

CHAPTER 1

INTRODUCTION

INTENT OF WATERSHED ANALYSIS

The intent of this Watershed Analysis is to develop and document a scientifically based understanding of the processes and interactions occurring within the Upper McKenzie watershed. This understanding, which is focused by the watershed's key issues, is essential for making sound management decisions. Gaining an understanding of the interactions between land-use activities and the physical and biological environments in this area will be invaluable to the success of managing this ecosystem for all its values.

Direction for conducting this report lies within the FEMAT Report (USDA/USDI 1993) and the FEIS ROD on Management for Late Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (USDA USDI 1994, hereafter referred to as the ROD). A Federal Agency Guide for Watershed Analysis (versions 1.1 and 1.2)(USDA 1994) was followed to guide this analysis.

This watershed analysis will produce a "living" document. Appendices and other additions will continue to be produced over time as new data is obtained or new issues are recognized.

Products of the analysis will include:

- A description of the watershed, including its biotic and abiotic resources
- A description of the watershed key issues
- Past and current conditions and processes on this landscape
- Trends and potential effects of future land management actions
- Recommendations for future management actions
- Guidance to be considered in future site-specific analysis and project-level planning

The findings within this analysis represent a foundation on which to develop site specific project proposals and to base specific future decisions.

RELATED DOCUMENTS

Documents with direction or information related to this project at the forest level includes the Willamette National Forest Resource Plan (1990) as amended by the ROD (1994). At the subbasin scale, the McKenzie Watershed Council is compiling some analytical information through the Lane Council of Governments (LCOG). An Integrated Resource Analysis (IRA) and a Watershed Analysis were conducted for the Santiam Pass portion of the watershed in 1993 and 1994, respectively. Information from these documents was incorporated into this analysis.

CHARACTERIZATION OF WATERSHED

LOCATION AND LAND USE

The Upper McKenzie Watershed Analysis Area (UPMKWA) extends north from the town of McKenzie Bridge into the Mt. Jefferson Wilderness. To the east, it abuts the western edge of the Cascade Crest (Figure 1-1). Management objectives on 99% of this landscape are outlined in the Willamette National Forest Land Management Plan (LMP), as amended by the ROD for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl (USDA, USDI 1994). Approximately 1% of the watershed is private land. A mix of private timber production and residential uses occur in these areas. Land allocations are listed in Tables 1 and 2 and shown in Figures 2 and 3.

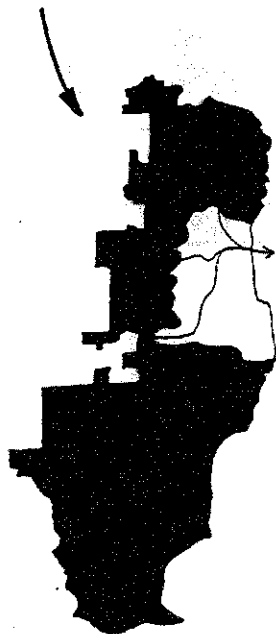
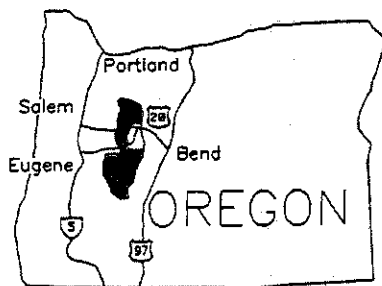
Table 1: Land Allocations within the ROD for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl (USDA, USDI 1994) and the Critical Habitat Unit designated by the USFWS (1991). Several of these allocations overlap.

