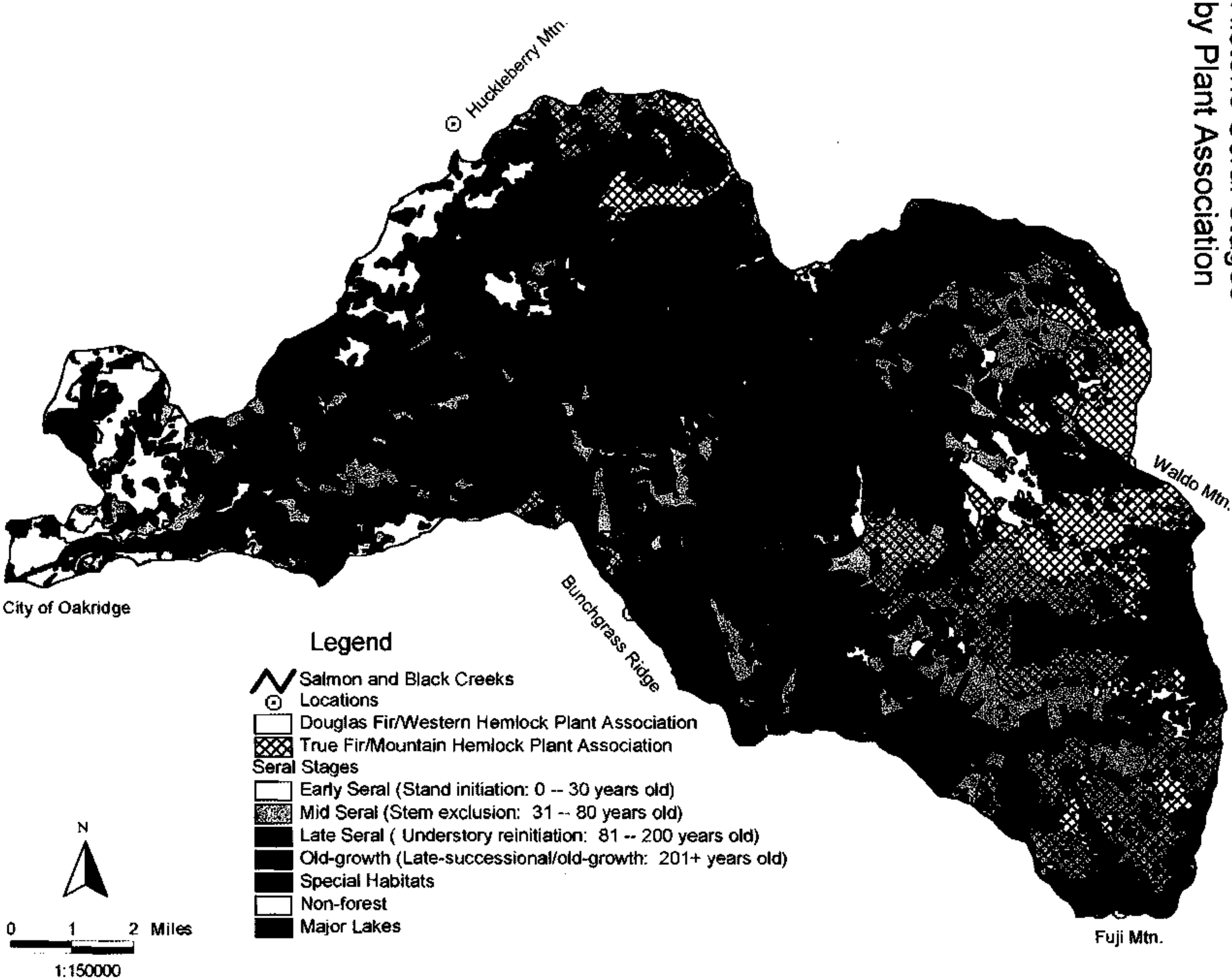
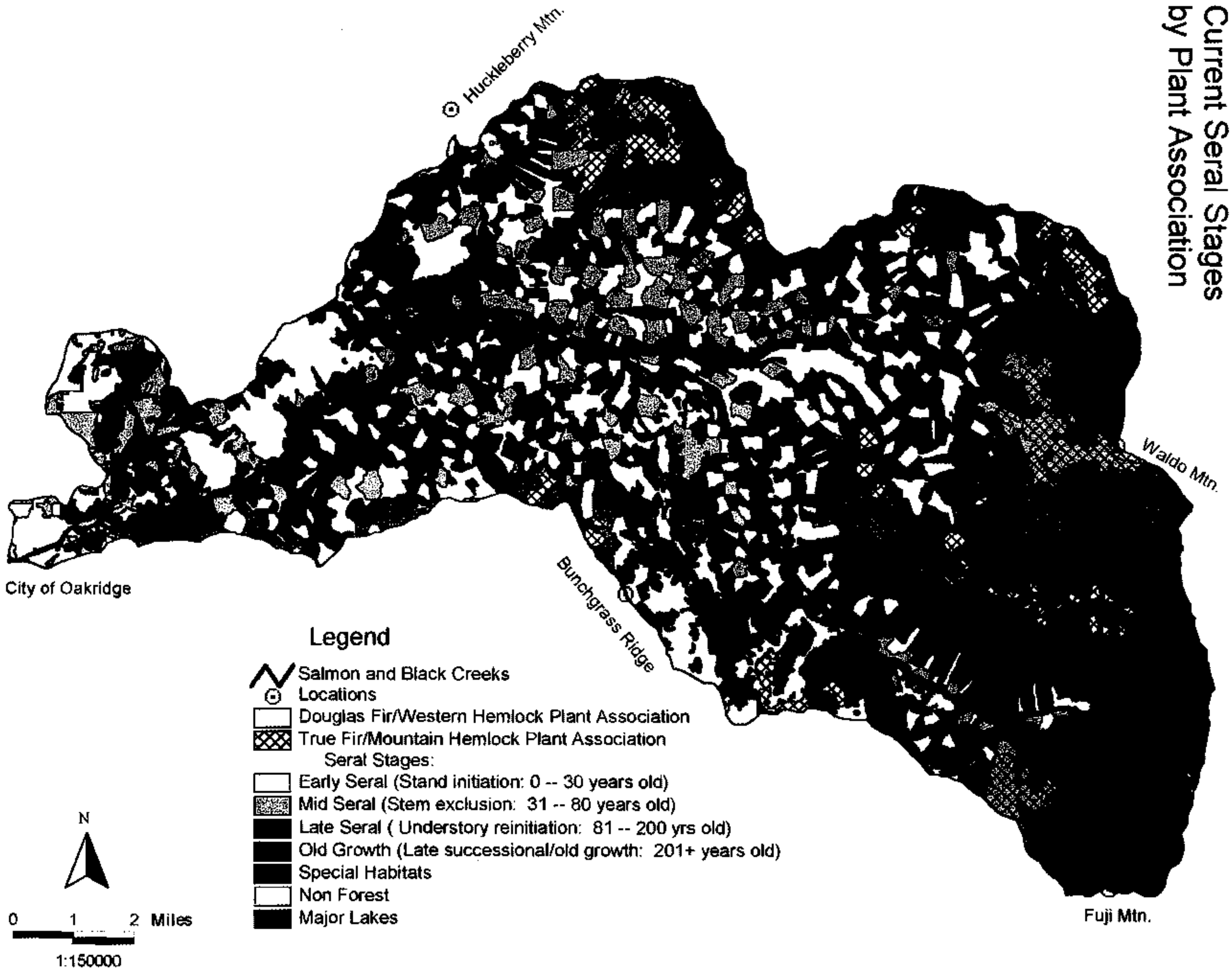


Figure 29:
Current Seral Stages
by Plant Association

Salmon Creek Watershed Analysis



Natural edges are formed where forested plant associations meet non-forested areas such as meadows, talus slopes or rock gardens. Transitional edges also occur where stand replacing fires (early seral) adjoin underburned or unburned patches (late seral) within fire areas. Some fires are relatively small, have irregular edges, or have varying levels of crown mortality. Within those areas contrast habitat is abundant, and if appropriate habitat for reproduction and feeding are both present, one would expect populations of contrast species to respond favorably to patchy or variable wildfires. Other areas within the watershed that did not host frequent patchy fires would have had contrast habitat mainly in association with non-forested inclusions in forested stands or along the edges of large natural openings. Appendix A (Figures 1a, 4a, and 7a) presents maps of approximate historic (1920) contrast habitat. The map of large home range contrast (TLC) guild habitat (Figure 30a of this chapter) displays the largest tracts of fire mosaics with early seral components in the early 1900's as well as the larger natural meadow complexes.

Aggregations of fire patches also provide short term benefits to species that use aggregated patches of early seral habitat (early seral mosaic guilds) and species that use combinations of early and mid seral habitat (generalist for early and mid seral guilds). Appendix A (Figures 2a, 5a, 10a, and 11a) contains maps of early seral patch and mosaic guild habitat thought to be present in a historic (1920) landscape. The map of large home range mosaic early seral (TLME) guild habitat is displayed in Figure 31a of this chapter.

As coniferous regeneration becomes established in areas that have not been recently burned over, landscapes lose the contrast habitat. Fire regenerated stands transition to closed canopy sapling and pole stands. At this point in development the habitat becomes best suited for generalist guild species (those species that use a combination of various habitat types). As these fire stands mature, they provide habitat for mid and late seral guilds.

In the historic landscape, elk habitat in the central portion of the watershed was likely limited by forage areas. Effective forage areas included natural openings and the recently burned patches. In the westernmost and northeast portions of subwatershed 18 1 and the eastern higher elevation sections of subwatersheds 18 2 and 18 3, elk habitat was likely not limited by forage due to fire frequency, abundance of natural openings, and/or relatively slow coniferous cover development. The interspersion of effective cover in large burned over areas may have resulted in temporary habitat limitations for elk within those portions of the watershed. Road density was not an issue in the historic landscape.

Interior Forest Habitat

Natural patterns of disturbance often involved large sections of the landscape. As these stands regenerated and developed into mature stands, suitable habitat for large and medium home range species in the late seral mosaic, late seral patch , and generalist for mid and late seral guilds was provided (see Appendix A , Figures 3a and 6a). Figure 32a of this chapter displays a potential historic (1920) map for terrestrial large home range mosaic late seral (TLML) guild habitat. This map depicts areas within the watershed that provided the highest amounts of the largest patches of late seral and old-growth habitat.

Habitat Structure

The amount of large woody debris and snag habitat in the historic landscape varied widely within the watershed. In some areas reburning of previously burned areas removed many of the snags and logs that remained after the original fire. Repeated burning lowered the amount of snags and down wood on the forest floor, particularly in areas on steep south and west facing slopes. In other fire areas, reburning did not occur and "natural" levels of snags and logs were high. Large wood typically was retained at higher levels within riparian and aquatic habitats.

Connectivity and Dispersal

Connectivity of habitat on the landscape varied with historic fire intensity and extent. However, higher order riparian areas typically served as key connectors between unburned or underburned patches within more fire-prone areas. Later seral habitats were contiguous through all but the highest and lowest reaches of the watershed from ridge lines to riparian zones in most areas. Figure 28 of this chapter displays a potential map of historic (1920) late seral and old-growth forest blocks.

Non-Native Species
No non-native species are known to have been present prior to European colonization. Native species had co-evolved to maintain their individual viability, though fluctuation in habitat conditions caused fluctuations in species populations, favoring some and disfavoring others.

CURRENT CONDITION
Edge Habitat
Portions of the watershed have become highly fragmented as a result of scattered setting timber harvest using regeneration harvest (commonly clearcut) methods within the past 5 decades. Within those areas contrast habitat is abundant. As long as habitat for reproduction and feeding are both present, populations of contrast species have responded favorably to recent management activities. Other areas within the watershed have not been treated with scattered setting clearcuts, or have had minimum fragmentation timber management strategies applied. In these areas, contrast habitat may not be as prevalent as in the more fragmented sections of the watershed, unless numerous natural openings are interspersed among forested areas. Appendix A (Figures 1b, 4b, and 7b) presents maps of current contrast habitat. The map of large home range contrast (TLC) guild habitat (Figure 30b of this chapter) displays the largest tracts of highly fragmented habitat along with the larger forest-meadow complexes.

Forest fragmentation may also provide short term benefits to species that aggregate patches of early seral habitat (early seral mosaic guilds) and species that use combinations of early and mid seral habitat (generalist for early and mid seral guilds). Appendix A (Figures 2b, 5b, 10b, and 11b) contains maps of current early seral patch and mosaic guild habitat. Compare current large home range mosaic early seral (TLME) habitat (Figure 31b of this chapter) with reference TLME habitat (Figure 31a of this chapter).

Areas within the watershed that have not recently experienced regeneration harvest or wildfire have lost the contrast habitat as harvested areas transition into closed-canopy sapling and pole stands. At this point in development the habitat is best suited for generalist guild species (those species that use a combination of various habitat types). Although minimum fragmentation harvest strategies do not create as much edge habitat for contrast species, they do provide suitable habitat for many generalist guilds, and may promote medium and large home range mosaic and generalist habitats in the long term.

Elk are considered to be large home range contrast species. They forage primarily in open areas and seek shelter in late seral or old-growth forests. Up to a certain point, elk habitat capability is generally enhanced by scattered setting regeneration harvests (forest fragmentation). When cover becomes limiting and edge habitat decreases through continued cover removal in heavily harvested areas, elk habitat capability declines. The current condition of elk habitat within the watershed varies with harvest intensity and road building history as well as naturally occurring features, such as meadows and other non-forested areas. Habitat effectiveness may also have been altered by fire suppression which may have changed the abundance and arrangement of natural foraging areas.

Current Habitat Effectiveness Indices for the 11 Elk Emphasis Areas in this watershed are summarized in Table 45 of this chapter.

Salmon Creek Watershed Analysis

Figure 30a:

Historic
Terrestrial, Large Home Range,
Contrast Species

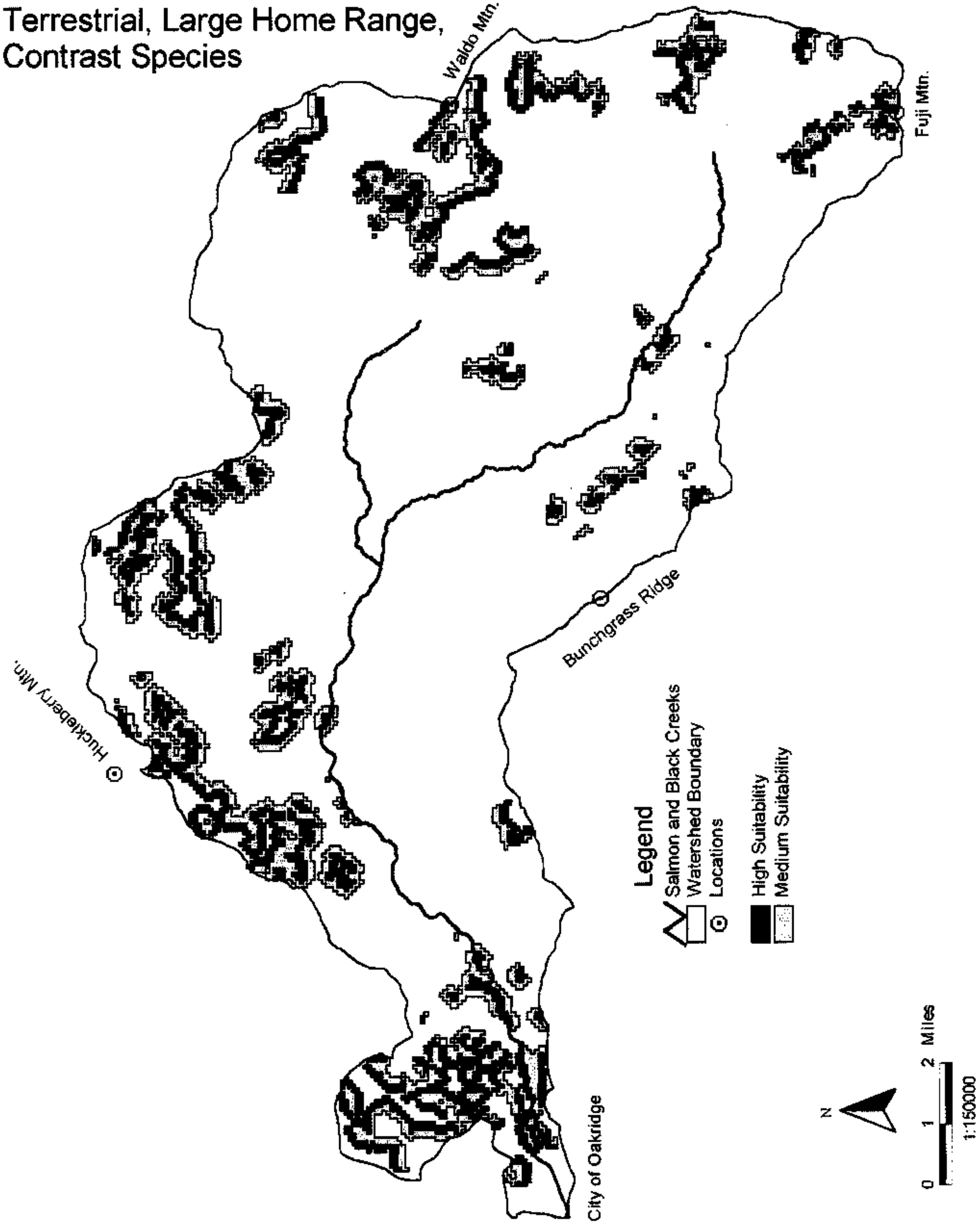


Figure 30b: Salmon Creek Watershed Analysis

Current
Terrestrial, Large Home Range,
Contrast Species

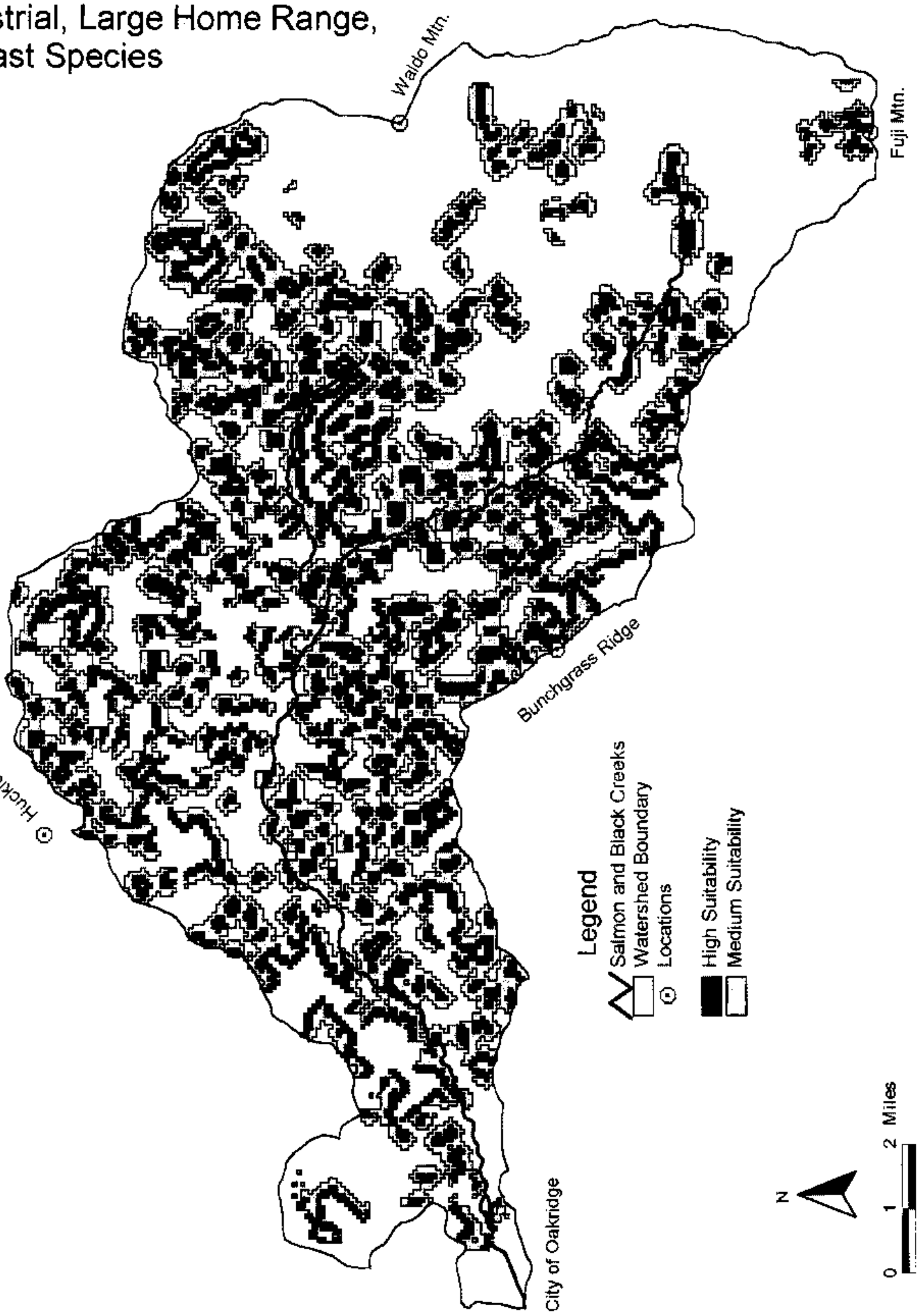


Figure 31a: Historic Terrestrial, Large Home Range, Mosaic, Early Seral

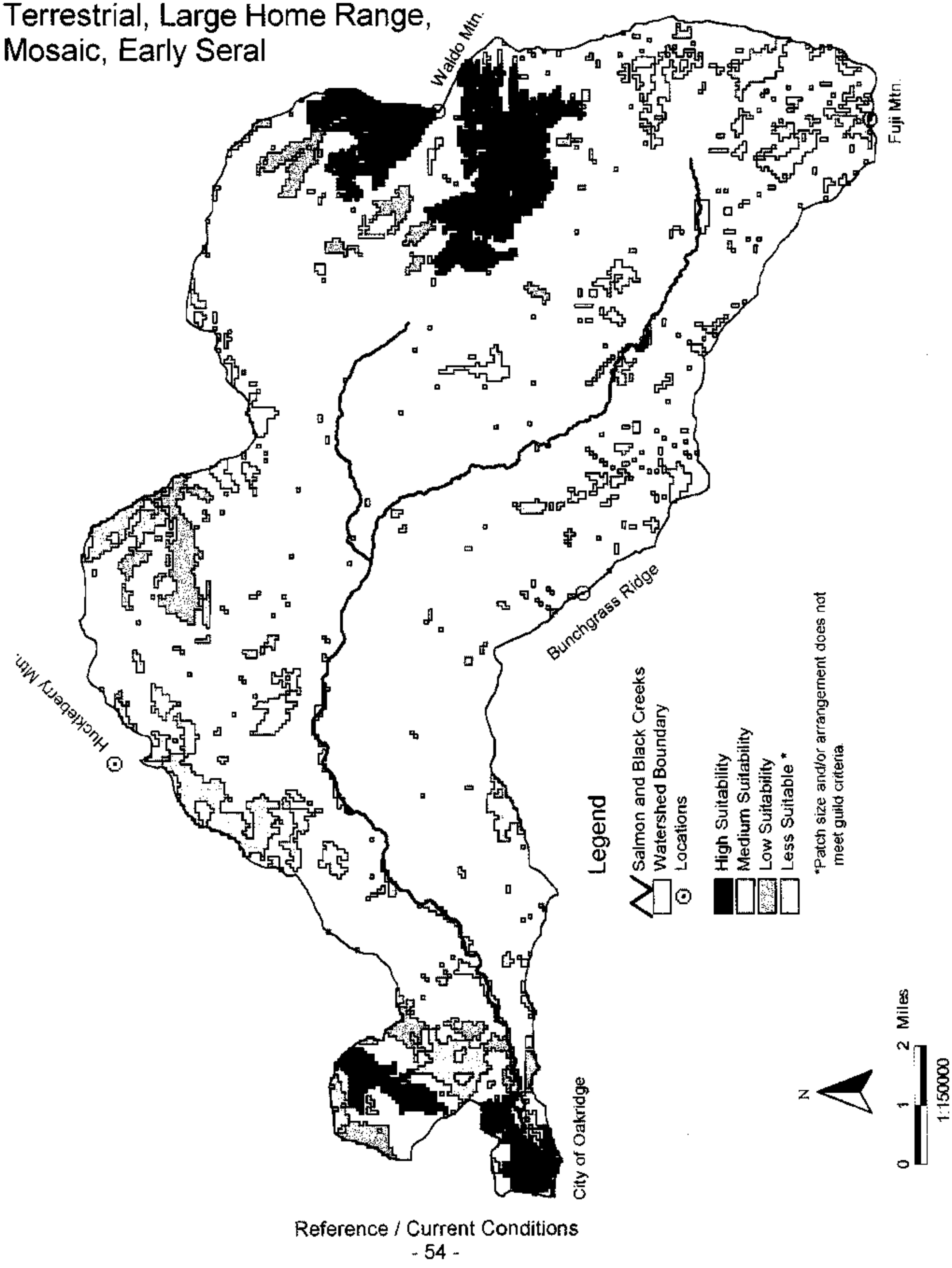


Figure 31b:
Current
Terrestrial, Large Home Range,
Mosaic, Early Seral

Salmon Creek Watershed Analysis

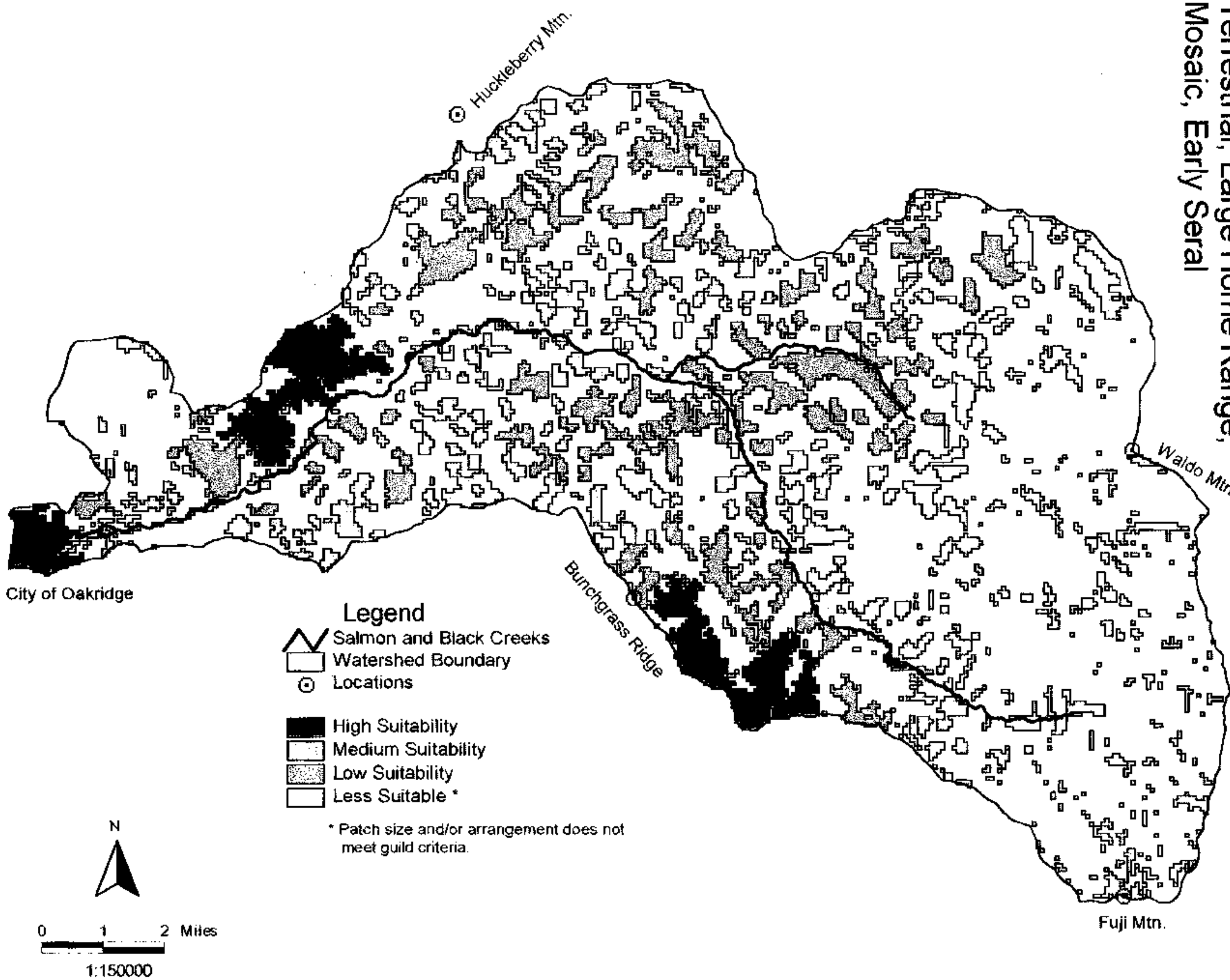


Figure 32a: Salmon Creek Watershed Analysis

Historic
Terrestrial, Large Home Range,
Mosaic, Late Seral

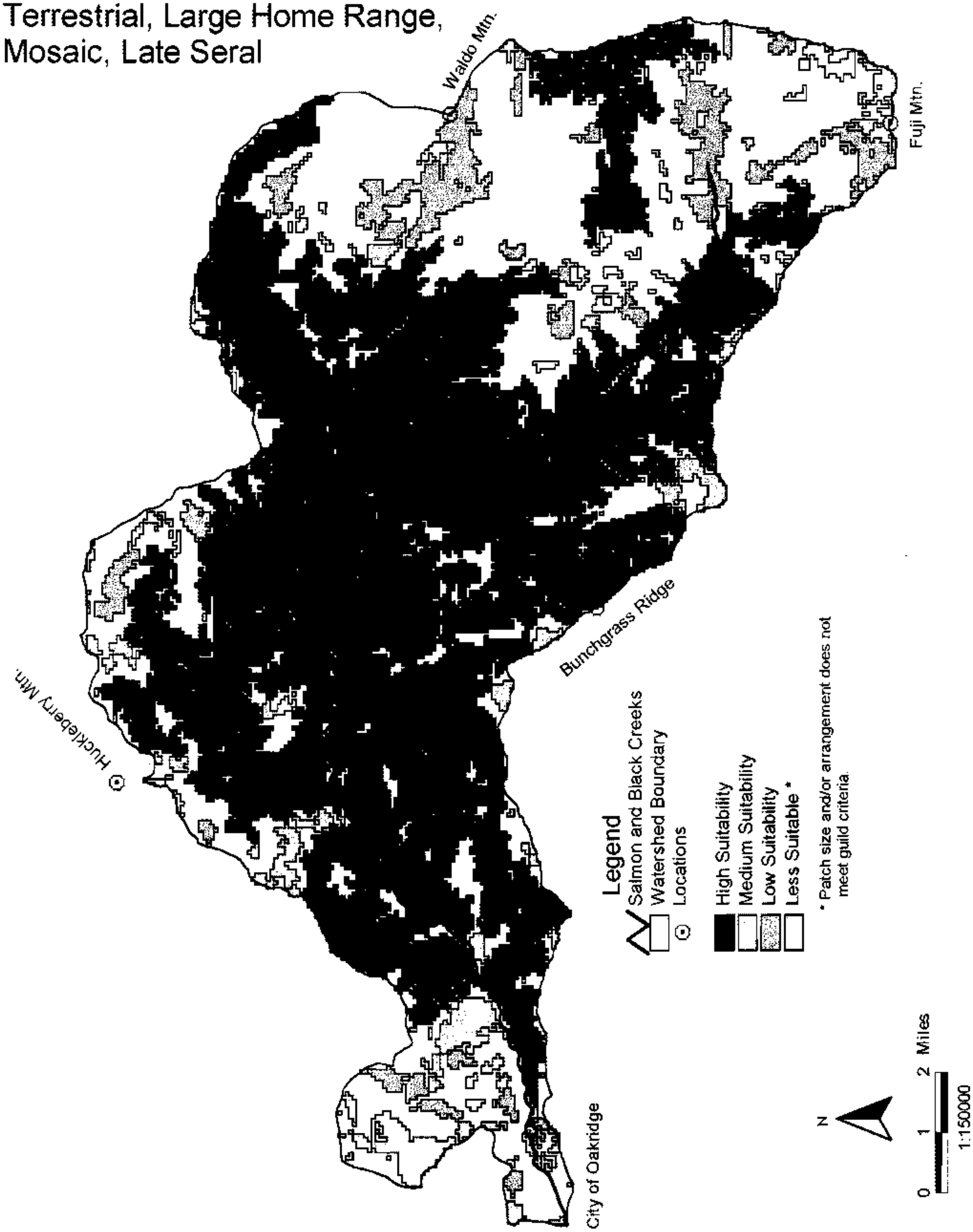


Figure 32b:
Current
Terrestrial, Large Home Range, Mosaic, Late Seral

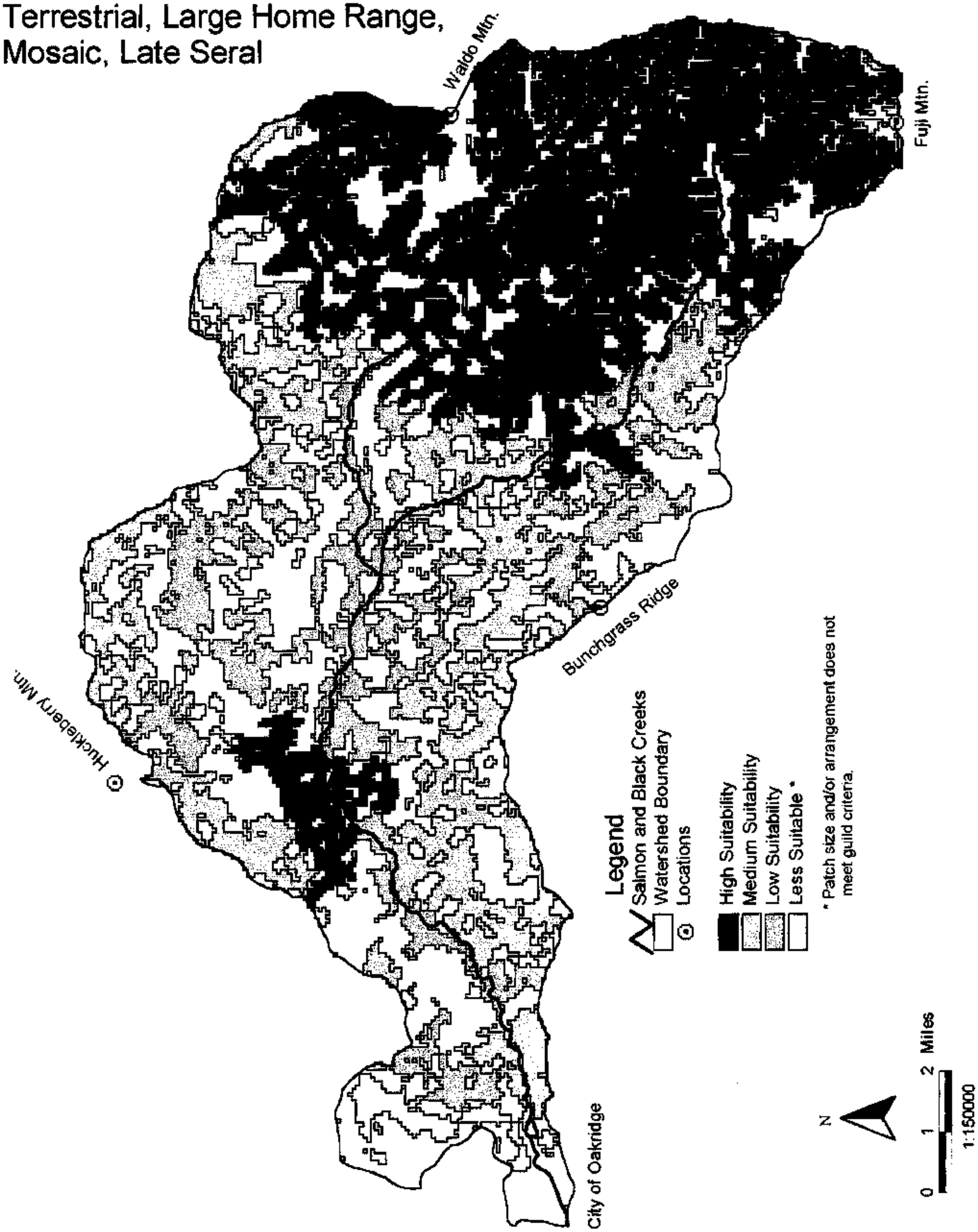


Table 45: Current Elk Habitat Effectiveness

		Individual Indices				Overall Index
BGEA	Emphasis	HEs	HEr	HEc	HEf	HEI
Bingo	High	.69	.97	.62	.38	.63
Flat	Low	.76	.01	.51	.51	.21
Furnish Head	Moderate	.76	.50	.64	.46	.58
Hatchery	Moderate	.78	.39	.66	.50	.56
Kelsey	Moderate	.75	.39	.67	.52	.57
Long Black	Moderate	.78	.45	.79	.47	.60
Pitch	Moderate	.84	.32	.67	.54	.56
Ranger	Moderate	.78	.39	.61	.49	.55
Salmon Head	Moderate	.55	1.00	.57	.49	.63
Shitepoke	Low	.79	.30	.58	.48	.51
Wallhead	Moderate	.81	.38	.59	.51	.55

Emphasis Ratings: (from Willamette National Forest Land Management Plan)

Standards & Guidelines: High from S&G FW-148, Moderate from S&G FW-151, Low from S&G FW-153

Individual Index:	Overall Index:	Index Definitions:
High > 0.5	High > 0.6	HEs - size & spacing
Moderate > 0.4	Moderate > 0.5	HEr - road density
Low > 0.2	Low - increase if any variable is below 0.2	HEc - cover quality
		HEf - forage quality
		HEI - overall

Interior Forest Habitat

Forest fragmentation, as described above, tends to reduce habitat suitability for species in late seral mosaic, late seral patch, and generalist for mid and late seral guilds for all home range sizes (Appendix A, Figures 3b, 6b, 9b, and 12b). Minimum fragmentation strategies tend to retain habitat suitability for these guilds in areas where harvest is avoided, but habitat is removed in harvested areas. Appendix A (pages 1 through 5) contains a list of which species belong to which guilds.

Northern spotted owls are representative of species that select for late seral and old-growth interior forest habitat. Spotted owls are considered to be within the large home range mosaic late seral guild (TLML). Figure 32b of this chapter displays a map for this guild. That map depicts areas within the watershed that provide the highest amounts of the largest patches of late seral and old-growth habitat within approximate home ranges (about 3000 acres) for this species. However, the map does not distinguish plant associations (vegetative communities), thus not all of the area mapped in the watershed would be best suited for northern spotted owls; for example, those areas in true-fir and mountain hemlock associations. Late seral and old-growth true-fir and mountain hemlock are better utilized by species such as marten, and black-backed and three-toed woodpeckers. The map in Figure 29 of this chapter depicts current seral stages by plant association for the watershed, and should be referenced to distinguish this biofeature.

A commonly accepted way to assess habitat conditions for northern spotted owls is to describe the conditions of the individual home ranges for each habitat activity center (HAC). The amount of habitat within an average size home range for the Oregon Cascades Province (1.2 mile radius or approximately 2900 acres) should be above 40 percent of the area within the home range in order to maintain reproductive viability of the site. Current amounts of suitable habitat within the provincial radius of known spotted owl sites within this watershed are displayed in Table 46 of this chapter.

Table 46: Current Spotted Owl Home Range Conditions (Acres of Suitable Habitat)
Watershed 18: (50 activity centers)

Owl MSN	0.7 Mile Habitat	1.2 Mile Habitat	LSR No.	Owl MSN	0.7 Mile Habitat	1.2 Mile Habitat	LSR No.
1117	385.22	1381.52	1117	2795	560.26	1828.53	2795
1118	684.15	1895.20	1118	2796	560.01	1542.57	RO220
1119	556.95	1528.25	1119	2802	562.29	1675.99	RO220
1120	739.77	1994.31	1120	2803	412.61	1356.43	2803
1125	576.62	1325.48	RO220	2810	797.52	2023.37	2810
1130	640.12	1841.15	1130	2813	306.98	1071.81	2813
1134	557.70	1610.08	RO220	2822	672.88	1702.22	2822
1138	518.80	1616.80	RO220	3568	616.79	1312.71	RO220
1139	477.59	1377.00	RO220	3569	556.80	1546.52	RO220
1140	512.74	1468.09	RO220	3571	418.19	1241.47	RO220
1141	599.22	1719.97	RO220	3572	456.20	1011.54	3572
1142	647.86	1455.34	1142	3575	674.04	1635.27	RO220
1143	578.06	1983.39	1143	3576	566.89	1520.71	3576
1152	482.33	1532.33	RO220	3577	602.95	1681.76	RO220
2741	462.52	1207.69	RO220	3578	509.14	1547.23	RO220
2742	441.66	1407.49	2742	3988	430.40	1405.56	RO220
2743	656.89	1291.49	2743	3989	721.26	2057.77	K406
2774	724.93	1930.07	2774	3990	381.23	1235.79	3990
2775	682.91	1853.95	2775	3991	656.97	2005.34	N.A.
2780	623.24	1596.29	2780	3993	319.94	1025.94	RO220
2782	552.46	1559.44	RO220	4103	318.52	358.83	N.A.
2786	685.77	1651.84	2786	4343	499.36	1430.60	RO220
2792	547.47	1684.86	2792	4344	410.93	1224.57	RO220
2793	502.67	1584.11	2793	4345	475.09	1099.04	RO220
2794	554.98	1659.46	2794	4390	681.26	1933.38	K506

highlighted values indicate suitable habitat below 40 percent

Key: MSN = Master Site Number
LSR = Late-Successional Reserve
N.A. = Not Applicable (not in an LSR)

Habitat Structure

The amount of large woody debris and snag habitat is variable within the watershed. Some areas, particularly within several hundred feet of roads, and most areas with gentle topography, have been heavily salvaged. In some cases most of the snags have been removed and woody debris has been reduced both on the forest floor and within riparian and aquatic habitats. In other areas salvage has not occurred and natural levels of snags and logs are present. In managed stands large woody debris and snag levels vary with the type of harvest and the time frame within which harvest occurred. Some older harvested stands have residual trees within them, and shelterwood stands now within LSR0220 will carry this overstory component into the future. These residual trees contribute to diversity within otherwise uniform young stands and will ultimately provide a source for snag and large wood recruitment. Many of these older harvest units (logged prior to 1970) also have very large logs remaining from the original harvest, due to merchantability standards of the time. Later, utilization became an issue and slash treatment became standard practice between 1970 and 1989. Harvested areas were often left with little or no snags, large woody debris, or residual trees big enough to offer recruitment for these habitat structures. As YUM (yard unmerchantable material) and PUM (pile unmerchantable material) requirements were used less frequently and Forest Plan standards for snag and large woody debris retention were adopted (1990), the amount of wildlife tree and down log habitat began to increase. Table 47 of this chapter displays acreage totals within the watershed that were treated with intensive harvest treatments prior to 1970, from 1970 through 1989, and from 1990 to present.

Table 47: Acres of Intensive Harvest Treatment for Three Timeframes

Harvest Years	Harvest Code	Subwatershed Acres 18 1	18 2	18 3	Total Acres	Sum Total 18 (%)
≤ '69	110	5,795	1,007	2,052	8,854	
	total	5,795	1,007	2,052	8,854	8,854 (11%)
% of Watershed		16	4.6	8.1	11	
1970 - 1989	110	5,993	1,534	2,732	10,259	
	130	479	407	987	1,873	
	141	428	54	490	972	
	143	0	0	70	70	
	220	916	0	0	916	
	total	7,816	1,995	4,279	14,090	14,090 (17%)
% of Watershed		22	9.2	17	17	
≥ '90	110	237	66	224	527	
	130	21	61	56	138	
	141	107	0	0	107	
	143	0	0	6	6	
	220	471	0	65	536	
	total	836	127	351	1,314	1,314 (1.6%)
% of Watershed		2.4	0.6	1.4	1.6	(24,258 (29.6%))

Table Legend (harvest codes): 110 = clearcut 130 = shelterwood cut 141 = shelterwood removal 143 = overstory removal 220 = commercial thin

Connectivity and Dispersal

Connectivity of habitat on the landscape varies with previous or current management allocation. Areas that have been included as Spotted Owl Management Areas (SOMAs), later replaced by Spotted Owl Habitat Areas (SOHAs), then Habitat Conservation Areas (HCAs), and presently known as Late-Successional Reserves (LSRs) tend to be relatively less fragmented and often have better connectivity than other areas within the commercial forest base. Areas within wilderness, roadless areas, and other relatively inaccessible areas normally have the highest potential level of connectivity.

Areas that have been historically managed as general forest and scenic management areas typically have lower levels of forest habitat connectivity. Figure 29 of this chapter displays a map of areas that are currently unharvested late seral and old-growth forests. Figure 33 of this chapter displays harvested portions of areas presently under no-harvest allocation (including riparian reserves) as well as riparian reserves that have been previously harvested by harvest method. The current connectivity and riparian habitat condition, as well as the current condition of lands presently under harvest allocation within this watershed, are presented in Tables 48 and 49.

Table 48: Current Connectivity and Riparian Habitat Condition

General Forest Area

Connectivity Acres Total	Connectivity Acres Harvested: Stand Age 0 - 30 yr.	Stand Age 31 - 80 yr.	Harvested Connectivity Total Acres	Percent Connectivity Harvested
13,795	2,502	704	3,206	23

LSR 0220 Area

Riparian Acres Total	Riparian Acres Harvested: Stand Age 0 - 30 yr.	Stand Age 31 - 80 yr.	Harvested Riparian Total Acres	Percent Riparian Harvested
10,456	2,717	777	3,494	33 %

Upland Acres Total	Upland Acres Harvested: Stand Age 0 - 30 yr.	Stand Age 31 - 80 yr.	Harvested Upland Total Acres	Percent Upland Harvested
28,427	7,114	1,549	8,663	30 %

LSR Acres Total	Overall Acres Harvested: Stand Age 0 - 30 yr.	Stand Age 31 - 80 yr.	Total Acres Harvested	Total Percent Harvested
38,883	9,831	2,326	12,157	31 %

Wilderness Area

Wilderness Acres Total	Wilderness Riparian Acres Total	Percent Wilderness Riparian
11,051	4,672	43 %

Figure 33: Connectivity Condition

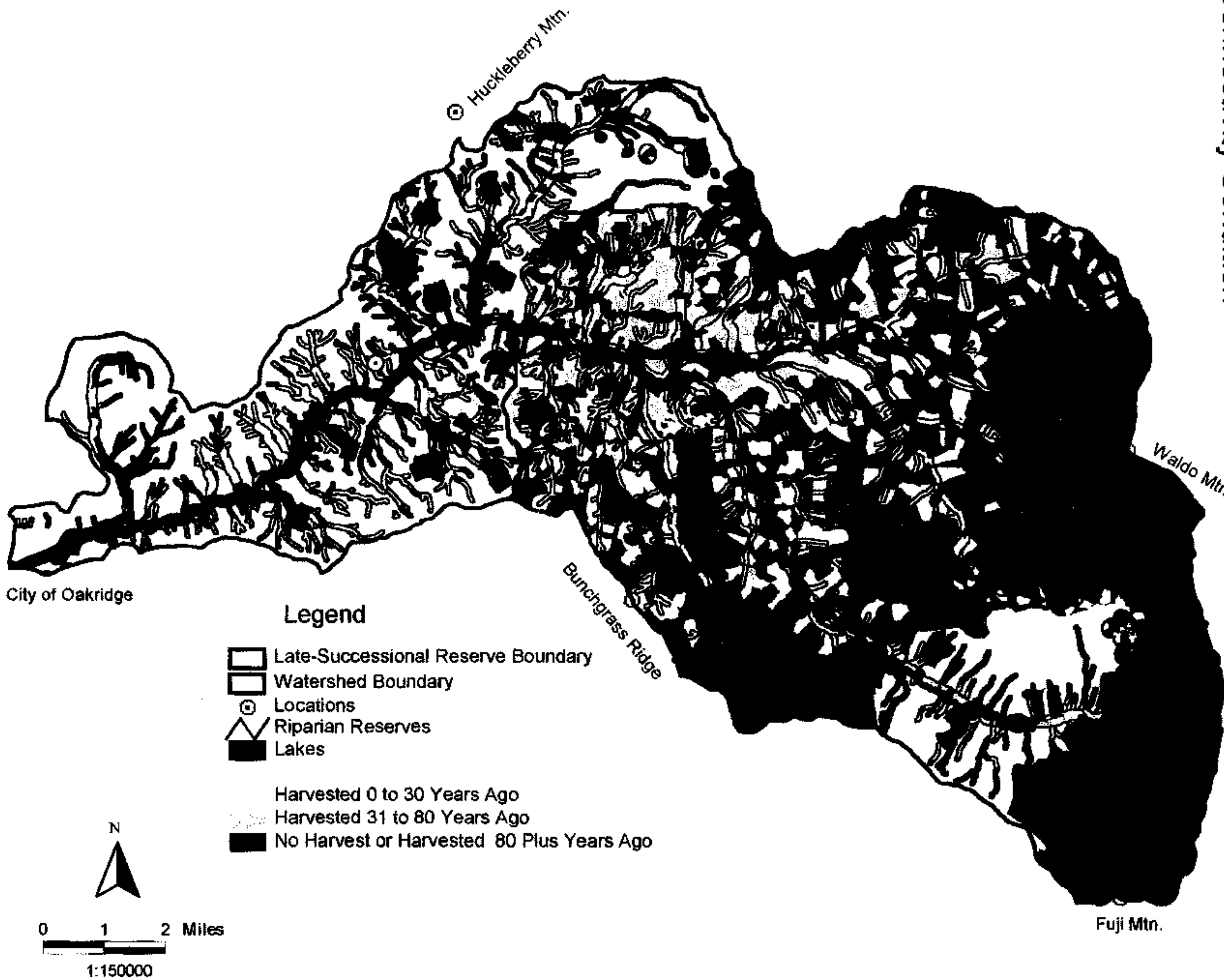


Table 49: Current Condition of Harvest Allocation Lands (in acres)

6th Field	Land Allocation Acres Total	SRI UNSUIT	HR Limit limit / acres	Seral Stage SI	SE	UR	LS/OG
18 1	11C = 309	13	7% / 31	68	65	153	10
18 1	11D = 754	0	7% / 53	97	78	232	346
18 1	11E = 979	106	13% / 69	61	229	499	84
18 1	14A = 11,036	568	13% / 1,435	4,329	1,088	2,611	2,440
18 2	14A = 3,885	323	13% / 505	470	235	1,919	938
18 3	14A = 105	19	13% / 14	19	0	7	60
Total Harvest Allocation Acres Condition Summary							
18 1	13,079	688		4,555	1,461	3,495	2,880
18 2	3,885	323		470	235	1,919	938
18 3	105	19		19	0	7	60
Total	17,069	1,030		5,044	1,696	5,421	3,878

Table legend: HR Limit = even age harvest rate limit; S I = stand initiation (0 - 30 year old stand); SE = stem exclusion (31 - 80 year old stand); UR = understory reinitiation (81 - 200 year old stand); LS/OG = late-successional/old-growth (201+ year old stand)

Non-Native Species

Terrestrial non-native animal species are currently present in this watershed. The overall effect these species (described below) have on native species is unknown. In some situations they may be serving as predators whereas in others their role may be as prey species for natives.

It is believed that Virginia opossum might have been introduced to the Oakridge area in the 1930's. One theory is that opossum were brought here by folks immigrating to the area during the great depression. During this period of time the animals were frequently raised as a cheap source of meat and were known as "Hoover's rabbits". Opossum, which are normally found associated with developed areas such as those adjacent to a residential/forested interface or agricultural areas, have been reportedly sighted in relatively remote portions of the watershed which suggests they may be well established. The opossum is an opportunist that will feed on essentially anything smaller than itself.

In the early 1960's the barred owl began to expand its range into the range of the spotted owl in the Pacific Northwest. The first record of barred owls in Oregon was documented in 1974. Although barred owls and spotted owls have been listed in the same Habitat Species Guild, vegetation manipulation during the past decades has seemed to favor the barred owl. Barred owls have been documented at numerous sites throughout this watershed suggesting the species has successfully exploited a niche for itself in fragmented areas.

Feral house cats are occasionally reported at random locations in the watershed and feral rabbits are frequently sighted in the vicinity of Flat Creek complex. It is unknown whether these species have established local populations or what effect they may be having on native species.