ROD Allocation	Acres
Late Successional Reserve (large)	111
Late Successional Reserves (100 acre)	4,933
Adaptive Management Area	25,290
Matrix	66,746
Riparian Buffers (w/default widths)	40,416
Critical Habitat Unit	38,074
Key Watershed	134,937

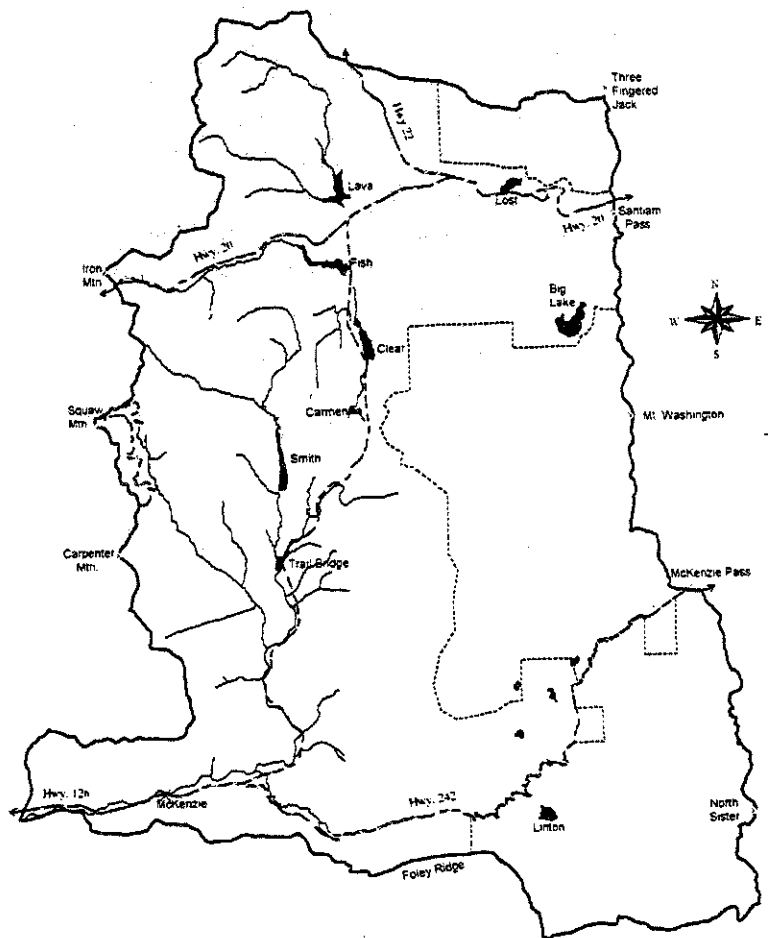
Table 2: Willamette National Forest Land Management Plan land allocations within the Upper McKenzie Watershed.

Management Area Number and Name	Acres
1 Wilderness	79,482
10B Dispersed Recreation-Semiprimitive Motorized	17,651
10C Dispersed Recreation-Semiprimitive Motorized	2,864
10E Dispersed Recreation-Semiprimitive Nonmotorized	14,394
10F Dispersed Recreation-Lakeside Setting	527
11A Scenic-Modification Middleground	6,195
11C Scenic-Partial Retention Middleground	11,579
11E Scenic-Retention Middleground	5,207
11F Scenic-Retention Foreground	7,438
12B Developed Recreation-Special Use Permits	662
13A Special Use Permit Areas	62
13B F.S. Administrative Use Area	53
14A General Forest-Intensive Timber Management	60,078
3A H.J. Andrews Experimental Forest	3
4 Research Natural Areas	1,880
5A Special Interest Areas	5,625
6D Wild and Scenic River - McKenzie River	4,290
7 Old Growth Groves	222
9D Wildlife Habitat-Special Areas	6,313
8000 Private lands	6,389