Aquatic Wildlife

FISH DISTRIBUTION

REFERENCE CONDITION

Historically, Salmon Creek contained, in addition to rainbow and cutthroat trout and several non-game fish species, populations of spring chinook salmon and bull trout (see historic distribution map, Figure 34 of this chapter). Excellent runs of spring chinook once utilized Salmon Creek and other tributaries to the Middle Fork (Salt Creek and the North Fork of the Middle Fork of the Willamette River). The migration of anadromous fish was blocked by the construction of Lookout and Dexter Dams on the Middle Fork of the Willamette River in the 1950's. Between 1957 and 1966, a yearly average of 3,472 spring chinook salmon and 223 steelhead trout were collected below Dexter Dam (Hutchinson et al., 1966). This data shows that there was a sizable run of anadromous fish that were excluded from the tributaries to the Middle Fork of the Willamette due to dam construction. It is estimated that a total of 215 miles of stream historically accessible to salmon and steelhead were blocked by the construction of Dexter and Lookout Dams This estimate includes Salmon Creek, the North Fork of the Middle Fork of the Willamette River, Salt Creek, Hills Creek, and the Upper Middle Fork of the Willamette River (Willamette Basin Task Force, 1969).

Historically about twenty percent of the spring chinook salmon in the Middle Fork Willamette River drainage returned to the lower reaches of Salmon Creek to spawn (Johnson 1917). Hutchinson et. al., (1966) reported that the magnitude of the spring chinook runs in Salmon Creek were comparable and may have actually exceeded the runs in the McKenzie River Drainage. A weir placed in the Middle Fork of the Willamette River just upstream from the mouth of Salmon Creek diverted all of the salmon that had migrated this far into Salmon Creek . These fish were then trapped about one mile upstream and artificially spawned by hatchery personnel. Only the earliest fish, and the smallest ones were able to pass these weirs to migrate further up the Middle Fork or further up Salmon Creek (McIntosh et. al., 1992). Hatchery spring chinook have been released into the Middle Fork of the Willamette Drainage since 1917.

The lower reaches of Salmon Creek , from the mouth to Salmon Creek Falls, had ideal spawning habitat and large well spaced pools as noted during the 1938 survey (McIntosh et. al., 1992). Long term residents of the Oakridge area claim that spring chinook salmon were able to pass the falls during the high flows of late spring, but that the falls were impassable during low flow (McIntosh et. al., 1992). The 1938 survey notes that in the first two miles above the falls are "some of the finest appearing spawning areas" seen during the course of the survey, but that above Wall Creek there was very little spawning gravel available (McIntosh et al 1992).

Historically bull trout probably also inhabited this watershed. Although there have been no confirmed sightings, there have been reports of anglers catching bull trout above Salmon Creek Falls as recently as 1992.

CURRENT CONDITION

Currently there are no known populations of bull trout in the Salmon Creek watershed, although suitable habitat still exists in the upper watershed and many of the tributaries (see Figure 35 of this chapter). Spring chinook salmon are no longer present in this watershed, although a limited number of fry were stocked in nearby Salt Creek in 1996.

Cutthroat and rainbow trout are common throughout the watershed. Rainbow trout exist lower in the watershed and cutthroat trout inhabit the upper portions. Population sizes of cutthroat trout populations are unknown. Although habitat has been altered through management activities such as timber harvest, road building and dams, it is not thought that cutthroat trout populations are threatened at this time although there is the potential for isolated populations above barriers such as culverts and waterfalls to decrease in size and viability. Some cutthroat populations may be out of compliance with fish management policy due to unknown population sizes (Wade and Ziller, 1995). Rainbow trout populations are also thought to be in good condition at this time (Wade and Ziller, 1995). (See distribution maps, Figures 36, 37, and 38 of this chapter)

Non-game fish species inhabiting the lower portions of the main stem Salmon Creek and some of its tributaries include whitefish, large scaled suckers, squawfish, red sided shiners, and speckled dace (ODFW personal communication). Various species of sculpin are also known to inhabit the Salmon Creek watershed. Figures 39, 40, and 41 show the distribution of many of these non-game species.

Many lakes have been stocked with brook trout, rainbow trout and cutthroat trout. Some lakes contain naturally reproducing populations of trout while others are stocked regularly by ODFW. Although brook trout have been stocked in many of the lakes in the watershed, there are no known populations of brook trout in streams in the upper watershed. Brook trout are present, however, in upper Wall Creek and upper Mule Creek.

Figure 34:
Historic Distribution of Spring Chinook Salmon and Bull Trout

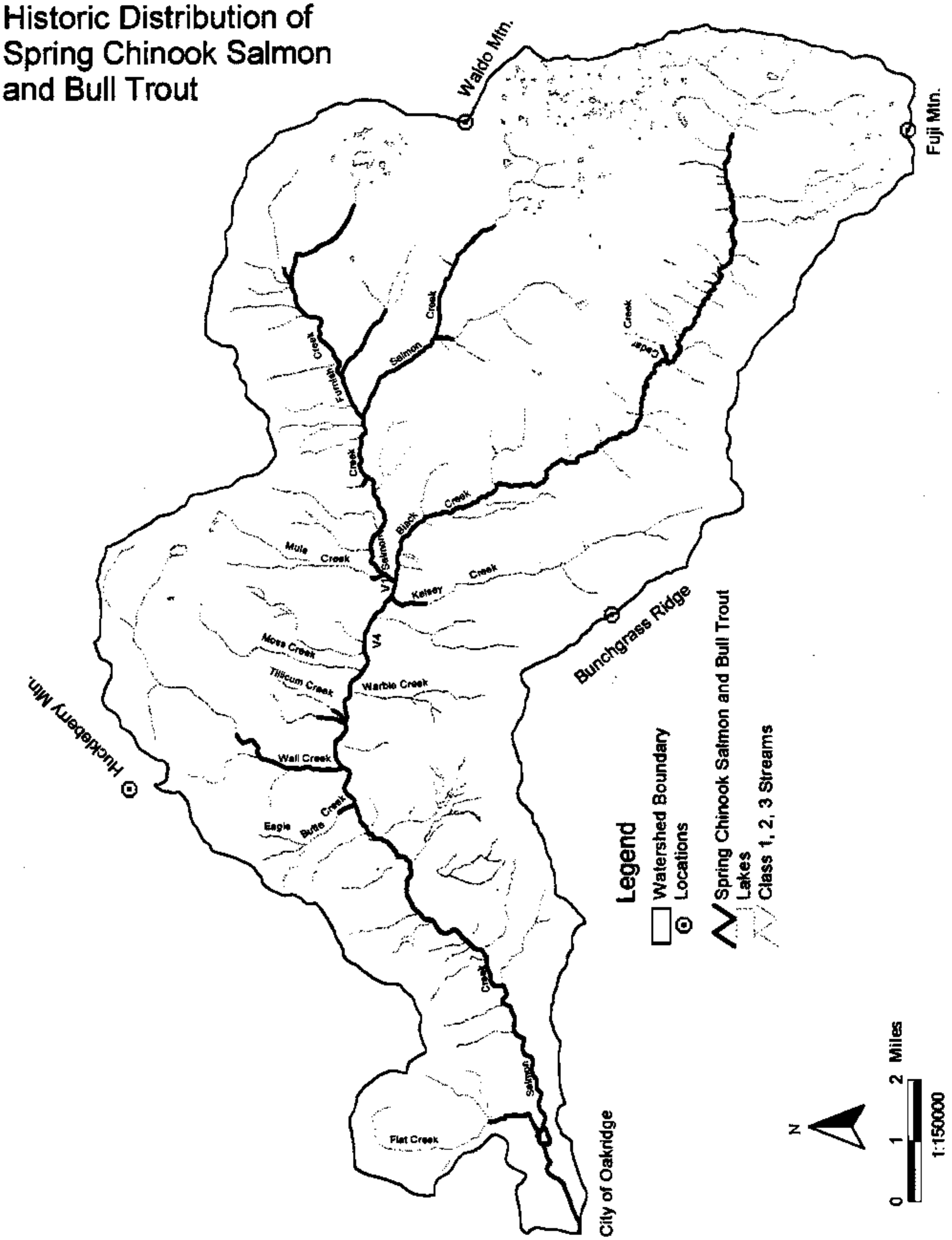


Figure 35:
Potential Distribution of Spring Chinook Salmon and Bull Trout

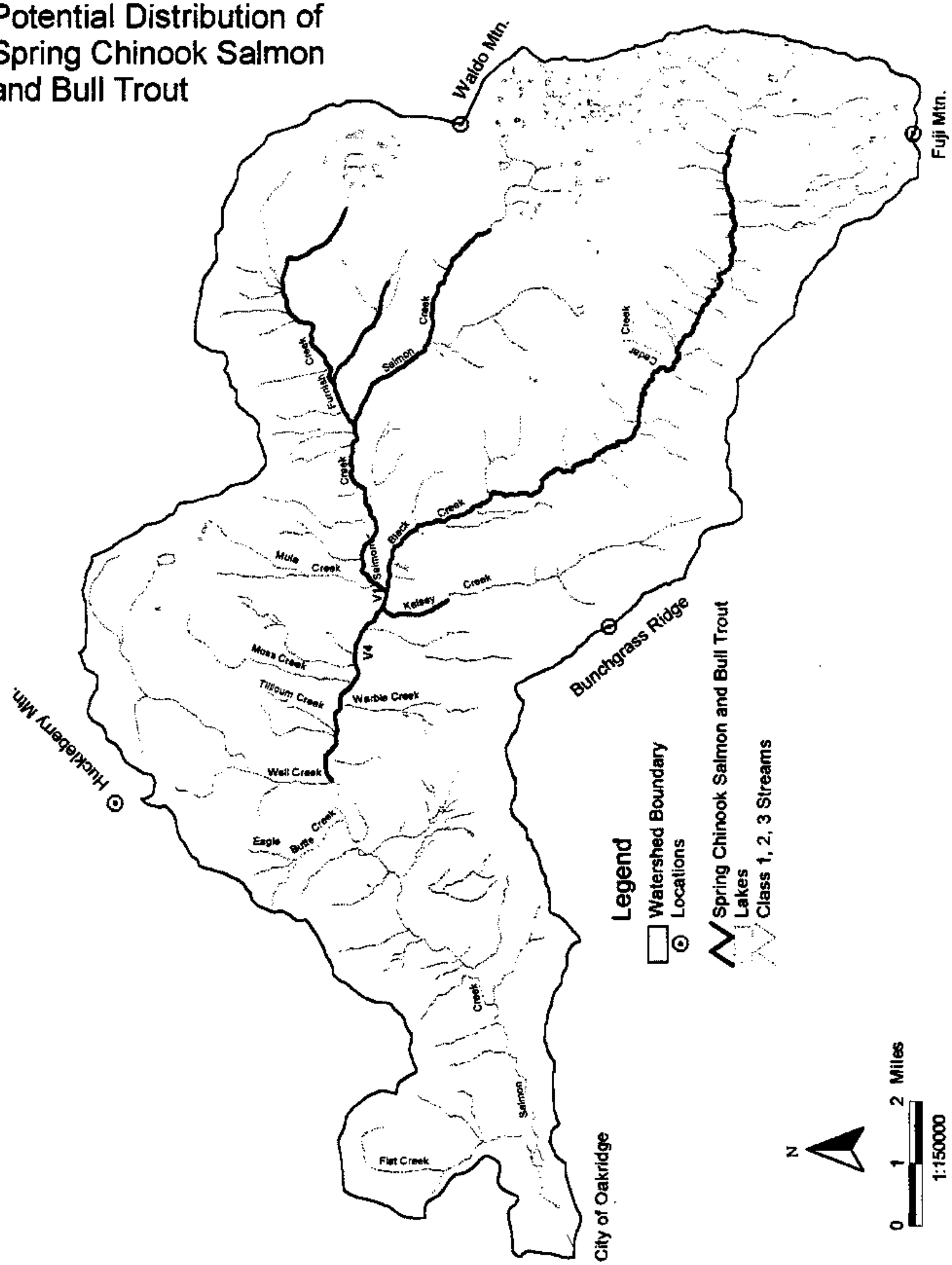
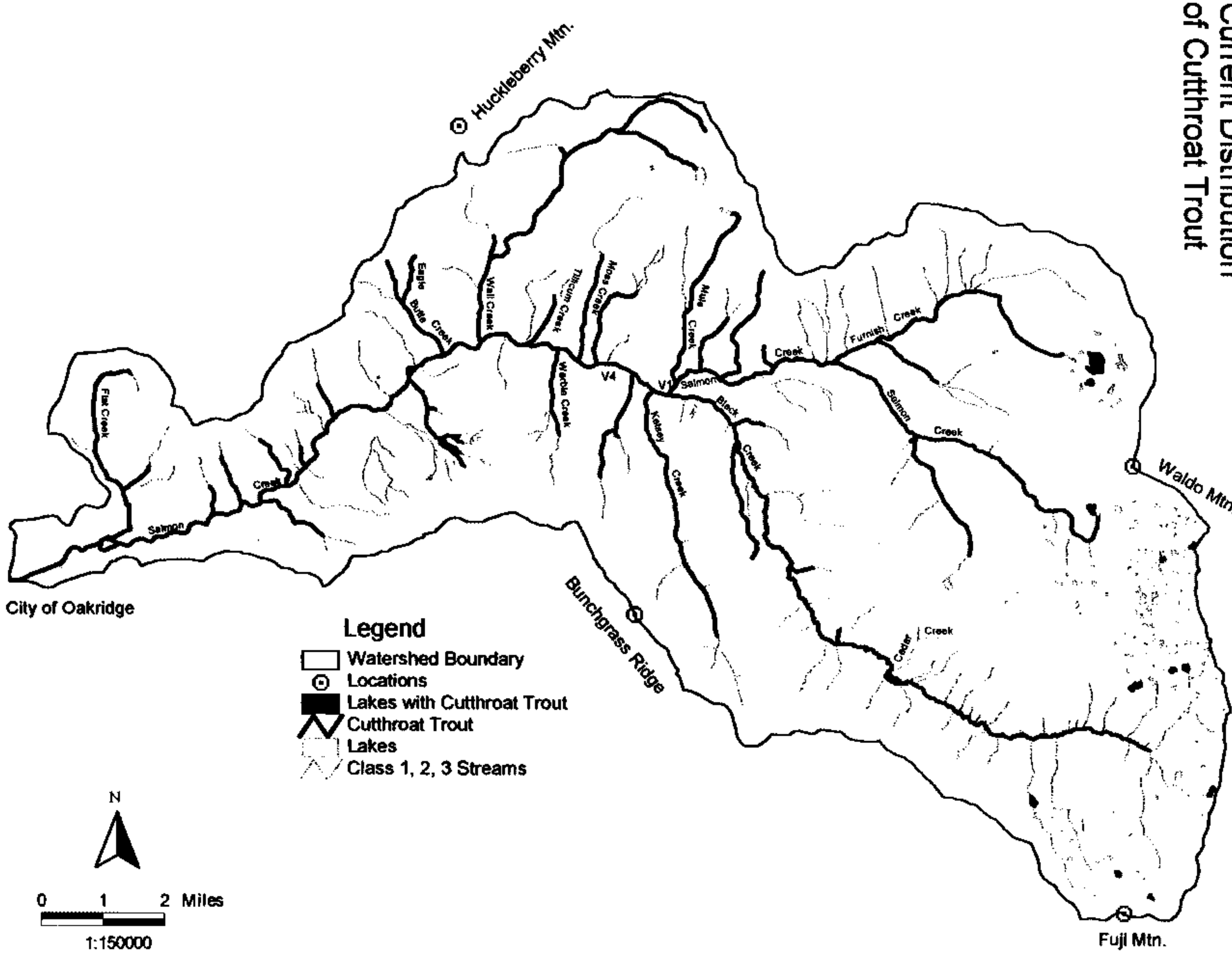


Figure 36: Current Distribution of Cutthroat Trout



Salmon Creek Watershed Analysis

Figure 37:

Current Distribution of Rainbow Trout

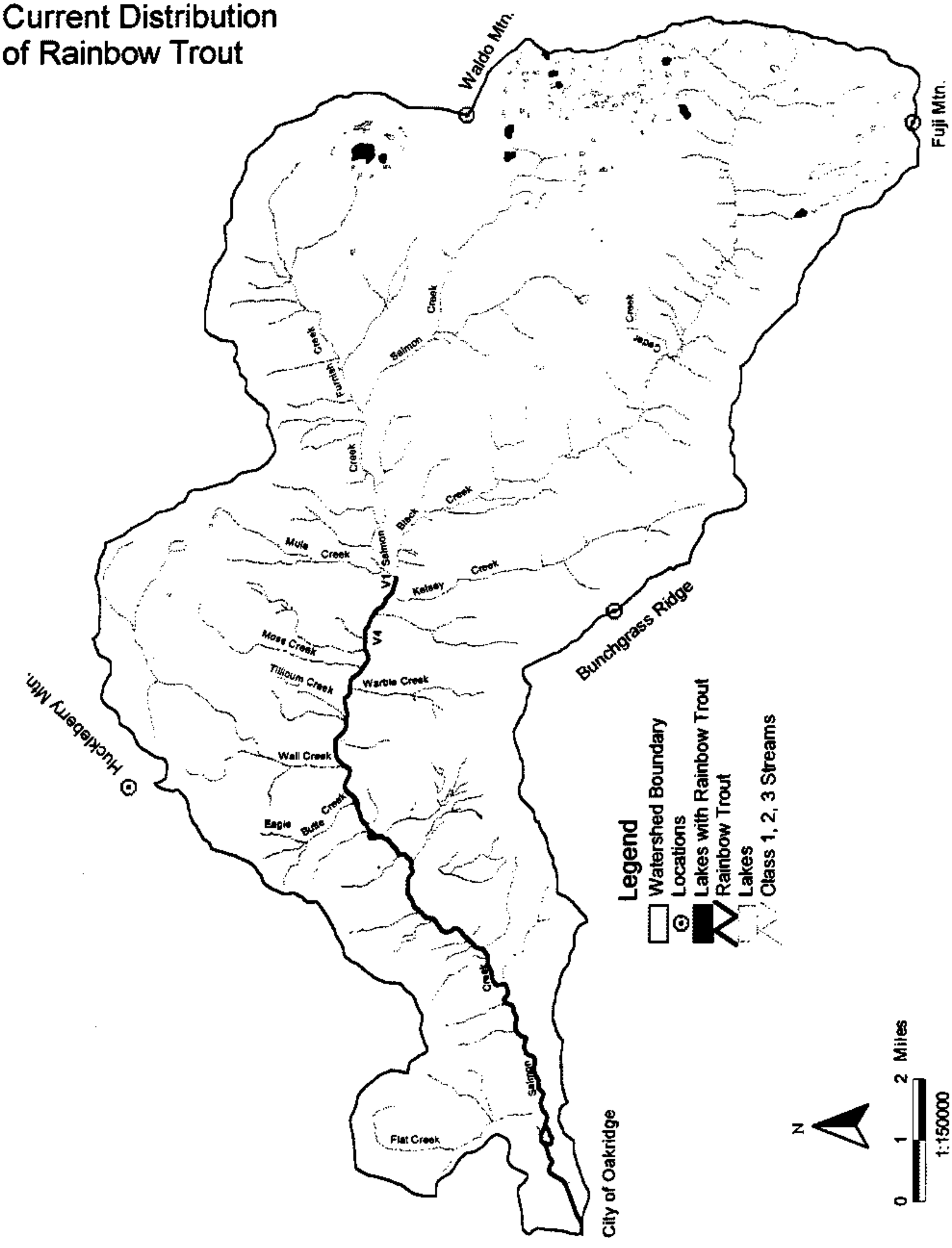


Figure 38:

Current Distribution of Brook Trout

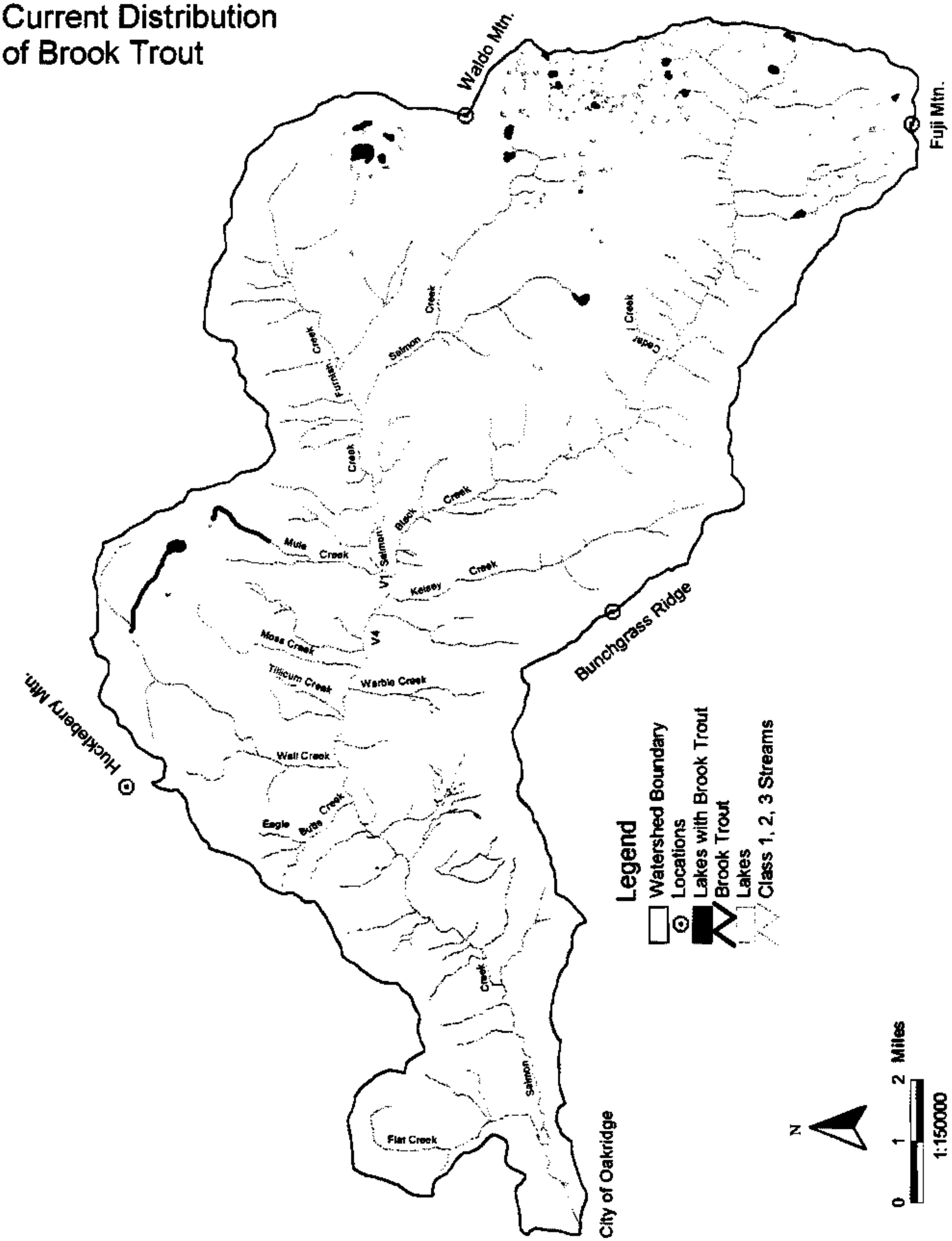


Figure 39:

Current Distribution of
Large Scaled Sucker

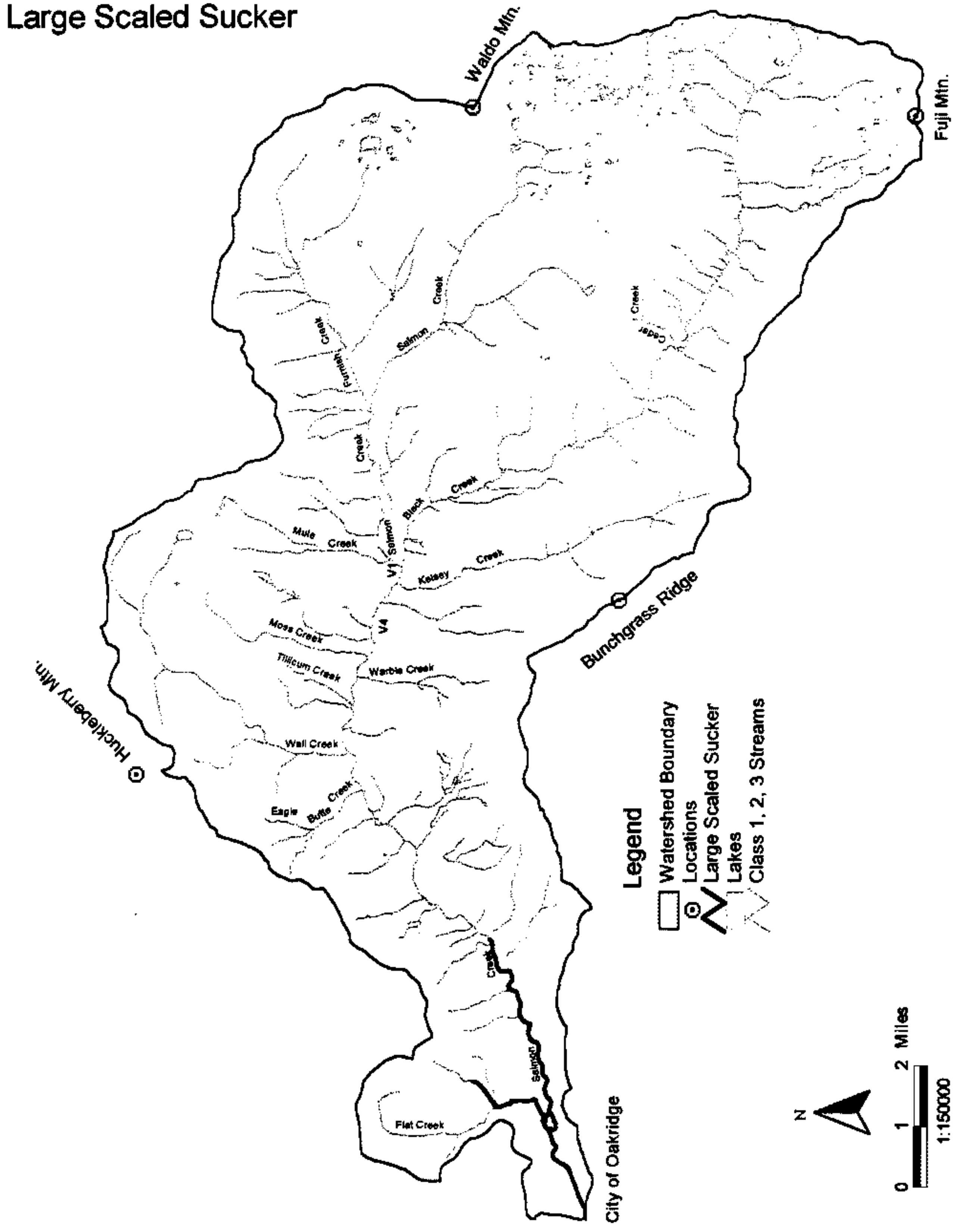


Figure 40:
Current Distribution
of Sculpin

Salmon Creek Watershed Analysis

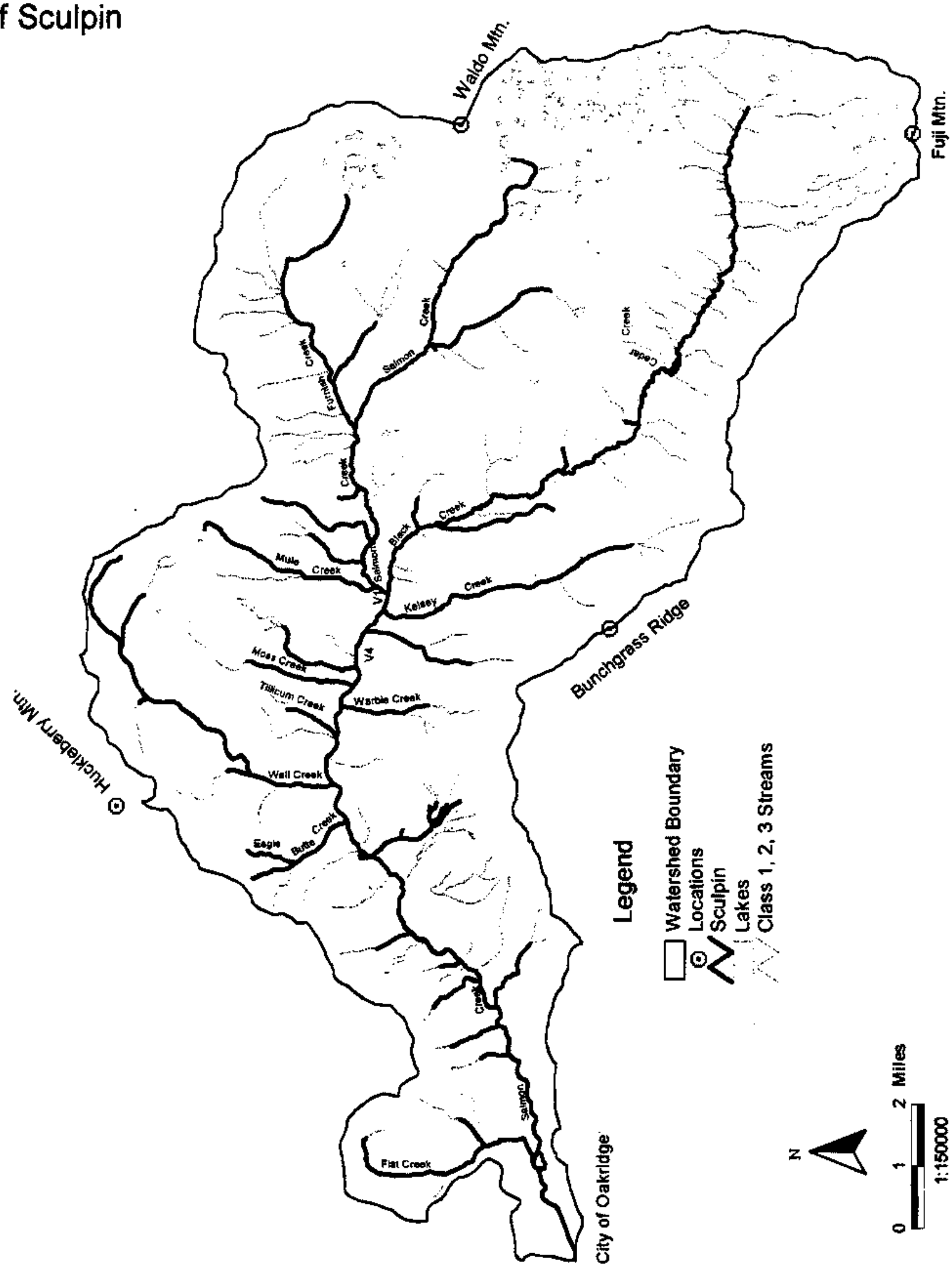
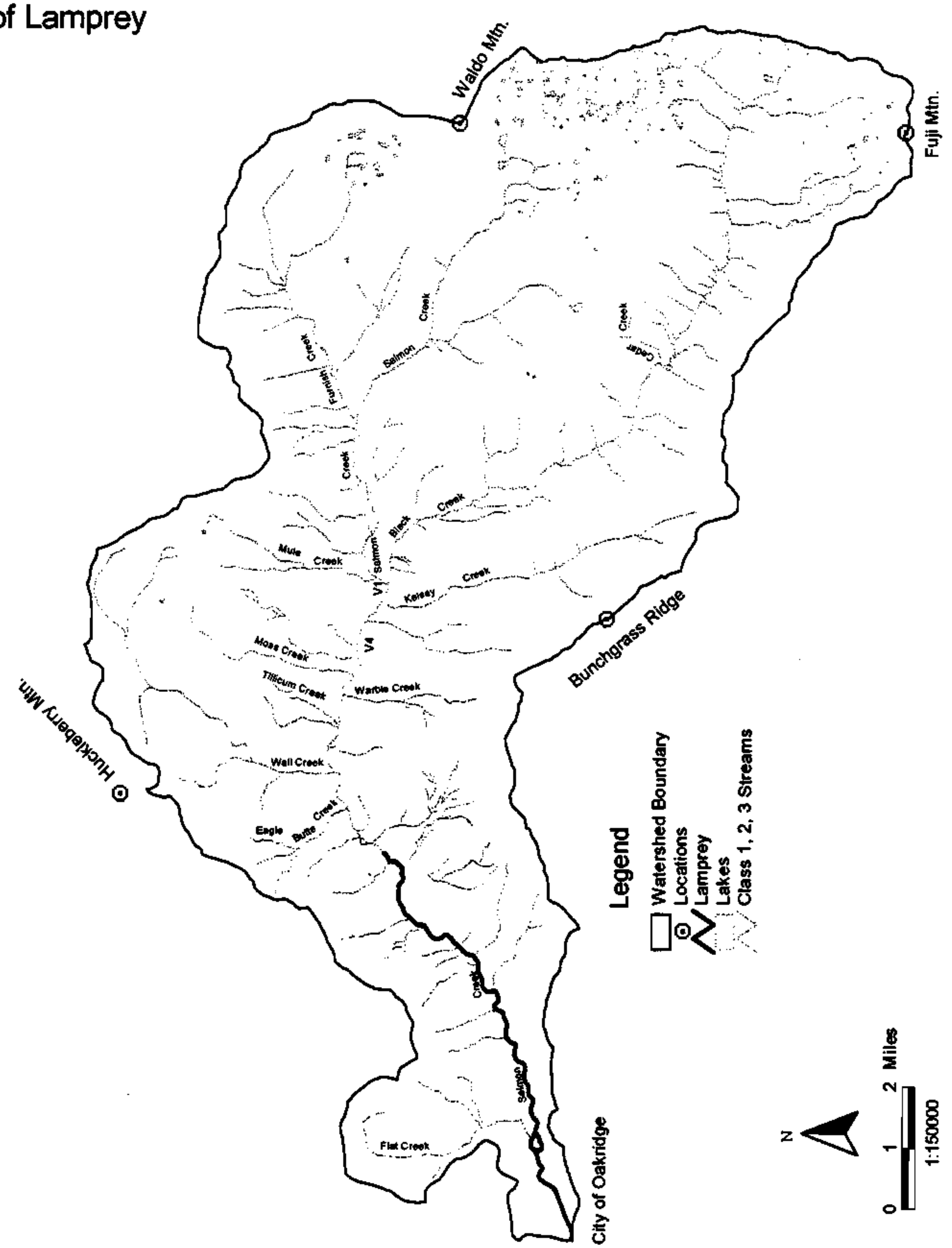


Figure 41:
Current Distribution
of Lamprey



SALMONID LIMITING FACTOR ANALYSIS - PHYSICAL HABITAT REQUIREMENTS

The Limiting Factor Analysis: an Overview

The purpose of a limiting factor analysis is to determine the physical habitat parameters that are thought to be currently limiting to resident salmonid populations. Restoration structure objectives can then be identified for the improvement of habitat conditions.

In general, salmonids require four kinds of habitat throughout their lifetime. These include adult, spawning, rearing and overwintering habitats (Behnke, 1992). All of these habitats are important, and a lack of any one of these may be sufficient to limit the potential size and overall health of the population. Temperature and large wood are also included in this analysis, as temperature may be a limiting factor for salmonids during various life stages. Large wood provides cover and is a major forming factor of many of the habitat types necessary for healthy salmonid populations. Parameters other than habitat, such as food, may also limit populations. However, it is thought that physical habitat is often more limiting than food (Benhke, 1992). It should be noted that limiting factors differ between species and life stages. Limiting factors are also temporal and spatial in nature and if the factor that is currently the most limiting is improved, the next most limiting factor will limit salmonid production (Bjorn and Reiger, 1991).

Adult Habitat (Large Pools)

Large pools that have sufficient cover provide essential resting and feeding areas for adult salmonids. Adult habitat is thought to limit trout populations in most high gradient western streams (Behnke 1992). Large pools are currently lacking in many reaches of the mainstem of Salmon Creek and Black Creek, as well as many of the tributaries in this watershed. Only a few reaches of the mainstem of Salmon Creek meet Willamette National Forest Plan or PACFISH objectives, however, a large portion of streams in this watershed are within 50 percent of these values (Appendix E).

The lack of large woody material throughout many portions of the watershed may, in part, explain the low numbers of pools in this subwatershed. Large wood is an important component of large pool formation, especially in low gradient alluvial reaches where plunge pools are typically formed by water flowing over wood. In addition to large pool formation, large wood provides cover for adult salmonids and captures allochthonous input which is a major food source for aquatic insects, the primary food base for adult salmonids in stream environments.

Spawning Habitat

Suitable spawning areas are also important for maintaining healthy salmonid populations. Spawning success may be poor if areas of silt-free gravel are not available (Behnke, 1992). There are currently gravels and cobbles suitable for the spawning of both resident and anadromous species throughout the watershed (Appendix E). While there are some sites with channel instability that may contribute sediment to the stream system, this is not thought to be limiting at this time. Annual high flow events tend to flush out fine sediment deposits. Large wood is also an important component of maintaining suitable spawning areas as it allows the sorting and storage of spawning gravels, especially in high gradient streams where the current is sufficient to carry gravels downstream.

Rearing Habitat

Rearing habitat is another potentially limiting factor for salmonid populations. Suitable rearing areas typically have a low water velocity and large amounts of cover. Areas such as stream margins, spring seeps, side channels, and small tributaries generally make suitable rearing areas (Benhke, 1992). High gradient areas in the upper reaches may lack suitable rearing habitat due to high water velocities, especially in reaches lacking in large wood. In addition to the formation of areas with low water velocity and large wood also provides the cover necessary for juvenile salmonids. Small tributaries and stream margins would probably serve as suitable rearing areas if enough cover is present in the form of large woody material or overhanging vegetation in tributaries to Salmon Creek and Black Creek, where side channel habitat is limiting. Side channel habitat is available throughout much of the length of the mainstem of Black Creek and Salmon Creek (Figures 25 and 19 on pages 32 and 26 of this chapter).

Figure 42: Spring Chinook Temperature Requirements by Life Stage

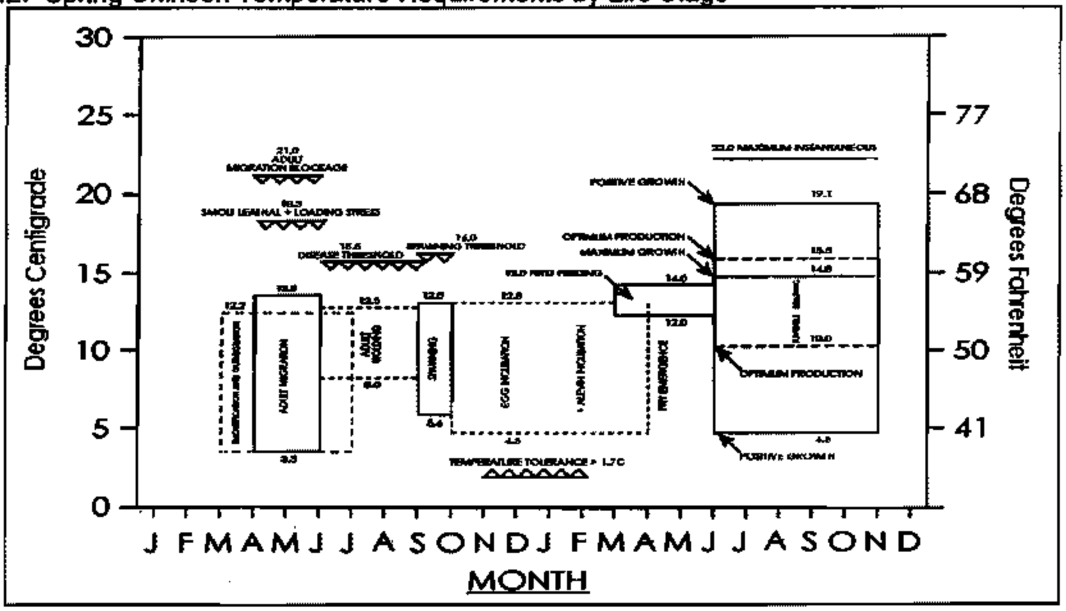
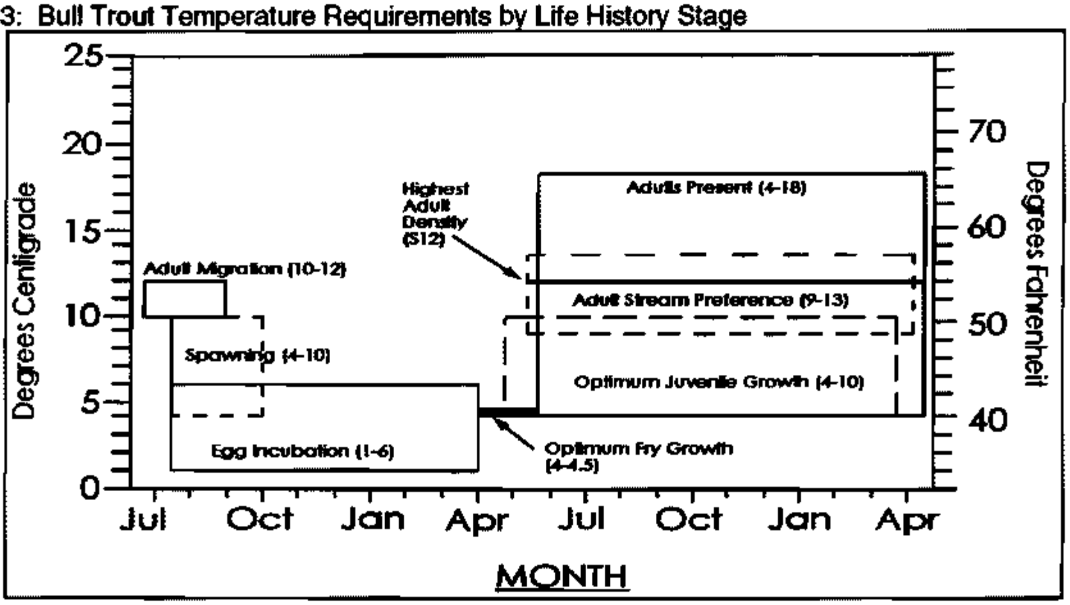


Figure 43: Bull Trout Temperature Requirements by Life History Stage



Overwintering Habitat

Overwintering habitat is also important for salmonids. Overwintering habitat for adult salmonids typically consist of deep water habitat with low velocities and high amounts of cover (Benhke, 1992). In addition to large pools, side channels and tributaries may also be used by overwintering salmonid populations, especially juveniles (Bjorn and Reiger, 1991). In small tributary streams with high winter water velocities, trout may migrate downstream to overwinter in larger deeper areas (Benhke 1992). Many of these small tributaries have impassable culverts, making migration back up in the spring impossible, and thus depleting already isolated populations of resident salmonids. There is currently a lack of large pool habitat, thus limiting the availability of adult overwintering habitat. In addition, the lack of side channel habitat and large wood for cover in many reaches in the Salmon Creek watershed makes overwintering habitat a potentially limiting factor for juvenile salmonids.

Water Temperature

Water temperature can also be a limiting factor for salmonids especially during the critical times of egg incubation, fry emergence, and juvenile rearing. Figures 42 and 43 show the critical temperatures, by life stage, for spring chinook salmon and bull trout. Mainstem Salmon Creek water temperatures measured at the Willamette Fish Hatchery have actually decreased since the high in the late 1970's (Figure 10 of this chapter). The maximum seven day average during the 1970's was 73 degrees Fahrenheit. This temperature would have been too warm to provide for healthy populations of spring chinook salmon, bull trout, and resident salmonids. Since this time, the maximum seven day average has decreased to between 62 and 66 degrees Fahrenheit, which is closer to optimum temperatures for both spring chinook salmon and resident salmonids. Bull trout are known to be able to withstand these temperatures, but they are above the optimum. Stream temperatures in the lower mainstem of Salmon Creek may be limiting for some life stages of bull trout and spring chinook salmon, but if the water temperatures continue to decrease in this area, water temperatures could potentially near optimum levels. It is expected that water temperatures will continue to recover towards pre-management conditions (summarized in Tables 8 and 9 and Figure 10 of this chapter) due to current management practices and the fact that a large portion of the watershed is within a Late-Successional Reserve (USDA, USDI, 1994a).

Temperatures in the upper Salmon Creek and its tributaries above the confluence with Wall Creek (including Wall Creek, Kelsey Creek, Black Creek, Mule Creek, Furnish Creek and the lower reaches of Ranger Creek) currently have water temperatures that are close to optimum for bull trout, spring chinook salmon and resident salmonids (Table 11 and Figures 12, 42, and 43 of this chapter).

Large Wood

Large wood is an important component of large pool formation, which is important for adult habitat and overwintering habitat. In addition large wood provides cover for both adult and juvenile salmonids during both summer and winter. Large wood is also important for the maintenance of suitable spawning areas. Large wood is currently below objective levels in many reaches in this watershed.

AMPHIBIAN DISTRIBUTION

REFERENCE CONDITION

Very little information exists on the historic species composition of amphibians in this watershed.

CURRENT CONDITION

Table 50 shows the habitat requirements for various amphibian species located in Oregon. Species observed in the Salmon Creek watershed are highlighted in this table. Figure 44 shows where these species of amphibians were observed in the Salmon Creek watershed. Amphibians would be expected to be present in other, unsurveyed areas as well, where habitat requirements are met. Species such as the roughskin newt and Pacific giant salamanders were observed throughout the watershed while other species were less common (Table 51).

Table 50: Herpetile Habitat

Species	Life History Stage	Habitat	Elevation Range (ft)	Prey	Predators
Tailed Frog (Ascaphus truei)	Adult & Larvae	In fast flowing permanent stream; adults in/near cold, clear streams, Headwaters	0-6562	Adults: snails, ticks, spiders, mites, insects. Larvae: diatoms, conifer pollen, algae, small insects	Pacific Giant Salamander
Western Toad (Bufo boreas)	Adult & Larvae	Large lakes, small ponds, shallow marshes; adults, forested areas possibly away from water	0-11812+	Flying insects, crayfish, sowbugs, earthworms	Birds, garter snakes, aquatic insects
Pacific Chorus Frog (Pseudacris Regilla)	Adult & Larvae	Variety: coastal sloughs, old-growth, deserts; adults quite terrestrial	0-9843+	Beetles, flies, ants, spiders, isopods, various insects	Garter snakes, bullfrogs, birds, mammals. Larvae: aquatic insects, salamanders
Red-Legged Frog (Rana aurora)	Adult & Larvae	Permanent bodies of quiet water, ponds, pools, reservoirs, springs, lakes, marshes; adults hang out on land near water's edge	<2789	Many insect species, arachnids, mollusks	Snakes, raccoons, herons, NW Salamander, bullfrogs, Roughskin Newts, cutthroat trout, owls, hawks, ducks, skunks, minks, cats. Larvae: giant water bugs, Dytiscid beetles, Odonate nymphs
Foothills Yellow-Legged Frog (Rana boylii)	Adult & Larvae	Near streams & rivers w/rocky or gravely substrate	<5906	Insects, snails	Garter snakes, fish, birds, mammals. Eggs: Rough-skin Newts

Table 50 (continued): Herpetile Habitat

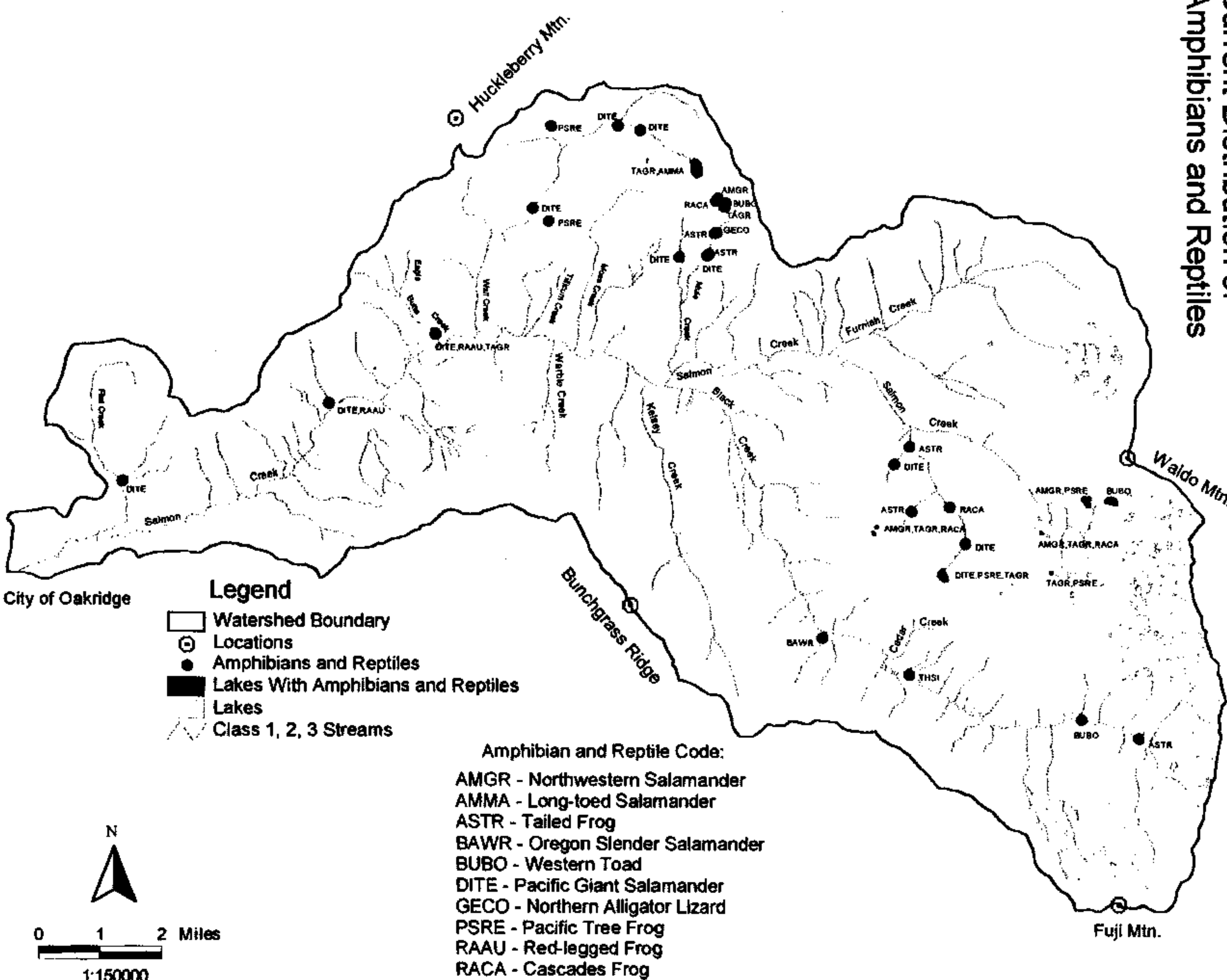
Species	Life History Stage	Habitat	Elevation Range (ft)	Prey	Predators
Cascades Frog (Rana cascadae)	Adult & Larvae	Montane meadows, marshes, ponds, relatively small water bodies, along creeks, lakeshore alcoves	>2625	–	Aquatic insects & salamanders, fish, snakes, birds
Western Spotted Frog (Rana pretiosa)	Adult & Larvae	Marshes, near edges of ponds and lakes, colder waters	?-9843	Insect species, arachnids, mollusks	Garter snakes
Western Aquatic Garter Snake (Thamnophis couchii)	Adults & Neonates	Permanent streams w/rocky substrate, stream margins	0-8006	Fish, amphibians	Otters, herons, hawks, osprey, Steller's jay
Western Pond Turtle (Clemmys mammorata)	Adults & Juveniles	Marshes, sloughs, lakes, ponds, slow portions of creeks/rivers.	0-6004	Various aquatic inverts/verts., algae, cattail/tule roots	Adults/Eggs: Otters, raccoons, coyotes, foxes. Juveniles: Bullfrogs, bass
Northwestern Salamander (Ambystoma gracile)	Terrestrial (Adult) Aquatic (Adult/Larvae)	Coniferous forests, inland valleys, subalpine areas Ponds, lakes, slow parts of semi-permanent streams	<10171	Larvae: aquatic inverts	Trout, aquatic beetle larvae
Roughskin Newt (Taricha Granulosa)	Terrestrial (Adult) Aquatic (Adult/Larvae)	Farmland, grassland, uplands, forests Ephemeral/permanent ponds/lakes/streams w/slow areas with veg.	0-9187	Small inverts. & verts, amphib eggs & larvae Zooplankton, aquatic insects	Few predators due to skin toxicity, some predation by trout
Pacific Giant Salamander (Dicamptodon tenebrosus)	Terrestrial (Adult) Aquatic (Adult/Larvae)	Moist conifer forest; in/near streams, talus roadcuts High gradient streams w/coarse substrate	0-7087	Terrestrial invertebrates & vertebrates. Aquatic inverts & vertebrates	Fish, weasels, shrews, other Pacific Giant Salamanders, Western Aquatic Garter snakes
Clouded Salamander (Aneides ferreus)	Terrestrial (Adult/Larvae)	Rock faces (talus), 2 different age classes of large downed logs, often Douglas fir	0-5578	Anthopods, ants	–
Oregon Slender Salamander (Batrachoseps wrightii)	Terrestrial (Adult/Larvae)	Mature fir forests, rotting logs/stumps, wood fragments, substrate temp 51-57° Fahrenheit	49-4397	–	–
Ensatina (Ensatina eschscholtzii)	Terrestrial (Adult/Larvae)	Conifer/deciduous forests of diff. ages, under surface debris, decaying logs, small mammal burrows	–	Invertebrates	Garter snakes, Steller's jay
Dunn's Salamander (Plethodon dunni)	Terrestrial (Adult/Larvae)	Semi-aquatic, associated w/rocks, moss covered rubble and seeps. Under rocks/logs, moist talus	0-3281 absent in most Willamette Valley	–	–
Western Red-Backed Sal. (Plethodon vehiculum)	Terrestrial (Adult/Larvae)	Coniferous forests, soft shale/sandstone outcrops, decaying logs, bark piles. Damp soils rather than wet situations	–	–	–
Long-Toed Salamander (Ambystoma macrodactylum)	Terrestrial (Adult) Aquatic (Adult/Larvae)	Lowland forest, disturbed pastures, high elevation lakes/ponds. Lakes/ponds, temporary water sources	0-8120	Larvae: variety of invertebrates, copepods, fairy shrimp, young Chorus Frog tadpoles, smaller NW Sal. larvae	Introduced fish species

*Adapted from Blaustein et al., 1995; except for Long-Toed Salamander which is from Leonard et al., 1993.
NOTE: Shading indicates species known to occur in the Salmon Creek watershed

Table 52 of this chapter shows the amphibian species located in the Oregon Cascades as well as the level of concern for each of the species by various agencies. Species of concern observed in the Salmon Creek watershed include the **tailed frog**, considered a protected, sensitive/vulnerable species by ODFW, a species of concern by the Oregon Natural Heritage (ONH) Database, and a BLM

Figure 44: Current Distribution of Amphibians and Reptiles

Salmon Creek Watershed Analysis



Amphibian and Reptile Code:

AMGR - Northwestern Salamander
AMMA - Long-toed Salamander
ASTR - Tailed Frog
BAWR - Oregon Slender Salamander
BUBO - Western Toad
DITE - Pacific Giant Salamander
GECO - Northern Alligator Lizard
PSRE - Pacific Tree Frog
RAAU - Red-legged Frog
RACA - Cascades Frog
TAGR - Rough-skinned Newt
THSI - Common Garter Snake

assessment species; the **red-legged frog**, considered a sensitive species of undetermined status by ODFW, a species of concern by ONH, and a BLM tracking species; and the **cascades frog**, considered a protected, sensitive/vulnerable species by ODFW and an assessment species by BLM; the **Oregon slender salamander**, considered a sensitive species of undetermined status by ODFW and considered to be threatened throughout its range by ONH; and the **western toad**, which is classified as a sensitive/vulnerable species by ODFW.

Table 51: Amphibian and Reptile Distribution in the Salmon Creek Watershed

Species	Location	Elev. (ft)	Stream Class	Valley Segment Type	Rosgen Type
Western Toad (BUBO)	Black Creek	3500	2	Moderate Gradient Valley Wall	A
Oregon Slender Salamander (BAWR)	Black Creek Tributary	2900	3	High Gradient Valley Wall	A
Pacific Giant Salamander (DITE)	Eagle Butte Creek	1800	2	High Gradient Valley Wall	A
Red-Legged Frog (RAAU)	Eagle Butte Creek	1800	2	High Gradient Valley Wall	A
Rough Skinned Newt (TAGR)	Eagle Butte Creek	1800	2	High Gradient Valley Wall	A
Pacific Giant Salamander (DITE)	Flat Creek Tributary	1800	2	High Gradient Valley Wall	A
N. Alligator Lizard (GECO)	Mule Creek	4400	2	High Gradient Valley Wall	A
Pacific Giant Salamander (DITE)	Mule Creek	3800	2	High Gradient Valley Wall	A
Tailed Frog (ASTR)	Mule Creek	3800	2	High Gradient Valley Wall	A
Tailed Frog (ASTR)	Mule Creek	4000	2	High Gradient Valley Wall	A
Pacific Giant Salamander (DITE)	Mule Creek Tributary	3600	3	High Gradient Valley Wall	A
Cascades Frog (RACA)	Ranger Creek	4000	2	Bedrock Canyon	A
Pacific Giant Salamander (DITE)	Ranger Creek	4800	2	Bedrock Canyon	A
Pacific Giant Salamander (DITE)	Shitepoke Creek	2000	2	High Gradient Valley Wall	A
Red-Legged Frog (RAAU)	Shitepoke Creek	2000	2	High Gradient Valley Wall	A
Pacific Giant Salamander (DITE)	Wall Creek	2600	2	V-Shaped, High Gradient	A
Pacific Tree Frog (PSRE)	Wall Creek Tributary	3200	4	High Gradient Valley Wall	A
Pacific Tree Frog (PSRE)	Wall Creek Tributary	5200	4	High Gradient Valley Wall	A
Tailed Frog (ASTR)	Black Creek	3600	3	Very high Gradient Valley Wall	Aa+
Pacific Giant Salamander (DITE)	Ranger Creek	5000	2	High Gradient Valley Wall	Aa+
Pacific Giant Salamander (DITE)	Ranger Creek Tributary	4000	3	High Gradient Valley Wall	Aa+
Tailed Frog (ASTR)	Ranger Creek Tributary	4300	3	High Gradient Valley Wall	Aa+
Common Garter Snake (THSI)	Black Creek	3100	2	Incised U-Shaped, Moderate Grad.	F
Pacific Giant Salamander (DITE)	Wall Creek	5200	2	Alluviated Moderate Slope bound	G
Pacific Giant Salamander (DITE)	Wall Creek	5200	2	Alluviated Moderate Slope bound	G
Rough Skinned Newt (TAGR)	Blair Lake	4750	Lake		
Long Toed salamander (AMMA)	Blair Lake	4750	Lake		
Rough Skinned Newt (TAGR)	Fat Hippo Lake	5200	Lake		
Western Toad (BUBO)	Fat Hippo Lake	5200	Lake		
Northwestern Salamander (AMGR)	Lower Salmon Lake	4700	Lake		
Pacific Tree Frog (PSRE)	Lower Salmon Lake	4700	Lake		
Tailed Frog (ASTR)	Ranger Creek	3600	Lake		
Pacific Tree Frog (PSRE)	Spirit Lake	5800	Lake		
Rough Skinned Newt (TAGR)	Spirit Lake	5800	Lake		
Cascades Frog (RACA)	Unnamed Pond	5200	Lake		
Cascades Frog (RACA)	Unnamed Pond	5300	Lake		
Northwestern Salamander (AMGR)	Unnamed Pond	5200	Lake		
Northwestern Salamander (AMGR)	Unnamed Pond	5300	Lake		
Rough Skinned Newt (TAGR)	Unnamed Pond	5200	Lake		
Rough Skinned Newt (TAGR)	Unnamed Pond	5300	Lake		
Western Toad (BUBO)	Upper Salmon Lake	4800	Lake		

Table 52: Amphibian Distribution and Sensitivity in the Westslope Cascades Province

Species	Occurrence In Province	ODFW Status	ONH Status	BLM Status	USFS Status	USFWS Status
Northwestern Salamander	throughout					
Long-Toed Salamander	throughout					
Roughskin Newt	throughout					
Cope's Giant Salamander	few localities	Pr-S/u	2	AS	S	
Pacific Giant Salamander	throughout					
Cascade Torrent Salamander	few localities	Pr-S/v	4	TS		
Clouded Salamander	throughout	S/u	3			
Oregon Slender Salamander	few localities	S/u	1			
Ensatina	throughout					
Dunn's Salamander	throughout					
Larch Mountain Salamander	few localities	S/v	3	ROD	ROD	C2
W. Red-Backed Salamander	few localities					
Western Toad	few localities	S/v				
Pacific Chorus Frog	throughout					
Tailed Frog	throughout	Pr-S/v	4	AS		
Red-Legged Frog	throughout	S/u	4	TS	S	C2
Cascades Frog	throughout	Pr-S/v	3	AS		
Spotted Frog	few localities	Pr-S/c	2	BS		C1
Foothill Yellow- Legged Frog	few localities	Pr-S/v	4	TS		C2
Bullfrog	few localities					

(from Corkran and Thoms, 1995)

Key to the Different Status Codes:

ODFW (Oregon Department of Fish and Wildlife)
- Pr = Protected
- c= Critical
- S = Sensitive
- v= Vulnerable
- p = Peripheral, naturally rare
- u= undetermined status

OHN (Oregon Natural Heritage Database)
- 1 = Threatened throughout range
- 3 = Review
- 2 = Threatened in Oregon only

BLM (Bureau of Land Management) and USFS R6
- TS = Tracking Species
- AS = Assessment Species
- S = USFS Sensitive Species
- BS = BLM Sensitive Species

USFWS (U.S. Fish & Wildlife Service)
- C1 = Candidate, sufficient information
- C2 = Candidate, insufficient information

ROD = Record of Decision for Amendments to USFS and BLM Planning Documents within Range of the Northern Spotted Owl, April 1994; survey & manage species

AQUATIC MACROINVERTEBRATES

REFERENCE CONDITION

Very little information exists about historic macroinvertebrate populations.

CURRENT CONDITION

Macroinvertebrate sampling in the Salmon Creek watershed was completed in lakes (Blair Lake, Upper Salmon Lake, Lower Salmon Lake, Fig Lake, Photo Lake, Spirit Lake, and Zircon Lake) as well as in the mainstem of Salmon Creek and its tributaries. No sensitive species were located during these surveys. Information gathered on macroinvertebrates will be useful as baseline surveys, but few conclusions can be drawn at this time.

SOCIAL

RECREATION

REFERENCE CONDITION

The aboriginal inhabitants of the Salmon Creek watershed are believed to have had their winter dwellings in the Oakridge area, perhaps in the lower portions of the watershed. The upper watershed was used on a seasonal basis for hunting, plant gathering, and other social activities. Euro-American subsistence activity, mainly hunting and fishing, took place on a limited basis from the 1840's to the 1920's. Certain species, such as beaver, cougar, fisher and wolverine, were hunted by commercial or bounty hunters, and in the case of grizzly bear and wolf, were extirpated from the area.

Modern recreational use began in the area in the 1920's, after completion of the Southern Pacific railroad and improved access for automobiles. The trail system was little used, however, except for administrative purposes, until after facilities were improved by the Civilian Conservation Corps in the 1930's. Recreational use of the Salmon Creek watershed was relatively insignificant until after World War II and when the development of the Pope and Talbot mill in Oakridge gave rise to a growing population seeking leisure opportunities.

CURRENT CONDITION

Scenic Values

Within the river corridor, visual quality objectives have resulted in fairly natural appearing views from Forest road 24. Outside of this zone, the visitor may expect to see the landscape as a mosaic of stand ages, modified by intensive timber management practices. Since 47 percent of the watershed is in a Late-Successional Reserve, this situation will change over time as the previously harvested areas develop into late-successional forests.

Currently, the most popular areas of scenic interest in the watershed are the gorge and falls through the area of the Salmon Creek Falls campground, and the trails leading to Waldo Mountain and the high lakes of the Waldo Wilderness. An environmental analysis has been prepared as part of the planning process for developing a loop trail through the Wall Creek (Warm Springs) Old-growth Grove.

Developed and Dispersed Camping

User days at the developed campgrounds (Salmon Creek Falls and Blair Lake) in the watershed have been steadily increasing over the years with annual fluctuations due mainly to weather conditions. Blair Lake (8 sites) is very popular with local people, especially during huckleberry picking season, and is full during summer weekends. Salmon Creek Falls (14 sites) receives more day use than camping and is generally only half full on weekends, except for holiday weekends when all district campgrounds are usually full. Water quality tested from wells at these sites shows no impacts from recreational use.

Of 178 inventoried dispersed recreation sites in the watershed, 36 are in the Waldo Wilderness, 61 are in the Late-Successional Reserve, 38 are in riparian reserves, 19 are in general forest, and the rest are in scenic allocations, old-growth groves, or smaller management categories. The majority are used for camping, hunting and fishing, especially during elk and deer hunting season.

The trail system

The most heavily used trail system in the watershed is the Warrior/Salmon Creek trail system, which is currently in the process of being expanded in cooperation with the City of Oakridge and State of Oregon. From the Salmon Creek trail, hikers and mountain bikers can follow the Warrior trail, then go through the former Pope and Talbot mill area to Greenwaters Park where a bridge is being constructed across the Middle Fork to access the Larison Rock trail and a future loop trail.

Currently, the only trail available for motorized use is the Flat Creek trail, which is easily accessible from Oakridge. It may be possible in the future to tie this trail in with the Salmon Creek trail system.

The Eugene to Crest trail is nearly complete along the southern boundary of the watershed and is popular with hikers, mountain bikers, and horseback riders. As this trail is extended all the way to the Pacific Crest trail, it is likely to attract more use by outfitter guides, as well as a burgeoning recreation public. Perhaps the least used trails, except for during elk hunting season, are the Blair Lake and Black Creek trail systems, especially into the Deer Camp area.

The trails into Spirit Lake, and the trails into the Swan, Gander, and the Salmon Lakes in the Waldo Wilderness are very popular with hikers and fishers. Special use permits are currently restricted in the Waldo Wilderness and will remain so until a needs assessment is completed. Dispersed campsites around wilderness lakes have improved significantly in the last 10-15 years when water set-back regulations came into effect and allowed riparian and lakeside areas to heal.

Swimming and Boating

Lower Salmon Creek has few swimming holes. More use is made of the lakes in the watershed for swimming. Though currently very light, kayak and small raft use of lower Salmon Creek is expected to increase.

Hunting and Fishing

The Salmon Creek watershed is more popular for deer and elk hunting than upland bird hunting. The highest concentrated use is during the elk season. Black Creek is used to access the Eagle Creek Quality Elk Hunt area, which draws hunters from outside the area who like to pack in and avoid competition with road hunters. The area is popular with the local population for fishing, especially rainbow trout, which are stocked by the hatchery.

AIR QUALITY

The Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl, Volume I, states in chapters 3 & 4 on pages 96-98 that for the selected Alternative 9, PM10 emissions and Total Suspended Particulates (TSP) emissions have dropped and currently exceed the goal of 50 percent reduction of these emissions by the year 2000 for the State of Oregon. This reduction will allow for fire use and will not compromise achievement of prescribed burning emissions reduction goals.

The production of smoke from wildfires is considered natural and exceptional by air resource managers, so does not influence the regulations of prescribed fire emissions. In the publication "A First Approximation of Ecosystem Health on National Forest System Lands", (Pacific Northwest Region, June 1993), an assessment was completed that compared smoke emissions and acres burned annually from presettlement times to current smoke emissions due to wildfire and prescribed fire. For Western Oregon, estimates of historic particulate emissions associated with forest fire were more than double current estimates of PM10 emissions from fuels reduction activities and wildfires.

INTERPRETATION

CHAPTER IV

INTERPRETATION

This chapter is a synthesis and interpretation of the information presented in previous sections. It specifically resolves or interprets the importance of differences or similarities between current conditions and reference conditions, and gives some indication of current use and resource trends. This interpretation is presented by Issue and Key Questions, as presented in Section III of this analysis and constitutes the answers to the Key Questions.

<u>ISSUE #1</u>

INTENSITY AND PATTERN OF VEGETATION MANIPULATION RELATED ACTIVITIES
Timber harvesting has essentially replaced wildfire as a regenerative force in this watershed. The gross amounts of early, mid, and late-successional habitat have not changed appreciably as the result of this replacement but the configuration and distribution of these types of habitat have changed dramatically. Abundant late-successional habitat exists in the high elevation, eastern portion of the watershed where historically fires burned relatively frequently. In the lower elevation western portions, where stand replacement events were relatively few, far between, and small, harvesting has greatly reduced late-successional habitat and to a large extent fragmented that which remains.

Projecting current management into the future results in a continuation of habitat fragmentation in the relatively small area available for harvesting, primarily because restored riparian reserves will provide for abundant edge habitat. In the bulk of the watershed (the LSR and other non-harvest allocations) unfragmented late-successional habitat will slowly increase as young stands created by past harvest mature. Habitat connectivity will improve as harvested riparian stands mature.

The intensity of past harvest has likely increased the frequency of peak flow events and contributed to elevated sediment levels in streams during high water, though road related sources probably contribute more sediment per area based on the proportion of the land that roads occupy.

Issue #1 Key Questions
QUESTION 1:

> Given current land allocations in the Willamette Forest Plan, as amended by the Northwest Forest Plan, what is the location and acreage of areas that are available for regeneration harvest for the next two decades and for commercial thinning, by decade, for the next 50 years?

Regeneration harvest opportunities are primarily limited to Blair Lake Basin and Cupit Mary Flats over the next few decades, due to recently planned harvest projects and resource conditions. Approximate acres available for regeneration harvest in the next two decades are as follows: 6400 acres in subwatershed 18 1, and 2850 acres in subwatershed 18 2. Subwatershed 18 3 is almost entirely within the Late-Successional Reserve and the Waldo Wilderness Area.

Approximate areas available for commercial thinning, by decade, for the next 50 years, are as follows:

In Late-Successional Reserve:
1995-2005: 1030 acres on lower Mule Mountain and lower portions of Kelsey and Warble Creeks
2005-2015: 3600 acres across the entire LSR
2015-2025: 2900 acres across the entire LSR
2025-2035: 3700 acres across the entire LSR
2035-2045: 360 acres widely scattered in Ranger, Furnish, and Black Creek drainages

In Matrix:
1995-2015: 1100 acres on the south slopes of Dead Mountain and Huckleberry Mountain and the north slopes of Squaw Butte.
2015-2045: 4550 acres widely scattered in subwatershed 18 1, 470 acres in subwatershed 18 2.

QUESTION 2:

How has the intensity and pattern of vegetation manipulation affected native and non-native plant and animal habitat diversity, species composition, guild viability, amount of interior habitat, and habitat connectivity?

TERRESTRIAL WILDLIFE

INTERIOR FOREST VS. EDGE HABITAT - EFFECT ON HABITAT DIVERSITY AND FAUNAL SPECIES COMPOSITION

As timber harvest strategies were applied in the watershed, the overall abundance of late seral and old-growth habitat decreased and the size of retained habitat blocks was reduced as forest fragmentation progressed. Just as edge habitat increases with moderate levels of fragmentation, interior habitat decreases. As previously described (Chapter III), this has likely resulted in a shift in the biotic community as less, high quality interior late seral forest habitat and a more fragmented forest with early to mid seral habitat became available. These landscape trends result in a decrease in large home range mosaic species and an increase in small home range guilds and contrast species of all home range sizes. Generalist species of all home range sizes likely gained occupancy to areas as they became less suitable for species that select for large blocks of interior habitat. These effects have reduced the capability of the late-successional reserve within this watershed to meet management objectives for the LSR. Currently 10% of the spotted owl activity centers in the LSR (and also 10% of all activity centers in the watershed) have home range conditions below 40% suitable habitat. Under the Willamette Forest Plan as amended by the ROD, late seral habitat conditions in the LSR should improve over time.

As described in the Current Condition section of this document, forest fragmentation has played a significant role in development of edge habitat within the watershed. A comparison of seral stage maps (Figures 28 and 29 on pages 48 and 49 of the Reference/Current Condition chapter) reveals the distribution and amount of edge habitat has disproportionately increased in the western two-thirds of the analysis area, and the average patch size is small relative to reference conditions. This trend may have resulted in a shift in the biological community, with a decrease in medium and large home range patch (e.g. rosy finch) and mosaic species (e.g. spotted owl and fisher), and an increase in small home range guilds and contrast species (e.g. mountain blue birds, California quail, and elk) of all home range sizes. This condition has resulted in higher populations of elk and deer than existed prior to timber harvest activity.

On the eastern one-third of the watershed, forest fragmentation has been less prevalent and relatively more late seral and old-growth habitat is present than in the reference example (compare Figures 28 and 29 on pages 48 and 49 of the Reference/Current Condition chapter). This has occurred as fire regenerated stands matured in the absence of intensive timber harvest or repeated large scale and frequent fires. Though it is difficult to speculate on how intensive and extensive fires might have been had they not been suppressed, it is possible that fire suppression may have contributed to the development of more late seral habitat in these areas than what existed 75 years ago. The result of having large tracts of timber maturing into late seral and old-growth forests is a shift in the biotic community from early and early-to mid-seral habitat users to mid-to-late seral and old-growth habitat users. This effect has increased the capability of portions of this watershed in LSR0220 to contribute to meeting long-term management objectives for LSRs. However, much of this area (and other portions of subwatersheds 18 2 and 18 3) that has matured into late seral and old-growth habitat is not within the Douglas fir/western hemlock plant associations most suited to spotted owls, but is within the true fir/mountain hemlock plant associations best suited to a host of other species.

The trend in edge habitat increasing with forest fragmentation is expected to plateau and then decline as late seral and old-growth forests continue to be removed in General Forest (matrix) under an 80 year rotation or in Scenic Partial Retention under a 100 year rotation where stands will not have the opportunity to return to late seral conditions. This scenario of edge habitat limitations is also expected to occur in the LSR as early and mid-seral stands mature since regeneration harvest (establishment of early seral habitat) no longer occurs in this area. Exceptions to this trend may be for small home range species which have relatively small minimum patch sizes and may be provided suitable habitat by prescriptions for timber harvest in matrix, and for areas of the watershed where high densities of riparian reserves will provide the late seral component of edge habitat along harvested stands in matrix. Though edge habitat may generally decrease across the landscape over time, edges would be concentrated along riparian reserves, along supplemental and larger LSRs, and occasionally along stand replacing disturbance patches within the larger LSRs.

As described above, habitat for edge dependent species has historically been on the increase within most of the watershed. The vegetational elk habitat effectiveness has increased over time for much of the watershed in response to arrangement of timber harvest units which strategically placed forage blocks in proximity to cover blocks. The exception to this is in areas that have been treated with large blocks of intensive harvest with little interspersed cover (such as Dead Mountain) or in areas where harvest has not occurred and successional development has affected historic forage/cover ratios.

Large home range generalist species such as the gray wolf and a sub-species of grizzly bear known as the Klamath grizzly were inhabitants of this watershed during the reference era. Although large home range generalist habitat is currently abundant, these historical inhabitants are absent from the present landscape. The Klamath grizzly was extirpated from the Cascades in the 1930's and is considered extinct. The gray wolf was declared extirpated from this portion of its historic range in the mid 1940's, however occasional reports of the presence of wolf-like canids in this watershed persist into the 1990's.

Two additional threatened or endangered generalist or special habitat species guild representatives of note that presently occupy habitat within this watershed are the bald eagle and peregrine falcon. Portions of three peregrine falcon nest site management areas (PFMA) exist within the watershed. The actual nest site for one of these areas (OE-36) is located in the watershed, with 84% of the PFMA within the watershed boundary. The other two nest sites, OE-30 and OE-22, are outside the watershed with 41% and 8% of the PFMA's located within this watershed boundary respectively. Fire history has variably affected the landscape within, and past harvest activity has influenced the condition of the PFMA's. Present land use allocation differs greatly between PFMA's with OE-36 situated entirely within LSR0220, and OE-30 and OE-22 falling under mostly matrix, scenic, or riparian reserve allocations.

Resource concerns with respect to these areas focus on the potential for noise disturbance to peregrines from management activities during the nesting season (January 1 through July 31), and that management proposals within PFMA's recognize and address the needs of peregrine falcon prey species. Management plans should be completed for PFMA's and used to guide activities proposed within these areas.

Most (67%) of a bald eagle management area (BEMA) is also located in this watershed. This represents 140 acres, all of which are under wilderness allocation. Management concerns with respect to this area focus on the potential for disturbance to eagles from recreation activities, and the potential for wildfire to impact bald eagle nesting habitat.

HABITAT STRUCTURE

Approximately 8,900 acres (11% of the watershed) were intensively harvested prior to 1970. On these areas snag levels may be variable, but are generally well below the average natural range. Down woody debris may be abundant, but in some areas (Dead Mountain burn for example) much of the larger pieces are likely to be in advanced stages of decomposition. In these areas large woody debris levels are also likely well below the natural range between the time existing logs decompose and existing regeneration stands begin contributing large woody debris to the forest floor. As a result, species that utilize snags and down logs as habitat may become less locally abundant until new snags and down wood become available for use. In other areas, very large logs were left during initial harvest operations, and given comparable environmental conditions, these logs will continue to provide suitable habitat for many species that utilize log habitat over a much longer period of time than would smaller logs of the same tree species.

Approximately 14,100 acres (17% of the watershed) were intensively harvested during the 1970's and 1980's. These areas generally have low levels of both snag and large woody debris as a result of higher utilization standards and unmerchantable log-yarding requirements that were employed during that period. These areas are below natural levels for these habitat components and will continue to be below natural levels until new snags and down wood become available for use. Thirteen percent of the 53% of the watershed affected by stand replacement fire in the past two centuries contained residual trees. Where these residual trees still exist, they will serve an important role as a future source of large snags and down wood in younger stands.

Though approximately 1,300 acres (1.6% of the watershed) have been harvested between 1990 and present, many of these acres included prescriptions that were in place prior to 1990 and the adoption of the current Forest Plan as amended by the ROD. As a result, these areas may also be below natural levels of snag and large woody habitat. For sales implemented under recent prescriptions the trend is for wildlife trees to be generally smaller than what was left prior to 1990 though numbers of snags retained is generally higher. Smaller snags and logs will not persist as long and will not accommodate cavities as large as, or retain temperature and humidity as well as those with larger diameters. Thus the trend toward leaving smaller wildlife trees has resulted in habitat that will not provide for all cavity dwelling species (e.g. pileated woodpeckers and colony nesters). This habitat may not be as effective in providing shelter to temperature and humidity sensitive species (e.g. Oregon slender salamanders and ensatina salamanders), and will not provide habitat as long due to more rapid decomposition. Species that utilize snag and down wood habitat during reproduction are listed in Appendix A.

CONNECTIVITY / DISPERSAL

As Figure 13 in the Reference/Current Conditions chapter shows, many potential connective corridors associated with riparian reserves have been exposed to habitat altering activities. This decreases their ability to provide suitable linkages between various portions of the landscape for some species of plants and animals. Previously harvested areas within riparian reserves may not moderate solar radiation, temperature, and humidity as much as mature stands or may not provide enough cover to allow successful movement through these areas or across the landscape by some species. Stand connectivity provides for genetic exchange in species that do not migrate. Without adequate connectivity of suitable habitat across the landscape populations may become isolated. Isolated populations may ultimately be detrimentally affected by genetic drift.