Figure 1-1. Upper McKenzie Watershed



Willamette NF



Upper McKenzie Watershed

Figure 1-2. 1990 Forest Plan Management Areas

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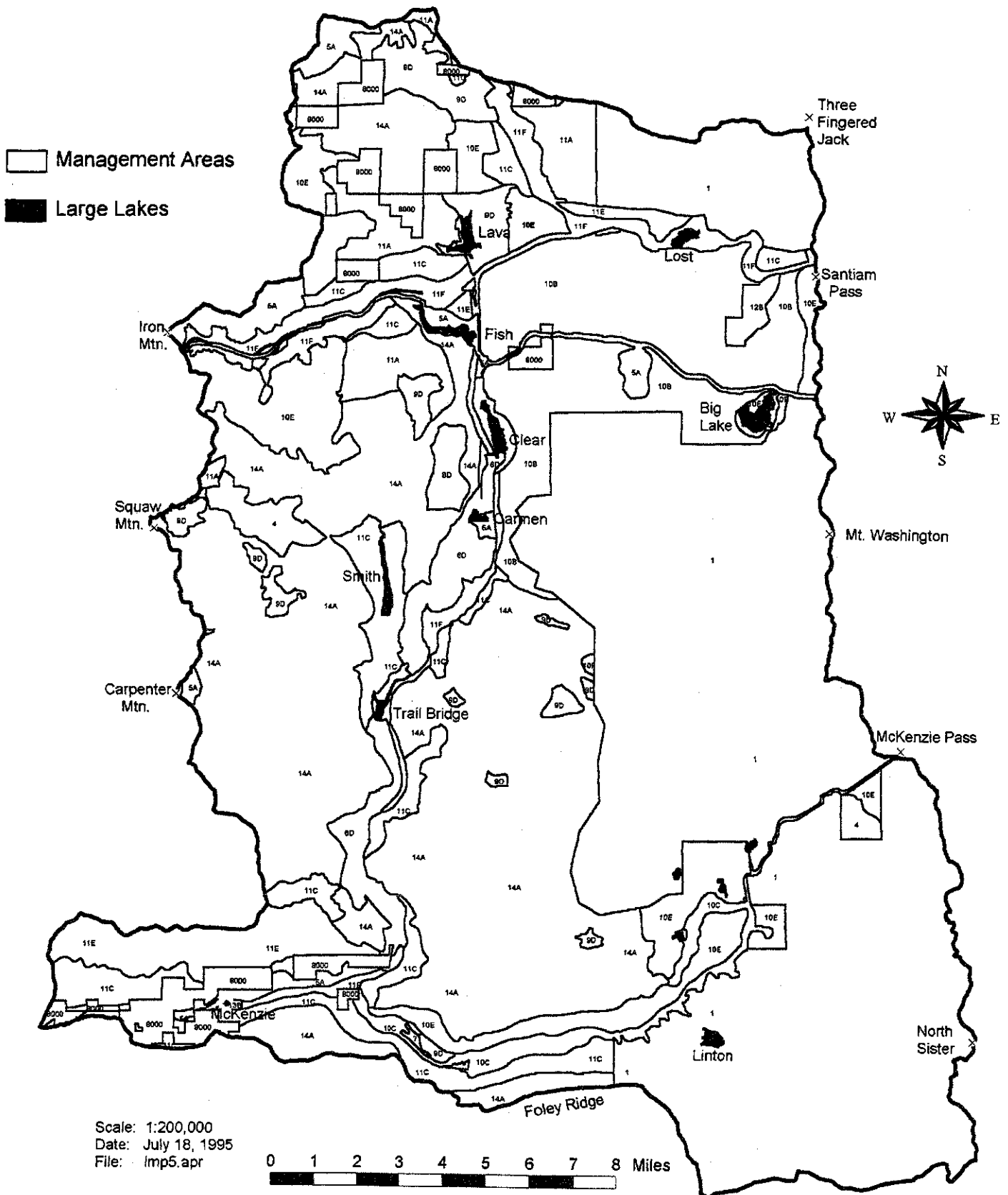


Figure 1-3. ROD Allocations - AMA & Reserves

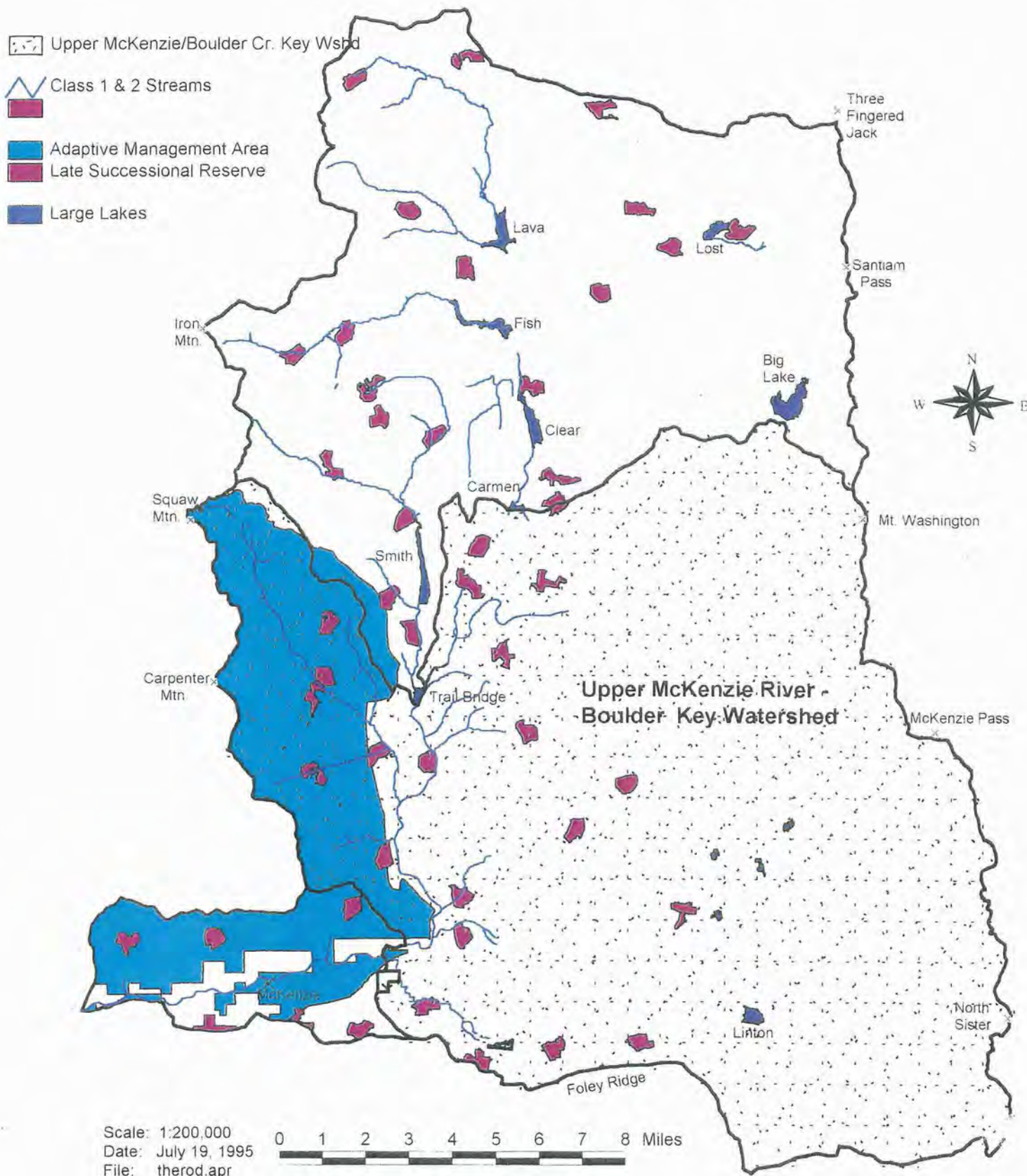
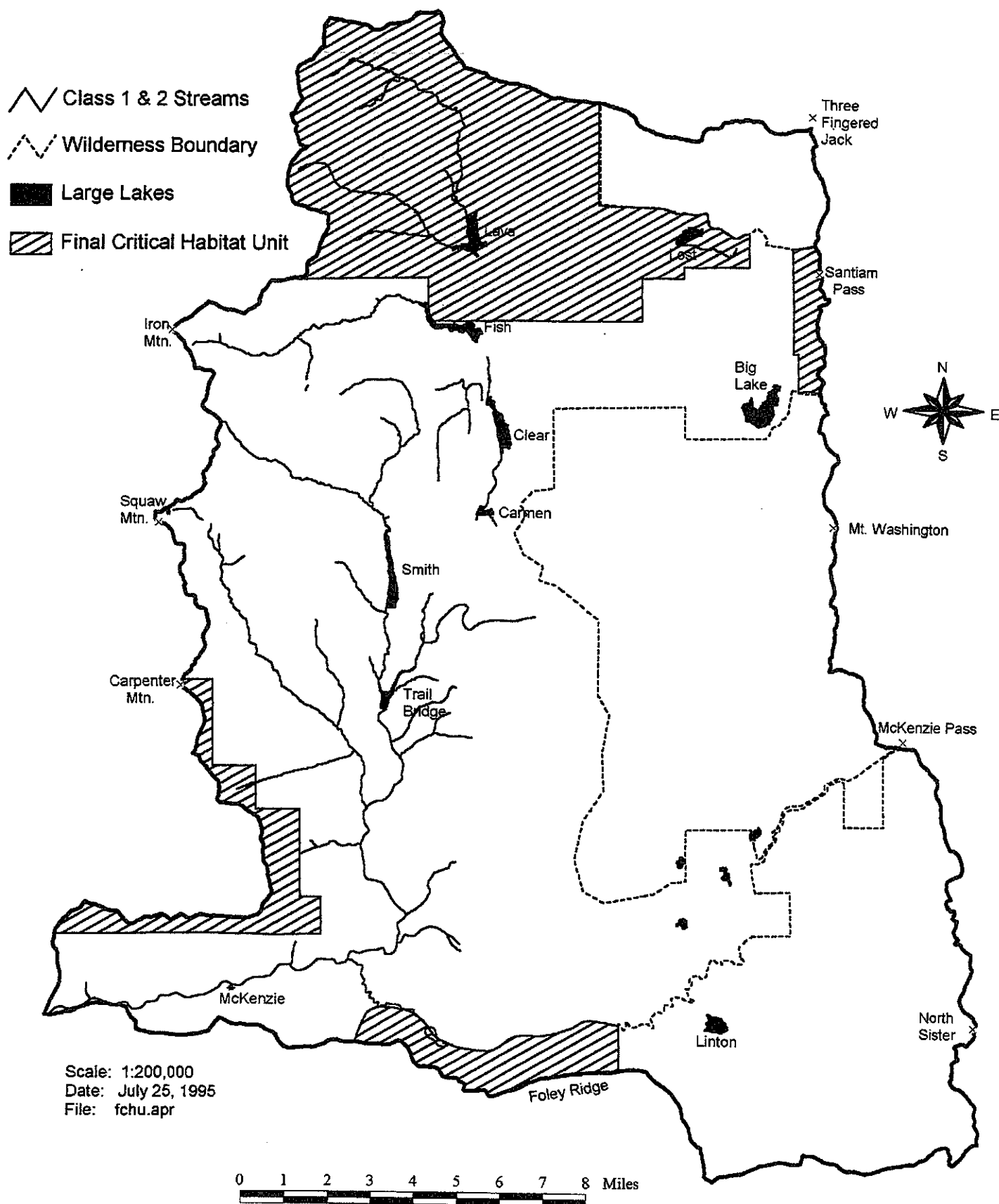