Areas within this watershed where connectivity habitat has been most affected by harvest activity include portions of subwatershed 18 3 along stretches of Fumish and Mule Creeks, and portions of 18 1 along Trapper Creek, Wall Creek, and in numerous riparian areas on Squaw Butte and Dead Mountain. Table 48 in the Reference/Current Conditions chapter shows that overall 33% of the riparian reserve acres in LSR0220 have been harvested and 23% of the remaining riparian reserves in general forest have been harvested. Forty-three percent of the wilderness acres within this watershed are intact lake or stream riparian reserves.

Upland portions of the watershed also provide important connective habitat, especially when located along ridges, in saddles, or on topographic benches. Table 48 in the Reference/Current Conditions chapter shows that 30% of the upland acres in LSR0220 have been harvested and from Table 49, also in the Reference/Current Conditions chapter, it can be seen that 42% of the acres available for harvest are presently 0 to 80 year old stands. Fifty-seven percent of the wilderness acres within this watershed provide higher elevation upland connectivity of mostly true fir/mountain hemlock plant association habitat.

The westward extension of this higher elevation true fir/mountain hemlock habitat along Mule Mountain and Bunchgrass Ridge has experienced some shifts in seral stage composition from reference conditions. Some areas of Mule Mountain have matured into late seral stands while at about the same rate, early seral stands have been created as a result of harvest activity. Much of the later seral stage acres along Bunchgrass Ridge have shifted into early seral conditions due to harvest activity and effects of the Warner Creek fire.

Within the LSR, both riparian and upland habitat connectivity should recover and improve in the long term under present management direction. Connectivity habitat in General Forest portions of the watershed should recover and improve within riparian reserves and upland areas that have been included in supplemental LSRs.

Table 1 displays the condition of the USFWS designated CHU (OR-19) within this watershed that is located outside LSR0220 and currently under harvest allocation. Seventy-four percent of these total acres are presently stands greater than 80 years old and serve as no less than dispersal habitat for northern spotted owls.

Table 1: Current Condition of CHU (OR-19) Acres Under Harvest Allocation

Subwatershed	Total Acres	SRI Unsuited	Seral Stage SI	SE	UR	LS/OG
18 1	2,114	199	543	210	829	332
18 2	3,537	323	438	157	1,833	785
18 3	103	19	19	0	5	59
Total	5,754	541	1000	367	2,667	1,176

Legend: SRI Unsuited = acres on soils unsuited for harvest activity
SI = acres in stand initiation (0-30 year old stands)
SE = acres in stem exclusion (31-80 year old stand)
UR = acres in understory reinitiation (81-200 year old stand)
LS/OG = acres in late-successional/old-growth (200+ year old stand)

On the landscape level, potential linkages between LSRs 0220, 0219, 0221, and 0222 are now, and should continue to be, best provided through riparian connectivity. Upland habitat connectivity may become compromised for some species under management of harvest allocation lands. Though this may not impede genetic exchange between more mobile species such as owls, goshawks, and pileated woodpeckers, it may reduce genetic exchange between less mobile species that rely on habitat characteristics not present in managed stands.

Analysis for dispersal habitat for northern spotted owls (50-11-40) may also have applications to other species that have good mobility, but that require visual cover, short term foraging habitat and some climatic moderation while moving across the landscape. Review of 50-11-40 analysis for this watershed indicates that all quarter townships are near to well above the level considered to be adequate to provide for dispersal of northern spotted owls. The three quarter townships with the lowest values are all within the LSR. In LSRs low levels of dispersal habitat, like low levels of suitable nesting or foraging habitat, compromise the capability of the LSR to function for its intended purpose. However, the values range from -2 to +8 from the 50-11-40 threshold and should continue to improve under present management guidelines for LSRs.

NON-NATIVE SPECIES

A variety of non-native animal species presently occur within this watershed. As discussed in Chapter III, the level to which these species have established populations and the overall effect they may be having on native species is not known. The barred owl is presently recognized as the only non-native terrestrial wildlife species of concern. The primary concerns are the known displacement and suggested potential for genetic dilution of spotted owl populations by barred owls.

PLANTS

NATIVE AND NON-NATIVE HABITAT DIVERSITY; INTERIOR HABITAT; CONNECTIVITY; SPECIES COMPOSITION; VIABILITY

Late-successional species habitat in the watershed has declined due to extensive harvest of old-growth stands and associated road building. Remaining old-growth in the watershed is concentrated at higher elevations and is in some cases highly fragmented. Many survey and manage species have limited dispersal capabilities, thus in fragmented habitat areas geneflow may be restricted between populations. Single species management after harvest in riparian forests along with adjacent upland stands has contributed to a simplification of species richness in plant communities.

Management activities have over time accelerated the spread and establishment of non-native vegetation that can aggressively outcompete native species. Clear cuts and other disturbed openings are sites where invasion is rapidly occurring by noxious weeds and other non-natives. Scotchbroom is an example of such spread.

Though the extent of effects of previous management activities on special habitats is not well documented at this time, a number of specific cases are known. Many sites have been altered, degraded or created by past management actions. In some areas intensive timber harvest has been implemented up to the edges or across special habitat areas; quarry activities have altered rock habitats.

QUESTION 3

How has the intensity and pattern of vegetation manipulation affected trails, recreation, aesthetics, special forest products, and firewood availability?

TRAILS

Hiking trail mileage has been reduced over the past 50 years.

RECREATION

Recreation opportunities related to roads, such as driving forest roads for pleasure, have increased. Non road related recreation opportunities on the other hand have decreased as a result of the road building related to vegetation manipulation. Big game populations are larger due to increased forage quantity and quality resulting in hunters having a better chance of a successful hunt.

AESTHETICS

Most people feel that vegetation manipulation has reduced aesthetic value of the landscape.

SPECIAL FOREST PRODUCTS AND FIREWOOD
Road building associated with timber harvesting has over time allowed easy access to forest plant communities containing desirable products for collection, including beargrass and firewood. Vegetation management activities has enhanced the production of products such as huckleberries.

QUESTION 4:

Where and to what extent has the change in spatial and temporal distribution of vegetation influenced the potential for water yield, water quality (especially water temperature), and peak flow changes?

WATER YIELD
Water yield has varied over time due to changes in the vegetative condition as a result of wildfire and timber harvest. During periods when large portions of the watershed were in early-successional conditions, water yield was likely higher due to a short term decrease in evapotranspiration. Due to the limited water storage capacity of lands within water yield Classes II and III, land types with high proportions of these classes would have a lower ability to store additional soil water input as a result of reduced evapotranspiration that would result from a wildfire event or timber harvest. All three subwatersheds have the highest proportion of their area in water yield class III.

Timber harvest in small watersheds has been shown to result in higher annual water yields. In two small watersheds logged in the H.J. Andrews Experimental Forest, annual water yield increased the most in the clearcut watershed. In the first year after logging, water yield increased 27 percent and averaged 30 percent over the first four years in the clearcut watershed (Harr et al. 1982). A decreasing trend in annual water yield will occur as the watershed is reforested. Harr (1983) estimated that after 27 years the increase in water yield from small watersheds will no longer be apparent.

In the case of large watersheds, it is likely that increases in water yield due to timber harvest does occur however it cannot be quantified due to the measurement error associated with discharge measurements from large watersheds. Harr (1983) estimated that a 70 year rotation on all commercial forest land in western Oregon would result in a six percent increase in water yield. Measurement errors on large watersheds however are generally on the order of 10 percent.

Within the Salmon Creek watershed, management impacts on water yields would be expected to be highest following periods when relatively large portions of the watershed were clearcut harvested, particularly in those portions of the watershed with a low water storage capacity. Annual water yield from the Salmon Creek watershed probably increased from approximately 1960 to the mid 1980's as the total number of acres of clearcut harvesting increased. Currently annual water yield is likely to decrease when compared to the previous two decades due to the reduced rate of stand replacement timber harvest.

PEAK STREAMFLOW
Aggregate Recovery Percent (ARP) values are a method of quantifying the potential for an area to experience increases in peak streamflow as a result of changes in vegetative condition due to management activities combined with rain-on-snow events. Those areas with the lowest ARP values would be associated with areas most likely to have increased peak flows. Current ARP values by subwatershed are listed in Table 7 of the Reference/Current Conditions chapter. Because roadside ditches function as extensions of the intermittent stream network, those areas with a high road density are more susceptible to management related increases in peak flows. Those planning subdrainages with a high proportion of their area within the transient snow zone combined with high road densities may be particularly sensitive to this effect (see Appendix D for a summary of road densities by subwatershed and planning subdrainage).

All subwatersheds are currently above a weighted mid-point ARP value based on Forest Plan values for planning subdrainages and weighted by area that each contributes to the subwatershed. Although subwatershed 18 1 currently has a relatively high ARP value, it would have highest potential for increases in peak flows associated with management. This area is predominantly within the transient snow zone, has a relatively high stream and road density, and has experienced, and will likely continue to experience the greatest portion of timber harvest within the watershed. Planning subdrainages of highest concern are those at or below the mid-point ARP value. Planning subdrainages in this category include 184 and 18u.

WATER QUALITY

STREAM TEMPERATURE

Stream temperature data collected in Salmon Creek at river mile one indicates a trend of increasing stream temperatures during the 1960's and continuing through the 1970's. Data collected since 1981 indicates that maximum stream temperatures have decreased when compared to the two previous decades. Temperatures within the lower mainstem of Salmon Creek however remain somewhat elevated above the relatively cool temperatures observed during the reference time period.

The lower mainstem of Salmon Creek from the mouth to approximately river mile ten currently does not meet the state water quality standard for temperature during at least some portion of the critical summer season (June 1 through September 30) of most years. From the mouth to headwater reaches, stream temperatures gradually become cooler. Available data indicates that above river mile ten, it is likely that summertime water temperatures are maintained below the maximum state water quality standard

The Willamette National Forest Land and Resource Management Plan (USDA, 1990) includes the objective of improving water quality within the Salmon Creek watershed. Specifically, Standard and Guideline MA-15-07 directs that summer water temperatures be maintained or reduced to below 70 degrees Fahrenheit by 1995 and to 67 degrees Fahrenheit by the year 2000. Available data indicates that continued reductions in maximum water temperature values would be necessary to reach the Forest goal for the year 2000.

Field data collected by the USFS indicates streams tributary to the mainstem of Salmon Creek are within state water quality standards for temperature. Brief or localized exceptions to this are likely associated with stream reaches still recovering from past management impacts or wildfires. Given the current standards for riparian area protection, it is likely the trend in the mainstem of Salmon Creek and its tributaries recovering from management activities will be in the direction of cooler summertime water temperatures.

STREAM TURBIDITY

Turbidity levels in streams have increased above natural levels in the lower portion of the Salmon Creek watershed (subwatershed 18 1) due to management activities including timber harvest, road construction and use, and removal of large woody material from stream channels. These activities have increased the frequency of landslides which deliver sediment to stream channels and in some cases have increased streambank and bed erosion. Chronic sediment source areas likely contributing to increases in stream turbidity are those areas where management has impacted areas of active or currently stable land flows composed of soils with a high clay content. Additional source areas of turbidity are existing management related landslides (Figure 5 of Reference/Current Condition chapter). The planning subdrainages with the highest number of road related landslides are 18Z, 181, 182, and 183.

QUESTION 5

> What are the most important delivery mechanisms for sediment generated by vegetative manipulation in this watershed? What are relative amounts of sediment delivery to streams by these mechanisms? Where are the high risk areas?

Delivery Mechanisms

- Landflows primarily located in subwatershed 18 1 are primary locations for delivery of fine sediments. (i.e. streams cutting land flow toe slopes)
- Steep, shallow soils (many areas across watershed but mostly in 18 2 and 18 3) are locations for potential sources of course sediment (debris torrents).
- Maps of high risk areas are located in the Reference/Current Condition chapter, Figures 3 and 4.
- See narrative in Reference/Current Condition chapter for discussion of important sediment delivery mechanisms.

The rate of sediment yield for individual tributary areas has varied depending on the fire history, hillslope processes, landtype and channel type. During the pre-management time period, increases in sediment yield rates can likely be associated with large unstable land forms, fire activity, and floods. Large fires coupled with steep topography resulted in increased sediment delivery to stream channels.

During the post-management time period, sediment yield has increased due to management impacts combined with fire and flood events. Those tributary areas that have a relatively high natural instability combined with moderate to high roading density and harvest impacts are the greatest current sediment sources.

Shallow mass soil movement, usually referred to as "debris torrents" and "debris slides", are the typical delivery mechanism for large amounts of sediment to the stream network. These events often occur in unmanaged forests but are accelerated by reduction of rooting strength due to harvesting and, more typically, by road construction and road related disruption of drainage patterns and sub-surface water flow. Road drainage entering the stream network is a more chronic source of sedimentation and may, over time, contribute more fine sediment than do debris torrents.

The areas of highest risk of becoming sediment source areas are identified as soil category 1 (fine sediment) and soil category 3 (coarse grained sediment), and are displayed in Current/Reference Condition Figures 3 and 4 respectively. Other high risk sediment source areas are those mid-slope roads on slopes greater than 40 percent and existing mass wasting sites (see Reference/Current Condition Figure 5).

QUESTION 6

Where and to what extent has removal of existing and future sources of large wood material in stream channels affected in-stream habitat condition? Where and to what extent has vegetation manipulation affected channel function and riparian habitat condition and its contiguity?

See the answer to question 4 under Issue #1.

Large woody material is an important component of most streams within the Salmon Creek watershed. Large wood provides cover for fish and amphibians; creates large pools; and stores and sorts sediment, increasing the availability and quality of spawning gravels. It contributes to stream bank stability and the retention of smaller sized organic materials used as a food base for macroinvertebrates. The rooting strength of vegetation along stream banks is an important component contributing to bank stability, especially where stream banks are composed of unconsolidated materials. Those riparian areas associated with streams that have experienced the greatest amount of harvest impacts are the areas of highest concern. Streamside vegetation also contributes to stream channel function and condition, by supplying fine organic material to the stream channel. The input of small to fine sized organic material is an important component of a healthy, functioning aquatic ecosystem. The riparian vegetation component that would require the longest time to recover from timber harvest related impacts is the supply of large woody material (LWM) to the stream channel. Large conifers are the most important source of large wood since they decompose slowly and can benefit the stream channels for a longer time than do hardwood species.

The majority of timber harvests within riparian reserves occurred between 1960 and 1989. The riparian reserves that experienced the largest amount of stand replacement harvest are those associated with Class IV streams. Table 2 displays the harvest by subwatershed and decade.

Table 2: Harvest by Subwatershed and Decade

Decade	SUBWATERSHED 18 1 % of Total Harvest Acres in Riparian Reserves		SUBWATERSHED 18 2 % of Total Harvest Acres in Riparian Reserves		SUBWATERSHED 18 3 % of Total Harvest Acres in Riparian Reserves	
	Acres	Percent	Acres	Percent	Acres	Percent
< 1929	195	4	0	0	0	0
1930-39	0	0	0	0	0	0
1940-49	152	3	0	0	0	0
1950-59	413	9	45	4	137	9
1960-69	1,388	31	337	29	527	33
1970-79	1,438	32	431	37	361	23
1980-89	831	19	303	26	511	32
1990-95	36	1	64	5	40	3

The streams in subwatershed 18 2 are currently the most deficient in large woody material with none of the surveyed stream reaches meeting current Willamette National Forest (WNF)objective amounts (see Reference/Current Conditions). Subwatershed 18 3 has the highest percentage of streams meeting current

WNF objective values. All of the subwatersheds will take many decades to recover the number and sizes of woody material within stream channels as existed under pre-management conditions.

Past management activities such as logging without leaving a riparian buffer, salvage logging adjacent to the stream channel, and stream cleaning projects have reduced the amount of large wood in the stream channels of the Salmon Creek watershed to levels below objective values and reference conditions (Table 3).

Table 3: Percent of Subwatershed Not Meeting Objective Values for Large Woody Material

Subwatershed	Total Stream Miles Surveyed	% Of Streams Not Meeting WNF Plan LWM Objective Values
Lower Salmon Creek (18 1)	12.1	82.7%
Black Creek (18 2)	12	100%
Upper Salmon Creek (18 3)	9	70%

The removal of this large wood from the riparian areas and the stream channels has resulted in reduced channel complexity, reducing the number of areas with high quality habitat for fish and other aquatic species. Nearly every reach surveyed in the last five years, in each sub-watershed, did not meet minimum objective values for large pools, which are an important habitat for adult fish. It should be noted, however, that the natural conditions of streams in the upper watershed may be below objective levels for LWM due to the high fire frequency, the generally smaller tree size in higher elevation areas, and the relatively faster wood deterioration rates of high elevation tree species. Other potentially limiting habitats affected by levels of large wood include spawning gravels, rearing areas, and overwintering habitat (see the Aquatic Habitat discussion in Chapter IV, Reference and Current Conditions). The greatest area impacted by timber harvest within riparian reserves are located adjacent to Class II and Class IV stream channels.

Stream channels with the greatest amount of adjacent stand replacement timber harvest are associated with the greatest adverse impacts. Short term impacts include the loss of fine organic material input to stream channels. Long term impacts are primarily associated with the loss of existing and potential LWM.

Removal of mid and late-seral forests within and near riparian areas may have resulted in a decrease in lake/river aquatic/riparian and riparian guild species that use mid/late seral habitats, with a corresponding increase in such guilds that use early seral habitats.

QUESTION 7

How have our vegetation management practices affected the Salmon Creek Fish Hatchery and the City of Oakridge emergency and secondary water supplies?

FISH HATCHERY

Summertime water temperatures in Salmon Creek have dropped but are still above desirable levels. The hatchery uses water from a well to moderate water temperatures. Increases in suspended sediment in Salmon Creek have likely increased maintenance costs for the hatchery. The ponds must be cleaned periodically because of sediment deposition. Suspended sediment also has the potential to adversely affect eggs and fry. The increased bed-load movement in Salmon Creek is adversely affecting the diversion dam.

See the answer to question 4 under Issue #1. Salmon Creek has been identified as a secondary municipal water supply for the City of Oakridge during the summer months. Currently the city plans to use this source only during emergency situations such as controlling large fires. No adverse impacts have been identified affecting the suitability of Salmon Creek for this purpose. Suspended sediment and bed-load movement have the potential to affect the quality of municipal water and the intake of the water system.

QUESTION 8

How will we protect small wetlands, seeps, and springs from management activities?

Site specific project analysis should indicate where small wetlands are relatively abundant. Management prescriptions for these areas should recognize that some percentage of these wetlands may be maintained in late-successional seral stages and some percentage in early-successional stages to provide for higher species diversity.

ISSUE #2

The exclusion of natural fire from the ecosystem has altered the natural processes.

ISSUE #2 KEY QUESTIONS

QUESTION 1:

Fire pattern, fire behavior, and burn intensity are affected by fuel loading conditions. How do current conditions compare to fuel loading conditions before the advent of fire suppression? What areas are at high risk?

There has been no significant change in terms of overall average fuel loading (tonnage or total fuel available) from reference conditions over the whole watershed. However the pattern of stands and their respective fuel loadings is very different now: less in the eastern third and more in the western portion where stands are smaller and with more edge.

The risk of stand replacement fire is more a function of stand age: young stands have more flashy fuels and younger trees are more susceptible to damage by fire. Subwatershed 18 1 has a larger number of acres in stands 0 to 80 years of age than typical reference conditions had (it has nearly doubled, from 20% to 40%). If late-successional and old-growth stands are important to maintain diversity and meet management direction, fire suppression efforts become very critical. This means access, fuel breaks and quick response in addition to fuels reduction efforts since fuels reduction would reduce the fuel loading conditions of these seral stages. Protection of younger stands is vital to bring area back to more older seral stages. Roads that once could be used as fuel breaks are rapidly becoming inaccessible by vehicle and non-functional as fuel breaks due to vegetation encroachment.

Identified areas of high risk are high mortality areas of the Warner Creek fire and the 1967 Dead Mountain fire. Older stands could also be at risk due to increased fire severity related to the gradual accumulation of large fuels, the continuity of those fuels, and past fire suppression in those stands.

QUESTION 2:

If we utilize prescribed fire within established forest stands (as opposed to post-harvest site preparation) in order to reduce high fuel loading and bring the landscape back to the reference condition, under what conditions could we control the fire? How many acres (per period of time and land allocation) and under what conditions could we prescribed burn and still remain within air quality limits, and where are the high priority areas?

PRESCRIBED FIRE CONTROL CONDITIONS:

- If the arrival of a weather front could be accurately predicted;
- If management can be flexible in terms of timing (season and year), budget expenditure, in terms of risk of exceeding prescription, as well as accepting potentially negative short term resource effects;
- If fire in riparian reserves is acceptable;
- Stands with lower fuel accumulations (100 to 200 years old) may be underburned with more control;
- Fuel loading is not a special concern, rather when and how the fuel burns. Any age stand can burn catastrophically under extreme conditions but stands that have been underburned may not burn catastrophically under extreme conditions;
- Air quality is not now a limiting factor as long as ignitions occur before July 1st or after September 30th, which is when conditions would be most favorable for control;
- Priority areas for prescribed underburning would be the LSR and adjacent areas to prevent future catastrophic fire in an area where late-successional habitat is currently at low levels.

During the Warner Fire Recovery Project, Charley Martin, District Fuels Management Specialist, addressed the issue of allowing natural fire to burn within a prescription that would reduce fuel loadings and preserve habitat (Final Environmental Impact Statement, Warner Fire Recovery Project, Appendix B). Results are felt to be consistent with our ability to introduce prescribed fire into natural stands to meet the same requirements, given that the probability of ignition will change because we are the ignition source. Higher elevations will become available in early to mid summer even though conditions for burning will be similar to those found in the spring. However, the probability of exceeding prescription will be higher and the probability of a rain event will be somewhat lower in early to mid summer (Table 4).

Table 4: Fire Prescription Probabilities for Any Given Year

Time of Year	Probability Rx* 5 Day Window	Probability of Rain in Rx**	Probability of Exceeding Rx***	Probability of Ignition
Spring	Moderate / High	Moderate	Moderate	Low
Summer	Low / Moderate	Low	High	High
Winter	Unknown	High	Low	Low / Unknown

* Probability includes all windows, all years

** With 1 foot and greater flame length

*** If given a window, what is the likelihood it will exceed prescription

Smoke management and air quality are discussed in the Reference/Current Conditions chapter.

QUESTION 3

Under a reference condition fire regime, what would the habitat diversity look like? Where could prescribed fire help us to re-establish or maintain the reference condition?

Reference era terrestrial wildlife habitat conditions were discussed in Chapter III. Reconstructing reference condition habitat diversity involves varying degrees of speculation in an effort to fill in the gaps where knowledge of fire history is weak, and overcoming limitations such as using a 200 year fire history timeframe. Other limitations include accurately predicting the timing, intensity, and extent of underburns between stand replacement fires.

Within the eastern one-third of the analysis area, fire suppression may have contributed to changes in edge habitat abundance that may have naturally developed along the borders of fires which frequently and extensively affected vegetation in this area (creating the early seral portion of edge habitat). Fire exclusion may have allowed late-seral habitat conditions to develop in areas that might have otherwise been exposed to repeated burns. Relatively more late seral and old-growth habitat is present now than under reference conditions (compare Figures 28 and 29 on pages 48 and 49 of Reference/Current Conditions chapter). This trend toward later seral habitat continues as fire regenerated stands are allowed to mature under a relatively low level of intensive timber harvest or repeated large scale and frequent fires. The result of having large tracts of timber maturing into late seral and old-growth forests is a shift in the biotic community from early and early-to-mid-seral habitat users to mid-to-late and late seral habitat users.

This effect has increased the capability of portions of this watershed in the LSR to contribute to meeting long-term management objectives for LSRs. However, much of this area (and other portions of subwatersheds 18 2 and 18 3) that have matured into late seral and old-growth habitat is not within the Douglas fir/western hemlock plant associations most suited to spotted owls, but is within the true fir/mountain hemlock plant associations best suited to a host of other species (e.g. mountain chickadee, pine grosbeak, heather vole). This trend has also reduced the abundance of early seral habitats which may have reduced capability to support high elevation early seral or contrast species such as boreal owls, elk, Cassin's finch, calliope hummingbird, mountain bluebird, and green-tailed towhee.

It is difficult to assess whether fire exclusion has increased, decreased or had a neutral effect on the abundance of edge habitat above and beyond that created by timber harvest without accurately knowing the intensity and patchiness of historic fire events. Frequent reburns of an area may have a tendency to mask the natural complexity that may have been present within this fire affected area, and speculations on what the potential pattern and intensity of suppressed fires might have been is difficult.

In some areas throughout the watershed where late seral/old-growth stands remain, evidence suggests a shift from a more open forest habitat to a gradient between densely-structured and open-structured habitat. This shift in late seral/old-growth habitat structure would increase suitability for some species (e.g. spotted owl) and decrease suitability for others (e.g. northern goshawk).

An analysis of forested stands less than 80 years old on soil types that are commonly found associated with special habitats (SHABs) identified 980 acres that can be classified as potential SHABs. The age of these stands and their positions on the landscape (often located adjacent to or in the immediate vicinity of existing SHABs) suggests these areas were once SHABs that may have become forested due to fire suppression.

These areas, and portions along the western edge of the High Cascade Plateau where big game forage quality and quantity would benefit from the effects of fire, are candidates for prescribed fire. Prescribed fire could assist in maintenance of reference conditions elsewhere in the watershed such as areas where underburning historically provided open late seral/old-growth forest habitat - particularly in Douglas fir plant associations.

In some areas of the watershed, particularly in Douglas fir/western hemlock plant associations, episodic historic natural fire events were favorable to early-mid seral plant species by recruiting seral species into canopy gaps. This created relatively stable percentages of species numbers. Over the long term, fire suppression and forest succession may pose the biggest threat to herbaceous fire dependent species. While early seral vegetation created by harvest activities may be more diverse in the short term following harvest, subsequent shrub and sapling competition, roadside re-vegetation with non-native species, noxious weed and other non-native spread may result in replacement of species that historically were adapted to periodic low to moderate intensity fire events.

QUESTION 4

How would prescribed fire affect TE&S and ROD species habitat, fire dependent plant species, big game habitat, and aquatic species habitat?

Late seral species, such as the spotted owl, could experience a short term loss of habitat for their prey species but a long term benefit to structural development of late seral stands. Great gray and flamulated owls could benefit short and long term due to the creation of contrast habitat. Falcons could benefit short and long term as fire effects improve prey species habitat and enhance hunting success over a more open canopy. Wolverines may also benefit short and long term as habitat for their most important prey (big game) improves.

Prescribed fire can enhance forage quality in the short term and cover quality in the long term.

Openings created by fire would be favorable for early-mid seral plant species habitat by opening canopy cover, scarifying seeds, and preparing seed beds with reduced competition and high nutrient availability.

Repeated low to moderate intensity fire events help maintain open habitat, and encourage sexual and vegetative reproduction. Historic natural fire events were beneficial to most plant species, assuming fires occurred during the time when plants had completed their reproductive cycles for the year.