Figure 1-4. FCHU - Final Critical Habitat Units



GEOLOGY AND WATER

The Upper McKenzie Watershed is truly a landscape formed by fire and ice. It is located in a area of volcanic terrain on the west side of the Cascade Range. Two physiographic provinces meet here: the Western Cascades and the High Cascades. The High Cascades are divided into three areas: older, Early High Cascade volcanic flows (9 - 4 million years old); younger, Late High Cascade volcanic flows (4 million - 12,000 years old); and recent volcanic flows (12,000 - 1,500 years old). The Early High Cascade flows are ridge-capping basalts in the highest elevations of the Western Cascades.

Two periods of major faulting took place in the area 8 - 10 million and 4 - 5 million years ago as a result of extension of the Earth's crust. These major northwest-trending fault systems developed near the present boundary of the Western and High Cascades. These fault systems control the north-south flow of many of the upper reaches of Cascade rivers, including the McKenzie, South Fork of the McKenzie, Smith, and North Santiam (Priest et. al. 1983).

Approximately 3 - 5 million years ago, regional uplift began taking place at a rate of approximately 20 centimeters per 1,000 years, which produced an increase in elevation of approximately 1,300 feet. This increase in elevation was associated with an increase in stream gradients, some of which were more than twice their norm (Sherrod 1986). The increased stream gradients produced deeply dissected valleys; increased relief; and created drainage patterns now present in the Western and Early High Cascades.

The early High Cascades and Western Cascades were subsequently eroded by at least three periods of alpine glacial advance down-valley as far as Blue River (Long & Leverton 1984, Scott 1977, Van Dusen 1962). Glacial floods and lower mean sea levels produced further valley scouring. However, subsequent outwash, still water, and landslide deposits (to depths of over 100 feet) refilled the valleys to a base stream level that matches the existing sea level. Valley fills have been drilled to 146 feet in the Blue River area and up to 175 feet in the McKenzie Bridge area (Williamson 1961).

Remnants of these ancient glaciers are found on the side slopes of the Three Sisters, which now contain approximately 5.6 billion cubic feet of ice in five major glaciers. The glaciers cover 3.2 square miles (Allen 1985). The younger volcanic flows, which erupted after the ice ages, buried most of the glacial deposits in their path. The extent and volume of these recent lava flows (as recent as 1,500 years ago) combined with their associated cinder cones (over 50 in all) make this watershed geologically unique. These recent lava flows filled ancient valleys and produced water falls, lakes, and underground springs in an abundance not found in other watersheds.

The filtering characteristics of the younger High Cascades lava and glacial deposits produce a subsurface aquifer very low in fine sediments. Unlike streams that flow overland within stream channels, the water that flows subsurface within the upper McKenzie does not have potential to pick up channel sediment, nor is it exposed to air temperatures and direct sunlight that could heat the water. This results in springs with extremely clear and cold water, such as at Clear Lake and Koosah Falls, and the sources of Sweetwater, Anderson, Ollallie, and Lost Creeks. Because these creeks were filled by

younger High Cascade lava flows, they flow within channels that have broad valley bottoms that are not incised or entrenched.

In contrast, streams such as Kink, Twisty, Boulder, and Scott Creeks that flow over the lava of the older High Cascades and glacial deposits have more incised channels than those flowing over the New High Cascades. The channels are more incised because they have downcut through the glacial deposits, returning to their original channels within the older High Cascades lava that have been subjected to fluvial processes for a longer period of time. The upstream portions of these channels are intermittent where streams flow over the top of the glacial deposits and have not cut down into the underlying lava of the older High Cascades.

Streams within the Western Cascades, such as Frissel, Deer and its tributaries, and Hackleman (in the upper reaches) have been greatly modified by fluvial processes including downcutting and mass wasting of unstable hillslopes. These processes, which began when the uplift of the block produced steep gradients, continue to this day. Water that flows from the Western Cascades generally contains more sediment and is warmer than water from the High Cascades.

FISH RESOURCES

The geological processes of this landscape have played an essential role in determining the Upper McKenzie Watershed aquatic community. Following the most recent glacial periods, this portion of the McKenzie River began to be inhabited by the aquatic animals currently present. This diverse aquatic community has adapted to many landscape processes including erosion, groundwater storage and delivery, and large woody debris transport. Our understanding of the aquatic organisms and their interactions among themselves and their landscape is limited. Animals of cultural or economic value are better known and will be described in this analysis.

To understand the aquatic community of this portion of the McKenzie basin, it is best to first review two general types of geology described above that shape habitat elements of the aquatic community. The processes of storage and delivery of large quantities of groundwater in the High Cascades, and erosion, sediment, and debris transport in the Western Cascades have created numerous habitat types that provide for sixteen suspected or documented fish species. The New High Cascades, with their constant, cold, clear water flow, host an aquatic community adapted to a narrow range of environmental conditions. Bull trout spend a portion of their life in the New High Cascades by utilizing the spring-fed portions of the subbasin as spawning and rearing habitat. Willamette spring Chinook, returning to the McKenzie River as adults, also seek out cool water temperatures in the upper subbasin and utilize gravel and cobble-rich portions of rivers and streams as spawning habitat. Much of the necessary sized gravel and cobble sought by spring Chinook originated from the Western Cascades, and these substrates now compose a significant portion of the McKenzie riverbed. Here in the Upper McKenzie Watershed, the landscape to which these two species have adapted is due to the contact between the Western and High Cascades.