Moderate intensity fall burns may assist in germination of fire dependent species such as woodland milkvetch and branching Montia. The Warner Creek and Shady Beach fires both burned in the fall and both fire areas experienced increased germination of these two species. It is unknown whether spring fires would stimulate these species to germinate.

Short term effects to aquatic habitat include increased water temperature, decreased shade, increase in water pH, increased sedimentation rates, increase in nutrient output, abrupt change in aquatic foods with associated change in insect populations, creation of additional large woody material input (existing large woody material usually not affected), and could cause a long term shortage of new large woody material input. Aquatic habitats will recover as vegetation recovers. Increased sunlight, nutrients, and insect populations can be a benefit to fish. Smaller order streams would be more likely to see these effects.

Prescribed fires may be detrimental to localized populations of sensitive and threatened amphibian species such as salamanders and frogs. The existence of supplemental Late-Successional Reserves and Riparian Reserves may help to minimize these effects if these areas are not subject to prescribed fire. Also cool or patchy burns may facilitate escapement of individuals within such populations.

ISSUE #3

The density, condition, use, and location of road and trails has altered the landscape processes and influenced wildlife habitats.

ISSUE #3 KEY QUESTIONS

ROADS (system and non-system)

QUESTION 1:

Where has the density, condition, location, and use of roads influenced natural and management induced disturbance (i.e. landslides, surface erosion, slope movement)?

Road related slope failures have altered the spatial and temporal distribution of landslides within the Salmon Creek watershed. Although landslides occurred during pre-management conditions, roads within the watershed have increased the frequency of these events when compared to the natural condition.

The majority of road related debris slides likely occurred before 1970 and are associated with sidecast construction techniques on steep terrain. Failure mechanisms associated with this construction technique come in two stages; immediate, and delayed with approximately a 20 year gap between the two.

The majority of inventoried road failures have occurred in subwatershed 18 1. As can be seen in Reference/Current Condition Figure 5 (Roads on slopes greater than 40%), the highest number of these inventoried road failures are located south of Salmon Creek in Subwatershed 18 1 (Planning Subdrainages 18Z, 181, 182, and 183). The majority of road construction activity occurred during the 1960's and 1970's and the greatest risk of road failures generally occurs within the first two decades after construction. Therefore if roads are properly maintained, it is likely the rate of road related failures due to unstable fill material will be lower in future decades when compared to rates observed over the last two decades. Another potential source of sediment from roads is the potential for the capacity of culverts to be exceeded during high runoff events. In addition, lack of road maintenance could result in culverts being plugged or otherwise non-functional. Data from the Watershed Improvement Needs inventory indicates a high proportion of undersized stream crossing culverts and road relief culverts with partial to total blockages (see Reference/Current Condition chapter, Table 4). Failure of these structures could result in catastrophic failure and erosion of the road fill and possibly initiation of a debris torrent. These events have the potential to deliver large quantities of sediment to stream channels with associated damage to aquatic and riparian habitat.

QUESTION 2:

Where and to what extent have the presence, patterns, and use of roads and trails affected native and non-native plant and animal habitat diversity, species composition, guild viability, amount of interior habitat, habitat connectivity, and riparian reserves?

TERRESTRIAL WILDLIFE EFFECTS

INTERIOR FOREST, HABITAT, CONNECTIVITY, DIVERSITY, AND FAUNAL SPECIES COMPOSITION

Terrestrial wildlife guilds whose habitat requirements might benefit from the road network established in this watershed could include patch species with small home ranges that select for early seral (e.g. bluebird spp., fence lizard), mosaic species with small home ranges that select for early seral (e.g. mountain quail, black-tailed rabbit), contrast species with small to medium home ranges that select early seral (e.g. dusky flycatcher, big brown bat, little brown myotis), and most generalist species especially those with smaller home ranges that select for early to mid seral habitat. Guild maps in Appendix A can be referenced to see how current guild habitat has changed and to see that changes can often be associated with areas having higher road density.

The effect of the influence of roads on wildlife populations such as deer and elk has been the focus of many studies and has been discussed in numerous publications (Thomas 1982, Mannan et al. 1994). References on this subject can be found in Appendix H of this document.

Concerns about the effects of roads on big-game animals generally are not associated with the road itself. The negative influence of roads on big-game animals is associated with humans that use the roads. The potential effectiveness of otherwise appropriate habitat for big-game animals is thus diminished as open road density and traffic levels increase in areas where these animals are hunted. Open road densities greater than 2 miles per square mile of habitat have potential to significantly reduce elk use in an area. Eight of the eleven Big Game Emphasis Areas in this watershed currently exceed 2 miles per square mile of habitat. The habitat effectiveness variable for roads is currently below Willamette National Forest standards for six of the emphasis areas (Reference/Current Condition chapter, Table 45).

Frequent human disturbance associated with roads and trails is known to frighten big-game animals from distances ranging from .4 miles to .8 miles. The disturbance response by elk has been found to be greater towards slowly moving vehicles on lower level forest roads than towards faster moving vehicles on more improved forest roads. Table 5 shows that overall 82% of the watershed is within .5 mile of a road and 89% is within 1 mile, with a range between subwatersheds of 76%-97% and 77%-99% respectively.

Table 5: Area and Percent of Land Within 1/2 or 1 Mile of Roads

Subwatershed	Total Acres	Total Acres within 1/2 Mile of Road	Percent of Total	Total Acres within 1 Mile of Road	Percent of Total
18 1	35,271	34,160	97	34,767	99
18 2	21,744	14,203	65	16,738	77
18 3	25,417	19,263	76	22,140	87
18 Totals >>	82,432	67,626	82	73,645	89

Table 6: Road Openings and Trails Within Riparian Reserves

Subwatershed	Riparian Reserve Total Acres	Road Type	Acres of Road in Reserves	Percent Reserves in Road Openings	Miles of Trail in Reserves
18 1	11,465	Forest Service	283	2.5	10.4
18 1		SP Railroad	15	0.1	
18 2	6,763	Forest Service	89	1.3	5.0
18 3	7,470	Forest Service	78	1.0	4.6
18 Totals >>	25,698		465	1.8	20.0

Habitat connectivity may have been affected at site specific locations for riparian associated species, but the overall impact of roads on riparian habitat connectivity in this watershed is relatively insignificant. Certain species such as bats may benefit from some road openings in riparian areas. These openings could have value as important feeding sites. Amounts of road openings and miles of trail within riparian reserves are listed for this watershed in Table 6.

Some features associated with roads and trails may provide structural habitat for selected species. These features include roost sites under bridges or in the roof of shelters that could be used by bats, or shelter under boardwalks across wet areas that could be used by amphibians. Some segments of trail are situated close to occupied or potential sites for threatened, endangered, or sensitive plant or animal species. Use of motorized vehicles on trails is restricted in some areas. Seasonal restriction of motorized trail maintenance work has been applied to some segments of trails close to known bald eagle and peregrine falcon nest sites. Based on feedback from the USFWS, relocation or closure of some trail segments to protect T & E nest sites may be appropriate, as well as seasonal restriction of dispersed recreation sites close to occupied bald eagle and peregrine falcon nest sites. The Forest Plan and regional species recovery plans require management plans to be prepared for occupied bald eagle and peregrine falcon nest sites in addition to consultation with the USFWS for any actions potentially affecting these areas. Though spotted owls are present in some areas close to trails and dispersed sites, no activity centers have been identified that are likely to be adversely affected by recreational use of existing facilities.

HABITAT STRUCTURE

Snag and large woody debris habitat generally tend to be deficient near roads. Roads have traditionally facilitated the salvage of down wood contributed from adjacent stands. Many snags are removed from the vicinity of road prisms for safety concerns. As the anticipated level of maintenance decreases and segments of roads are closed or abandoned, certain areas of the watershed may eventually experience an increase in levels of snag and down wood habitat. This restored habitat characteristic may not be long term however, as future access needs into areas would most likely re-open old corridors and result in removal of these components.

NON-NATIVE SPECIES

The extent to which roads and trails may affect non-native species within this watershed is not well understood. Domestic animals such as cats and dogs are known to have been abandoned throughout the area. When these animals are intentionally abandoned it is usually along a road and often not far from the community of Oakridge. Occasionally pets are separated from their owners along trails or at dispersed campsites associated with roads. The introduction of these animals into the ecosystem is usually short term as they succumb to inefficient survival skills or fall victim to larger native predators. However some relatively insignificant detrimental effects may occur such as competition for habitat and prey resources, or by direct interactions including nest parasitism and predation on native species. Whether or not roads have affected the dispersal establishment of opossum and barred owl populations in this watershed is unknown.

RIPARIAN AND AQUATIC DEPENDENT SPECIES

Figure 1 of this chapter displays the overlap between road clearings (including road surfaced area and altered roadsides) and riparian reserves. Table 6 of this chapter displays the acres of riparian reserves and percentage of overall riparian reserves occupied by road openings. These road surfaces and open areas may pose barriers to movement by the least mobile species, but do not affect the dispersal of more mobile species. Table 3 of the Reference/Current Condition chapter displays the number of stream crossings along roads by stream class. Many of these stream crossings are associated with impassable culverts and/or steep fill slopes and cut banks. These features may also complicate travel for less mobile species. Though railroad tracks are known to pose migration problems for northwestern pond turtles, the length of railway in this watershed is small and most of it positioned where pond turtle migration is not expected to occur.

There are many culverts in the Salmon Creek watershed which create upstream migration barriers for fish. These barriers prevent these fish from utilizing suitable habitat located above these barriers. In some situations, resident populations of trout exist above barriers however they are currently genetically isolated. It is also known that in small tributary streams with high winter water velocities, trout commonly migrate downstream to overwinter in larger, deeper streams (Benhke 1992). When impassable culverts are present these fish migrate downstream, but are not able to migrate back up stream. Along the mainstem of Salmon Creek and Black Creek all stream crossings are bridges and therefore do not affect migration. In fish bearing tributary streams however, stream crossings are generally associated with culverts. Nearly all of these culverts create upstream migration barriers.

PLANTS

The extent of effects of the presence, patterns, and use of roads and trails on special habitats or threatened, endangered, and sensitive species is not well documented at this time. Many sites have been altered, degraded or created by past management actions. Road cuts have potentially affected natural meadows by intercepting ground water or serving as a noxious weed vector. In other cases, special habitats may have been created or enhanced by impoundments, rip rap placed over tall fill slopes, or construction of bridges. Many instances of the creation of "linear" meadows and wetland habitat is evident in this watershed.

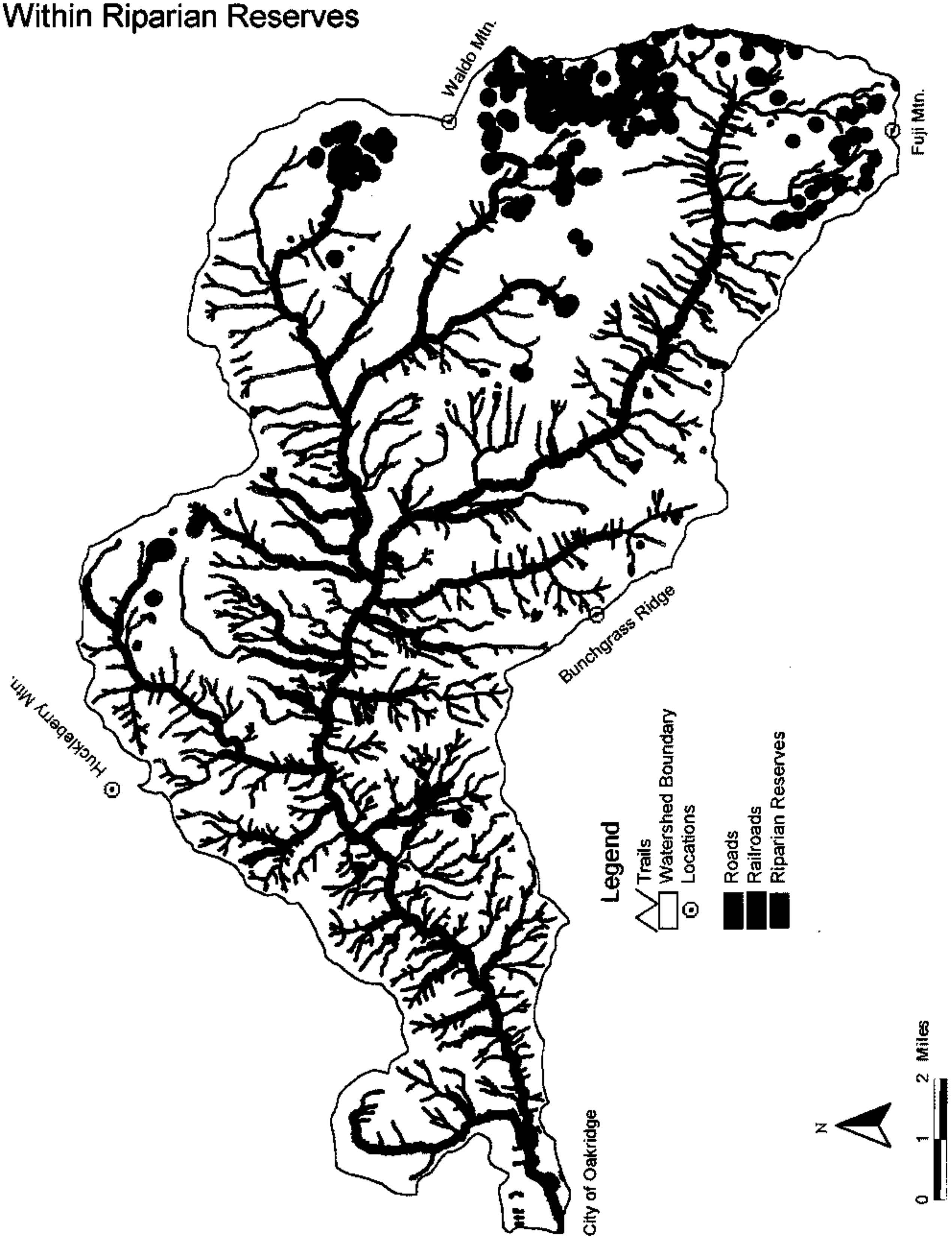
Some sections of trail cross areas that have been or may be altered by the type and level of use. In some areas trails pass across meadows and rocky areas (special habitat areas). In such areas extensive use by horses, motorcycles or mountain bikes may deepen trails which could effect the moisture regime of the meadow, or may loosen rocks that support the trail surface, causing raveling off at the trails edge. These occurrences are site specific as many miles of trails exist that have little or no effect on special habitats.

Several non-native plants are now well established in the vegetative communities in the watershed. Non-native vegetation will continue to be a formidable presence in the landscape. Continuing invasion and establishment will occur, whether from inadvertently traveling on vehicles/equipment, from stock packing use on trails, spread by road grading activities, perpetuated by timber harvest, or road right-of-way maintenance activities. These non-native plants out-compete natives in meadows formerly grazed and seeded with forage mixes, or by non-native erosion control and roadside seeding. Roadsides, temporary spur roads, and firelines often serve as seed beds for noxious weeds. The percentage of acreage in the watershed within a half mile and within one mile of roads indicates that the majority of the watershed is subject to the threat of changes in species composition by weed spread (see Table 5 of this chapter). However, if roads are closed and allowed to overgrow, many noxious weed and non-native populations would eventually become shaded out by overtopping vegetation. The same trend holds true in maturing stands. Some will remain in the system as they are already naturalized species. Of concern are upper elevation areas where tree regeneration is slower and migrating weed populations could invade and establish and displace native plants, and floodplain areas where Himalayan blackberry and other invasive non-natives exist.

Figure 1:

Roads, Railroads, and Trails Within Riparian Reserves

Salmon Creek Watershed Analysis



Some introduced species have contributed to social and economic well being by offering berry picking opportunities, by enhancing scenic quality, by controlling other undesirable exotic species, providing for erosion control, and providing flowers for sight-seeing. Others have less desirable social and economic effects such as toxicity to livestock, infestation of agricultural areas, contamination of food stuffs and buildings, depredation on crops and poultry, and reduction of bird watching opportunities in some areas. Loss of native species can have social and economic effects in terms of entity and medicinal values.

QUESTION 3:

Where has the density and location of roads affected hydrological function (i.e. wetlands, expansion of the drainage network, and streamflows)?

Roads contribute to increases in peak streamflows primarily due to the area of road surface that has a reduced infiltration capacity, more rapid routing of water to streams in roadside ditches, interception of subsurface flow and conversion to more rapid surface flow, and in some situations the formation of gullies where runoff is concentrated below culvert outlets .

Interception of subsurface flow by a midslope road can result in the area below the road becoming dryer due to a routing of water away from these areas. Roads can create areas of increased surface water by concentrating water in roadside ditches on the upslope of the road, or surface water may be increased in those areas where relief culverts concentrate runoff from roadside ditches below culvert outlets.

Adverse road related affects are most likely to occur where road construction has occurred on mid-slopes. Figure 5 of the Reference/Current Condition chapter displays a map of roads within the watershed on slopes greater than 40 percent. The highest overall road density is found in subwatershed 18 1. Current Road densities by subwatershed and planning subdrainage can be found in Appendix D.

QUESTION 4:

What are the potential resource effects of not maintaining all the roads in this road system due to lack of funding?

Since the timber harvest program has declined with an associated decrease in road maintenance funding, road maintenance will not be done to the extent it was in the past. Road maintenance will be concentrated on the maintenance level 5 and 3 roads. Maintenance levels will have to be reconsidered and lowered on a portion of the road system so as to balance the budget with the maintenance program. This will result in some of the system roads that have been accessible by passenger cars now only being accessible by high clearance vehicles and in some cases not being accessible at all. Brush will encroach into the roadway on some of the system roads, making them impassable. Rock fall, tree fall, and slope ravel will close roads or make them accessible only to high clearance vehicles. Some loss of the roadway is possible from failed drainage systems and embankments. As a result we could see a loss in accessibility to some dispersed recreational sites and opportunities.

If roads are not maintained there is a higher probability of culvert and roadbed failures and formation or extensions of gullies below culvert outlets. These road related problems could introduce sediment into the stream system. Such introduction could silt in spawning gravels, reducing the spawning success of native trout and potential future salmon and bull trout. Introduction of sediment would also increase stream turbidity. Culvert failures could also block up-stream migration of fish.

Decreased maintenance will compromise drainage structures, resulting in diversion of water onto fill slopes, creating an increased likelihood of road related slope failures.

QUESTION 5:

Where are the high risk or high priority road/stream crossings which do not have drainage structures designed to withstand 100 year events?

With the exception of several site specific project areas (Heart and Finberry timber sales), the answer to this question is not known. An adequate amount of time was not available to do the extensive analysis needed to generate this information.

ACCESS

QUESTION 6:

How does changed access influence the potential for human caused fire ignitions, suppression response time, and the amount of acres burned?

The Willamette National Forest Fire Management Analysis System (NFMAS)-
This planning process was developed to provide fire managers with optimal organizations and funds for fire suppression. Included are three segments; Level I analysis, Level II analysis, and Initial Attack Assessment (IAA) model. Level I analysis introduces all of the elements used to build a database for IAA, except for fire behavior information (output from Level II). This includes weather data, fire occurrence, fire management analysis zones (FMAZ), and representative locations (RL). The IAA model uses Level I data and combines it with resource values, suppression costs, escaped fire sizes, and resource information loss/benefit (Net Value Change or NVC) information. IAA also utilizes fire behavior information that is called Level II. The output from the model provides information on the changes in the number of acres burned, resource loss and emergency suppression costs over an array of alternatives (9 alternatives were used). Alternative 4 was chosen because it represented the least Cost + NVC.

Table 7: Wildfire Response: South Zone (non-wilderness)

Location Code	District	Type Response
RL1	Rigdon	Roaded -- Engine
RL2	Lowell	Roaded -- Engine
RL3	Oakridge	Roaded -- Engine
RL4	Rigdon	Roaded -- Hand
RL5	Lowell	Roaded -- Hand
RL6	Oakridge	Roaded -- Hand
RL7	Rigdon	Roaded -- Hand or Air
RL8	Lowell	Roaded -- Hand or Air
RL9	Oakridge	Roaded -- Hand or Air

Table 8: Wildfire Response: South Zone (wilderness)

Location Code	District	Type Response
RL1	Rigdon	Hand
RL2	Oakridge	Hand
RL3	Rigdon	Air
RL4	Oakridge	Air

Representative locations for this analysis were chosen based on primary type of first attack and time of attack on fires that occurred from 1970-1989 by district. Oakridge is assigned RL3, RL6, RL9. The types of first attack for the non-wilderness FMAZ were grouped into 3 categories: roaded (primarily an engine first response), roaded dispersed (primarily a hand first attack), and remote non-wilderness (primarily attacked from the air or by ground forces). The types of first attack for the wilderness FMAZ were grouped into two categories: hand and air. The above information is displayed in Table 7 and 8 on previous page. Time to first attack was assigned as one hour.

It is important to remember that this analysis was based on a period of time when most of the district road system was established and fire size was minimized due to accessibility of engines and hand crews. With road closures or road removal, response times are estimated to increase by one half to one hour. This would also mean a decrease in RL3 and an increase in RL6 and probably little change in RL9 since it applies to areas similar to that which is found east of Waldo Lake to the Crest that is non-wilderness. Net changes expected would be increase in response time, increase in fire size, increased number of initial attack forces, increased mop up time, increased use of retardant, and increased resource damage. Overall, an increased Cost + NVC. This situation is currently being addressed on a regional level because of its expected impacts on regional resources such as smoke jumpers, retardant planes, Type I fire crews, helicopters, and rappel crews. Currently there are no fire dollars available to keep roads accessible.

Roads in areas of relatively low road density are more important for fire suppression activities than any given road segment in areas with a high road density.

QUESTION 7:

How does changed access, including abandoned trails and historic sites, affect public and administrative use of the forest?

Closure of roads will restrict the amount of roads used by hunters, firewood cutters, and recreationists in general. Many hunters do not venture far from roads and firewood collectors are closely tied to roads. Road closures would reduce the amount of land accessible for various activities such as driving for pleasure, hunting, special forest product collection, and firewood cutting.

A decrease in maintenance on roads accessing trail heads would make it more difficult for some to access existing trails. Road closures would have the effect of extending the trail system by effectively creating a new trailhead at the point of road closure. Such a trail system expansion could add to or detract from the trail experience and would certainly increase the amount of trail maintenance that would need to be done.

Transformation of roads to trails could increase horse, mountain bike, and ORV use. Business increases 20% at Sentry Market over the summer season (spring fishing through fall hunting). An increase in trail users could seasonally benefit local businesses, especially if increased recreational opportunities are marketed effectively.

A significant decrease in the amount of open roads could reduce the number of human-caused fires but would also hinder our ability to suppress natural and human-caused fires.

ISSUE #4

Aquatic communities may have been changed from reference conditions due to the introduction of non-native species.

ISSUE #4 KEY QUESTION

QUESTION 1:

What are the effects of introduction of non-native species on native aquatic communities?

Stocking of non-native species and strains of fish and the introduction of fish to naturally fishless lakes has occurred since the early 1900's. ODFW has been largely responsible for fish stocking. Anglers have stocked lakes and streams with their favorite fish species to a lesser extent. The introduction of non-native species of fish has negatively affected naturally occurring aquatic species. The introduction of brook trout to many of the lakes has affected downstream native populations of cutthroat trout and rainbow trout, as well as anadromous species such as bull trout. Brook trout often migrate down-stream from the lakes where they were originally introduced. Brook trout often out compete rainbow trout and cutthroat trout and hybridize with bull trout.

The introduction of fish to previously natural fishless lakes may negatively affect species naturally occurring in the lake. Introduced fish prey on frogs and salamanders (which were previously the top predator), as well as aquatic macroinvertebrates and the larger species of zooplankton, thus changing the community structure of the lake. Bullfrogs have similar effects on native species.

The presence of brook trout in upper Wall Creek and upper Mule Creek would prohibit the future re-introduction of bull trout into these areas. Although many of the high elevation lakes that have been stocked with brook trout have outlets that are tributaries to Salmon Creek, brook trout are not present elsewhere in the watershed.

The relative importance of these native non-fish communities varies, depending upon social values. Social values determine whether fishing for native (rainbow and cutthroat trout) or non-native species (brook trout and kokanee) is more important, or whether amphibians native to lakes are more desirable than fish.

ISSUE #5

The diversion dam for the Willamette Fish Hatchery has the potential to fall, which in turn, could disrupt operations at the fish hatchery.

ISSUE #5 KEY QUESTION

QUESTION 1:

Should the new diversion dam be equipped with a fish passage structure?

Currently the diversion dam for the fish hatchery located at approximately river mile one on the mainstem of Salmon Creek does not provide for the upstream migration of resident fish species. In 1994 the Willamette National Forest's Land and Resource Management Plan (USDA, 1990) was amended by the Northwest Forest Plan (USDA, USDI, 1994a). The Northwest Forest Plan contains Aquatic Conservation Strategy

Objectives which apply to all lands administered by the U.S. Forest Service and U.S. Bureau of Land Management within the range of the northern spotted owl. Objective number two states; "Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian dependent species." To comply with this direction, the reconstruction of the diversion dam for the fish hatchery should be designed and constructed to allow for the upstream migration of resident trout species.

ISSUE #6

There is a concern for protection of water quality for the Oakridge municipal water supplies and the Willamette Fish Hatchery.

ISSUE #6 KEY QUESTIONS

QUESTION 1:

What facilities and management activities could potentially contaminate the Oakridge Municipal wells, the emergency municipal water source (Salmon Creek) and Willamette Fish Hatchery water sources?

Available hydrogeologic information indicates the potential for a direct hydrologic connection between surface water in Salmon Creek and the wellfield supplying the City of Oakridge. The Willamette National Forest has developed several documents detailing the policy and direction guiding the protection from contamination source areas of water such as the wellfield supplying the City of Oakridge and other sources of water on the forest. The following is a list of documents containing current policy and direction and a summary of the content of these documents.

- Willamette National Forest Pollution Prevention Plan:
  Prepared in response to Executive Order 12856 to serve as the guiding document covering facilities to reduce the acquisition and disposal of hazardous materials.

- Hazardous Substance Management Plan, Willamette National Forest:
  Policy and direction concerning hazardous substances, their purchase, use, and storage.

- Willamette National Forest Hazardous Material Spill/Discovery Emergency Action Plan:
  Guidance for the response to spills or discovery of hazardous materials within the boundaries of the Forest.

FACILITIES

Any chemical or petroleum spill occurring at the Flat Creek Forest Service complex or on the railroad right-of-way could potentially enter the aquifer. The underground fuel storage tanks at the fish hatchery have been filled with a sand/concrete mixture and therefore may not pose any threat to the aquifer. Past chemical and/or petroleum spills at the old Bald Knob mill site may have potential to enter the aquifer. Old underground tanks and future industrial use at the mill site may also pose a potential threat.

ACTIVITIES

Fuel and chemical spills along Forest road #24 and by the railroad could potentially pose a threat to the aquifer. A number of other activities could also pose a threat. These include meth lab operations and disposal of waste products, vehicle accidents, residential facilities, and illicit dumping,

Currently, the greatest risk to the wellheads supplying the City of Oakridge is from an accidental spill from the railroad or hazardous materials originating from the old Bald Knob Mill site. Although the potential for an accidental spill of hazardous materials into Salmon Creek from Forest Service operations is possible, due to the low frequency and magnitude of these operations, there is a low risk of contamination of Salmon Creek.

QUESTION 2:

Do administrative and recreational facilities affect water quality?

This analysis did not indicate that administrative or recreational facilities in the watershed pose a threat to the municipal or fish hatchery water supply.

RECOMMENDATIONS

CHAPTER V

RECOMMENDATIONS

INTRODUCTION

The following recommendations are made "to bring the results of the previous steps to conclusion, focusing on management recommendations that are responsive to watershed processes identified in the analysis." (USDA, USDI, 1995). The recommendations are based upon the analysis synthesis presented in the preceding Integration Chapter. While a summarization of the rationale is presented with each specific recommendation, a review of the discussions interpreting the analyses for each issue statement (Chapter IV) will assist in a full understanding of the rational behind these recommendations.

In many cases not enough site specific data or relevant studies exist to absolutely quantify the full ramification of the current conditions. In the face of this incomplete information, the watershed analysis team, in an interdisciplinary process, has relied upon known resource problems and professional judgment to generate these recommendations which in many cases are conceptual in nature.

ISSUE #1

Intensity and pattern of vegetation manipulation related activities.

Riparian Reserve Widths

One of the primary reasons for this watershed analysis was to determine whether prescribed interim riparian reserve widths can or should be changed (USDA, USDI, 1994a, page B-13). Riparian reserves provide dispersal and connective habitat for terrestrial animals and plants as well as protection of aquatic environments. These corridors and connections will in many cases be wider than prescribed due to overlap with special wildlife habitat allocations, supplemental Late-Successional Reserves, green tree retention clumps, and areas unsuitable for timber management. It is recommended that interim widths as stated in the Northwest Forest Plan be maintained. This analysis has found no information indicating the interim widths are excessively wide or too narrow to accomplish the dual objectives of the Aquatic Conservation Strategy and providing for terrestrial habitat connectivity. Due to the scope of this analysis, it is recognized that site specific project analysis could reveal circumstances that require consideration for modifications to the interim riparian reserve widths. If site specific project analysis determines a need for deviating from the interim riparian reserve widths, the rationale for these differences must be documented and demonstrate that Aquatic Conservation Strategy objectives and terrestrial habitat connectivity would not be adversely affected.

Riparian Reserve Restoration

It is recommended that riparian reserves in this watershed can best be served, from an aquatic and terrestrial connecting habitat perspective, by an aggressive program of riparian restoration in areas where past clearcut harvest has created large areas of early-successional forests. This restoration should consist of any activities that would speed up the development of late-successional conditions. Such restoration activities could include density control to develop larger stem size and a shade tolerant understory, reintroduction of large woody material and/or other structural elements into channels, reforestation and underplanting, and possibly fertilization.

Activities in Riparian Reserves

Watershed analysis is also conducted to determine what management activities are appropriate within this watershed (USDA, USDI, 1994a, page C-7) and specifically within riparian reserves (USDA, USDI, 1994a, pages C-31 and 32). Considering past experience in this and adjacent watersheds, it is recommended that the following activities are generally acceptable within riparian reserves, assuming appropriate, site specific environmental analysis determines they are consistent with Aquatic Conservation Strategy objectives, Forest Plan Standards and Guidelines, and terrestrial habitat needs. In many cases the following activities are beneficial to the attainment of Aquatic Conservation Strategy Objectives. Those that do not directly benefit are neutral to those objectives.

- Commercial Thinning of Young, Managed Stands

Commercial thinning (usually cutting and/or removal of trees greater than 6 inches in diameter) is beneficial to riparian reserve objectives if it is shown that thinning will increase the average diameter of the stand, and/or accelerate the development of a shade tolerant understory. Accelerating the diameter growth and increasing horizontal and vertical diversity of riparian stands will assist in creation of late-successional conditions sooner and provide for a faster development of large woody material sources for in-stream and terrestrial habitat. See Appendix G for a more in-depth discussion of the detriments and benefits of thinning.

- Young Stand Density Management

Precommercial thinning (cutting trees less than 6 inches in diameter and leaving them on site) has the same future advantages as commercial thinning. Young stand density management prescriptions should consider options that avoid a later commercial thinning entry.

- Planting and Underplanting

The establishment of forest cover and the re-establishment of shade tolerant understories in otherwise undiverse young stands have obvious advantages to future riparian habitat.

- Collection of Regenerative Materials (seed, scions, cuttings, etc.)

Seed material and cuttings are collected and used for general reforestation and riparian area revegetation. Removal of this kind of material in a well vegetated riparian zone will have little influence on the amount of vegetation within riparian zones. Seed without the proper, early-successional environment may not germinate or seedlings will not survive and cut shrubs will vigorously resprout. Collection of such material can have high off-site benefits to riparian zones and upland areas needing revegetation. Such collections should have a neutral effect on the riparian zone experiencing the collection, given that this material is annually renewed and that collection would be done prudently leaving a substantial percentage of the vegetation in place.

- Collection of Special Forest Products

Commercial harvesting of berries and conifer boughs is considered neutral to riparian resources since these collections do not remove the associated plants, and involve the harvest of material that is annually renewable and, since collection would be done prudently, leaving a substantial percentage of the vegetation in place.

- Road Maintenance

The cutting of road side brush and trees, including blowdown trees that fall across roads, to provide for better visibility and a passage wide enough for vehicles, occurs only within the roadway prism. It would occur in areas where decisions have been made to keep the roads open for a variety of resource, administrative, and recreational reasons. Road side brush and tree cutting would have a neutral effect on riparian systems since the presence of the road itself has a much more profound effect and generally would affect a small percentage of any stream reach. (see the ROD Standards and Guidelines, C-32 & C-33)

- Wildlife Tree Creation or Enhancement

The killing or topping of green trees to create dead and defective tree habitat in areas that are currently deficient in this habitat structure has a beneficial effect on riparian objectives. It creates a more diverse forest structure and will generate large woody material for in-stream and terrestrial habitat faster than would natural processes.

- Improving Aquatic Habitat (i.e., large woody material or other structural placement in stream channels)

While there could be some short term negative effects due to sediment production and damaging of small amounts of riparian vegetation, introduction of various channel structural elements in stream reaches currently deficient in large woody material (due to floods or past management) would have long term benefits to the complexity and productivity of in-channel habitat for fish and other wildlife species, as well as improving bank stability. Habitat improvement projects should be based upon a limiting factor analysis. Habitat improvements should be prioritized by protecting and improving habitat in areas where high quality habitat and healthy fish populations exist and where threats to habitat and structures from high flows are low. Habitat that is currently badly degraded would be a lower priority. A more project specific analysis is needed to determine which areas have highest priority.

- Browse Enhancement or Release of Trees

Cutting of brush for forage generation or to release sapling trees occurs in young, managed stands that have yet to close their tree canopy. This activity could have negative effects if it occurs on channel edges but this activity is never proposed close enough to stream channels to affect channel shade. This activity has a neutral effect on riparian objectives, and tree release can have long term benefits if that activity accelerates the development of a diverse coniferous forest.

- Fertilization (as long as there is no direct application to water surfaces)

Fertilization benefits riparian area function to the extent that it accelerates the growth and development of a diverse conifer stand. It also may increase the productivity of the stream system by generating increases in energy and nutrients that enter the stream through litter fall. Fertilization is not recommended within stream channels or wetlands.

- Provision of Recreational Opportunities (trails, campgrounds, river and lake access, viewpoints, dispersed sites)

Current recreational sites and facilities often contain areas of bare soil and comparatively low vegetation density. These sites are almost always on flat or at least stable ground that is relatively resistant to erosion. Since the bare areas are relatively few and far between, the current number and use level of these sites and facilities have a neutral effect on the function of riparian systems.

- Creation and Maintenance of Water Sources

Creation of sites for pumping water to supply fire suppression and road maintenance water needs can be detrimental to riparian connectivity and fish passage if improperly designed and placed. If properly designed, placed, used, and maintained they can increase the diversity of the riparian habitat by creating deep pools where none existed before. These facilities can be beneficial or neutral where their creation is designed with appropriate analysis. These facilities should be monitored for the presence of T,E, and S species and fish before any maintenance or enhancement work is begun.

- Creation of Skyline Corridors if Needed to Avoid Construction of Excessive Amounts of Road

Road construction is often the largest source of sediment. It may sometimes be preferable to yard logs through riparian zones to avoid the need to construct road to access landing sites providing for yarding away from streams. Though skyline corridor clearing may increase the amount of solar radiation entering a riparian zone, the effect is short lived as narrow canopy gaps can close fairly quickly. Skyline corridors are most compatible with riparian area objectives if properly designed and trade-offs between corridor effects and road construction are evaluated. They may be the least impact alternative if their creation is to avoid the construction of potentially more damaging roads.

- Use of Individual Trees for Cable Yarding System Tail Holds

Cable yarding tail and guy line anchor points often require the cutting of a tree to provide a secure anchor without the threat of pulling a whole tree over. If in riparian areas, these trees are usually left in place when felled. Since these tail holds usually involve one tree and there are relatively few landings near riparian zones, their effect on riparian functions is negligible and their creation is in most circumstances neutral to riparian values. Since there is value to down trees as well as standing trees, there may be some benefit to riparian resources if down trees are needed to enhance riparian or terrestrial habitat. Additionally, if tail holds in the riparian zone can accomplish full log suspension on adjacent upland areas, there would be a benefit to riparian areas by avoiding adjacent soil disturbance.

- Fuels Treatments (generally hand pile and burn or light underburning)

Reduction of fuels may be prescribed to protect a riparian zone from future fire risk, especially in areas where fuel is generated by thinning. Treatment of such fuel accumulations has the additional advantage of providing for easier travel for large animals, and can be considered beneficial to riparian systems. See also the discussion of prescribed underburning of LSR's discussion in Issue #2 of this chapter.

- Noxious Weed Treatment

Killing or reduction of noxious weeds, if properly and sensitively done, can have large benefits to riparian systems. Such treatment can avoid supplantation of native species. Certain noxious plants can affect the use of riparian zones by removing favorite foraging plants or by restricting travel (as Himalayan blackberry can).

- Crossing of Streams by New Road Construction

When properly designed and constructed, road crossings may have minimal effect to riparian management objectives (as long as fish and Herpetile passage is included), as they affect relatively small portions of the riparian zones. Road construction may be preferable to yarding across streams if acceptable log suspension cannot be achieved from existing roads. All new culverts will meet 100 year flood criteria.

- Culvert and Bridge Maintenance

Cutting of selected trees within 100 feet upstream of large culverts and all bridges is sometimes proposed to protect these structures from debris that could, if large amounts accumulate against trees growing within or between channels, i.e. sand bars in the stream channels, cause a failure of the stream crossing structure. Such cutting can have small negative effects, but prevention of structure failure may have larger, long term benefits to riparian resources.

General Upland Activities

Certainly if the above activities are considered to be acceptable within riparian zones (again with appropriate, site specific environmental analysis), they are also considered acceptable in upland areas.

Small Wetlands

The inconsistency in the definition of a small wetland (less than 1 acre) between the Northwest Forest Plan and the Willamette National Forest Plan should be resolved. It is recommended that the 100 to 600 foot buffer width for small wetlands specified in the Forest Plan, MA-15-03, be dropped. In its place the definitions and buffer prescriptions (Table 2f, page 23) in the Willamette National Forest Special Habitat Management Guide should be adopted.

Thinning

For the reasons mentioned in Appendix G, in addition to the objective of maximizing timber volume production in matrix lands, thinning of young stands is recommended. As with all other activities, thinning should only occur when site specific exams and stand growth modeling show that thinning would better or more quickly accomplish various stand management objectives such as producing larger stems, more diverse stand structure, or capturing suppression mortality, and when analysis shows that it can be accomplished without significant resource effects.

Fuels Management

It is recommended that prescribed burning be considered in strategic areas, including within the LSRs, to more closely mimic natural processes and to better protect reserves from catastrophic fire. Wildfire was a wide spread ecosystem process in this area, and extensive portions of the area periodically underburned during times when stand replacement wildfire occurred. As mentioned in the Chapter II discussion of fire history, not enough is known of the extent of underburning in this area to provide specific prescriptions in terms of area per unit of time. It is recommended that a more intensive study of underburning be commenced to develop a better idea of how frequently and where prescribed fire should occur. Prescribed fire can be detrimental to late-successional habitat in terms of removing large wood, snags, and shade tolerant trees but may be beneficial on a landscape level in terms of protection from catastrophic fire and creation of new snags. It is felt that the percentage of this watershed treated with prescribed fire in a given decade should not be large. See the prescribed fire discussion under Issue #2 of this chapter for a more thorough discussion of underburn fire prescriptions.

Erosion

Erosion potential and slope stability should also be considered in determining where green trees, snags, and large woody material are to be retained in harvest areas, in addition to other objectives, such as those for habitat structure and logging feasibility.

Compaction

Current management direction has moved away from tractor logging in most cases, so no recommendations will be made. The experimentation with low ground pressure machines, designated travel paths, and other ground based systems (such as cut-to-length yarding, harvester-forwarders, grapple piling with minimal travel) should continue to have an associated monitoring program to determine whether these methods are meeting the Forest Plan Standards and Guidelines (not greater than 20% of activity area in a detrimental soil condition). The same holds true for compaction treatments such as sub-soiling. Amelioration of compaction through sub-soil ripping should be considered in compacted areas if such activities will not affect the health and function of live trees already on the sites.

Aquatic Habitat

It is recommended that reintroduction of bull trout and spring chinook salmon be considered for this watershed. The habitat, stream temperatures, and lack of competing species (such as brook trout) make the Salmon Creek watershed the most likely of the watersheds on the Oakridge Ranger District to successfully support reintroduction efforts. (The North Fork currently has large numbers of brook trout in the upper reaches and Salt Creek has higher water temperatures and has less available habitat.)

There is a need to restore and maintain the habitat for future reintroduction of spring chinook salmon and bull trout (specifically in reaches where it is currently deficient). Stream habitat improvement projects in Salmon Creek and its fish bearing tributaries should continue in anticipation of the eventual reintroduction of spring chinook salmon and bull trout into this watershed.

The upper watershed, above the confluence with Wall Creek, currently has water temperatures most suitable for bull trout and spring chinook salmon (maximum temperatures less than 57° Fahrenheit). Areas in the lower watershed, below Wall Creek, are currently above the optimum temperature for both spring chinook salmon and bull trout (Figures 42 and 43 of the Reference/Current Conditions chapter). The average of maximum 7 day average temperatures at the mouth of Salmon Creek are below 66° Fahrenheit (Figure 10 of the Reference/Current Conditions chapter). Temperatures in Salmon Creek (Tables 8 and 9 of the Reference/Current Conditions chapter) were historically nearer to optimum for spring chinook salmon and bull trout (Figures 42 and 43 of the Reference/Current Conditions chapter) but increased through the early 1980's. Temperatures have decreased since this time and should continue along this trend because much of the watershed is within a Late-Successional Reserve and future impacts from timber harvest activities will be minimal.

Other types of habitat, such as large woody material, spawning and rearing areas, and overwintering habitat, are also available throughout the Salmon Creek watershed (see the Reference/Current Conditions chapter: specifically the channel condition and aquatic wildlife sections). In addition, brook trout are only present in the upper portions of Mule Creek and Wall Creek and have not been located elsewhere in the mainstem of Salmon Creek, Black Creek, or its tributaries.

In areas used by boaters, large woody material or other channel structures that span the width of the creek should not be used in the mainstem of Salmon Creek to avoid creating boating hazards.

If any recreational suction dredging begins to occur it should be closely monitored to determine its effects on salmonoid eggs and young in order to determine how or if potential impacts could be decreased should this activity become more common.

Wildlife Habitat

Prohibit habitat altering and disturbance activities within bald eagle or peregrine falcon primary, secondary, or tertiary management zones until management plans are completed for bald eagle and peregrine falcon management areas. These management plans should be used to guide activities proposed within the watershed and should focus on reproductive security and prey species habitat enhancement for these areas.

Apply silvicultural practices in matrix, such as post thinning underplanting, which promote progression of hiding cover to thermal cover for big game.

Sensitive Plant Habitat

Continue to identify and classify special habitats during project level planning. Ground truth during field visits to confirm or reclassify SHABs identified during watershed analysis. Analyze SHABs to determine buffer prescriptions to maintain the integrity of SHAB type.

Rare forested stands identified in the Willamette National Forest Special Habitat Guide should be evaluated for significance when encountered during harvest project analysis to determine if they need to be included in a Research Natural Area, or otherwise protected from disturbance.

Conduct surveys, consistent with the Northwest Forest Plan Record of Decision, for C-3 Survey and Manage Species known in the watershed during planning efforts. Consider opportunities to designate special interest areas or areas of critical concern for "hot spots" of biological diversity on a planning area basis.

LSR Activities

Young stand density management (or early thinning), commercial thinning, and stand fertilization activities should be prescribed in Late-Successional Reserves, consistent with the findings of the interim LSR Assessment, to accelerate the development of late-successional habitat.

Noxious Weeds

Continue noxious weed surveys to identify new invaders and "sleepers" (those that may have the potential for dramatic future spread). Inventory other invasive non-natives at the same time. Continue introduction of biological control agents. Look for opportunities for future introductions.

Recognize that the main travel routes for weeds are roads, and consider every opportunity during the Access and Travel Management Plan analysis to close and decommission roads to allow native species to shade out non-native plants.

Coordinate more closely with right-of-way maintenance crews to ensure scotch broom is cleared along with other vegetation.

Look for opportunities such as using Jobs-in-the-woods crews, YCC crews, etc., to control scotch broom and blackberries in sites that are not well established.

Collect and propagate native species for use on decommissioned roads and other ground disturbing project sites that promote non-native spread. Prioritize higher elevation roads and sites that are not likely to revegetate quickly or shade out weedy species after closing for re-seeding with native herbaceous species. Consider the use of native leguminous species. Consider the use of native species with a potential for Special Forest Products collection opportunities.

Experiment with use of prescribed fire to eradicate noxious weeds, using small test plots.

ISSUE #2

The exclusion of natural fire from the ecosystem has altered the natural processes.

Prohibit habitat altering and disturbance activities within bald eagle or peregrine falcon primary, secondary, or tertiary management zones until management plans are completed for bald eagle and peregrine falcon management areas. These management plans should be used to guide activities proposed within the watershed and should focus on reproductive security and prey species habitat enhancement for these areas.

The various reserve areas in this watershed are important in maintaining diversity and meeting management direction. Fire suppression efforts are critical to maintaining the values of these reserves. Provision of access, establishment of fuel breaks, and providing for quick response to fires may overall be more important than fuels reduction efforts since fuels reduction could change the desired conditions of these late-successional habitat reserves. Underburning may be acceptable in some areas and unacceptable in others. Protection of younger stands is vital to bring the area back to older seral stages. It is recommended that priority road access be maintained in the Late-Successional Reserve (as determined by the ATM planning process), and fuel breaks be established to assure the needed protection, in addition to sensitive treatment of fuels. Creation of fuel breaks should involve treatment of activity generated fuels (such as those from precommercial or commercial thinning) along strategic road locations.

Prescriptions for underburning of relatively large blocks in Late-Successional Reserves should be developed. These stands can and should include the riparian reserve areas and should be dominated by Douglas fir. The area to be treated should be determined by an LSR assessment and LSR fire management plan. Potential priority locations include the south slope of Koch Mountain and the south slope of Long Prairie. Benefits to prescribed burning in the LSR include: the more fire susceptible early seral stands would be buffered (30% of the area is now in early seral condition) and the risk of stand replacement fires, which is a concern given the fire history of this area, would be reduced. Prescribed fire should be used mostly in mid seral stands. These stands do not provide optimal late-successional habitat. Mid seral stands do have bark development and crown height conducive to survival of moderate intensity ground fire and have little in the way of late-successional structural habitat that would be destroyed by fire. Every effort should be made to keep fire out of classic old-growth until the young stands begin to approach late-successional habitat conditions. Underburning in LSR's could have some short term detriment to late-successional habitat and short term benefit for big game. It would also have long term benefit for late-successional habitat in terms of protection from future catastrophic fire.

Prescribed natural fire in wilderness could help to restore big game forage quality and quantity in areas where current forage values are below reference conditions (the eastern portions of subwatersheds 18 2 and 18 3). Every opportunity should be taken to allow fires to play their natural role in the wilderness.

Prescribed fire should occur in the Deer Camp area to improve forage for big game.

Consider use of prescribed fire, girdling, and selective harvest methods to maintain and/or restore non-forested meadow complexes that are presently being encroached upon by trees.

Use prescribed fire as a tool to encourage germination of fire dependent species such as woodland milkvetch and branching montia. Monitor burns to determine whether they were successful in releasing these species from the seed bank.

Waldo Mountain lookout would be a key facility in helping to accomplish the prescribed fire goals. Tree topping and/or tree removal around the lookout should be done. A fire free safety zone, devoid of any vegetation, should be established around the lookout to help decrease the risk of the lookout itself being burned.

ISSUE #3

The density, condition, use, and location of roads and trails has altered the landscape processes and influenced wildlife habitats.

Implement road closures to be in compliance with Willamette National Forest Plan Big Game Habitat Quality standards in BGEAs:

Flat	= 16 miles	Pitch	= 9 miles
Hatchery	= 1 mile	Ranger	= 2 miles
Kelsey	= 1 mile	Wall Head	= 2 miles

The above road closures should be implemented to assist in accomplishing road restoration goals as identified in the WIN surveys, and as determined by the ATM planning process.

Prohibit habitat altering and disturbance activities within bald eagle or peregrine falcon primary, secondary, or tertiary management zones until management plans are completed for bald eagle and peregrine falcon management areas. These management plans should be used to guide activities proposed within the watershed and should focus on reproductive security and prey species habitat enhancement for these areas.

An inventory of roads located on steep ground needs to be done with an emphasis on the road system constructed prior to 1980. See the road discussion under Issue #1. Specifically, an inventory of the locations where the outside road edge is cracked and settled and an assessment of the viability of the road drainage system assuming minimal maintenance frequency.

The Access and Travel Management Plan team should initiate the following:

- Review non-system roads to determine if any should be converted to system roads or placed on the trail system. If not placed in the system, either road or trail, the recommended method of decommissioning to reduce the potential resource impacts should be identified.
- Review system roads that have chronic maintenance problems. Determine what actions to take to protect resources given that maintenance levels are being lowered.
- Determine which road systems produce high sediment delivery into the streams and recommend what actions to take.
- Determine if the road user should pay for maintenance of system roads when access to that road is only for that user, or users, if road maintenance funds are not available.
- Determine what actions to take if funds are not available to maintain system roads.

Since less than 1% of the culverts within the analysis area have been assessed for hydraulic capacity relative to a 100 year flood, this work needs to continue. The District WIN database indicates a number of culverts have diminished hydraulic capacity due to plugging, damage, or deterioration. The WIN information should be used to prioritize culvert restoration work. Culverts with a high likelihood to affect large areas of quality habitat should they fail should be repaired first. Continued analysis along timber sale haul routes will indicate deficient culverts and provide funding opportunities. However, additional emphasis needs to be placed on analysis of culverts in streams identified as having high aquatic habitat value.

Road maintenance scheduling needs to factor in the results of culvert inventories. Specifically, culverts with identified deficiencies that are easily corrected, plugged inlets for example, should be treated as soon as possible.

Replace or modify culverts that are currently blocking fish passage or compromising habitat connectivity. Generally, tributary stream culverts closest to the main stem Salmon Creek channel that would increase access to the greatest amount of habitat should receive the highest priority for such modification. Review the results of culvert condition surveys to determine the feasibility of developing small contracts for inlet and outlet improvements.

Bridges and culverts that are passable to fish that cross tributary streams should continue to be installed as new roads and trails are built in the Salmon Creek watershed.

ISSUE #4

Aquatic communities may have been changed from reference conditions due to the introduction of non-native species.

Study the effects of the introduction of fish into naturally fishless lakes in coordination with ODFW.

Brook trout should not be stocked in lakes which have outlets that are tributaries to Salmon Creek or Black Creek. Where naturally reproducing populations of brook trout in lakes occur measures should be taken to prohibit brook trout from establishing populations in streams where spring chinook salmon and bull trout could be potentially reintroduced. Currently there are no known populations of brook trout in the upper portions of the watershed, although they are known to exist in Mule Creek and Wall Creek. (Brook trout hybridize and out compete native species such as bull trout)

Look at the possibility of controlling brook trout, without negatively affecting other aquatic species, to prepare for a more successful reintroduction of bull trout and spring chinook salmon.

ISSUE #5

The diversion dam for the Willamette Fish Hatchery has the potential to fail, which in turn, could disrupt operations at the Fish Hatchery.

The new Willamette Fish Hatchery diversion dam should be equipped for fish passage, both for anadromous populations as well as resident populations.

ISSUE #6

There is a concern for protection of water quality for the Oakridge municipal water supplies and the Willamette Fish Hatchery.

The District Hazardous Materials Coordinator should monitor the implementation of plans and policies listed under Issue #6 in the Interpretation section of this document.

Use of hazardous materials should be limited to the maximum extent practicable.

The Willamette National Forest should work in cooperation with the City of Oakridge to develop a wellhead protection plan.

Development of projects that utilize potentially hazardous materials or equipment that could cause chemical spills should stress HAZMAT (hazardous material) planning and response. HAZMAT planning and response should also be stressed for operations at the Flat Creek facilities.

ADDITIONAL ITEM:

An issue that was discovered during the watershed analysis process and should be included in later addendum's to this document is that Fig and Photo Lakes should be monitored. Lake surveys conducted in 1996 indicated low (acidic) pH values as well as low alkalinity values. This means these lakes have a low capacity to resist changes in pH. Fig and Photo Lakes also have low levels of dissolved oxygen (DO) (Table 28 of the Reference/Current Conditions chapter). In addition chlorophyll "A" concentrations should be monitored in Blair, Spirit, and Lower Salmon Lakes as these lakes had higher concentrations than was observed in other lakes. Other lakes in the watershed should be monitored to obtain baseline information.