VEGETATION

Upper McKenzie vegetation is generally characteristic of vegetation west of the Cascade crest. Forested plant series classification is a convenient and often used way of defining and stratifying these plant communities.

The forested plant series typically found in the Western Cascades include:

1. Douglas-fir series (*Pseudotsuga menziesii*)
2. Grand fir series (*Abies grandis*)
3. Western hemlock (*Tsuga heterophylla*)
4. Pacific silver fir series (*Abies amabilis*)
5. Mountain hemlock series (*Tsuga mertensiana*)

For a more complete description of the environmental conditions, classification system, listings of plant species, and plant association groups for each series, refer to the Willamette National Forest Plant Association and Management Guide (Hemstrom et.al. 1987).

Douglas-fir

The Douglas-fir series occurs on warm, relatively dry sites at lower elevations on southerly exposures. Major tree species include Douglas-fir, incense cedar, and grand fir. Douglas-fir generally dominates both the canopy and regeneration layers. Common dry site indicator species associated with the Douglas-fir series are chinkapin, madrone, oceanspray, poison oak, salal, dwarf Oregon grape, whipple vine, and grasses.

Grand fir

The grand fir plant series represents cool and relatively dry conditions, often found in the transition areas between the western hemlock and the Pacific silver fir series. Within the watershed, it is found on relatively dry, south-facing slopes and excessively well-drained soils of relatively recent volcanic origin. Important species include Douglas fir, grand fir, lodgepole pine, western white pine, subalpine fir, Prince's pine, dwarf Oregon grape, vanilla leaf, and beargrass.

The grand fir series is common in the 3500 to 4500 feet elevation band on the relatively droughty volcanic soils between Clear Lake and Santiam Pass within the UPMKWA. It is also found in isolated pockets in the Lava Lake and Parks Creek area.

Western hemlock

The western hemlock series occurs on warm, moist sites over a wide variety of slope and topography. Common species within the series include: Douglas-fir, western hemlock, western red cedar, bigleaf maple, red alder, vine maple, dwarf Oregon grape, salal, rhododendron, swordfern, vanilla leaf, Oregon oxalis, twinflower, and redwoods violet.

The western hemlock series is common along the McKenzie River valley and lower elevations throughout the Upper McKenzie.

Pacific silver fir

The Pacific silver fir series represents cool, moist conditions on upper slopes. Important species include: Douglas-fir, noble fir, Pacific silver fir, mountain hemlock, western hemlock, vine maple, dwarf Oregon grape, big huckleberry, rhododendron, grouse huckleberry, coolwort foamflower, false solomonseal, queencup beadlily, dogwood bunchberry, sidebells pyrola, and beargrass.

The Pacific silver fir series dominates moist upper-slopes, from approximately 3500 to 5000 feet elevation within the UPMKWA.

Mountain Hemlock

The mountain hemlock series occurs in cold, moist conditions at upper elevations. Most of the annual precipitation in this series falls as snow and results in a deep long-lasting snowpack. Important species include: mountain hemlock, subalpine fir, lodgepole pine, western white pine, whitebark pine, Engelmann spruce, big huckleberry, grouse huckleberry, Prince's pine, and beargrass.

The mountain hemlock zone (Franklin & Dryness 1973) can be divided into two major subzones, a lower subzone of closed forest and an upper parklike subzone. In the lower subzone, there is an essentially continuous forest cover of mountain hemlock and its associates. The upper zone (subalpine parkland) is a mosaic of forest patches and tree groups interspersed with shrubby or herbaceous subalpine communities.

The mountain hemlock series dominates the high elevation, greater than 4400 ft. elevation. It occurs all along the Cascade crest within the Upper McKenzie. The subalpine parkland subzone is typically found at elevations greater than 5600 ft.

Fire

The fire history of the watershed is similar to other westside Cascade watersheds. Return intervals and fire intensities are related to the plant association for an area and the age and health of the stand. The historic fire return intervals vary from low-intensity ground fires at approximately 25 to 110 year intervals to high-intensity stand-replacing fires at intervals of 100-200 years and greater.

Unique Botanical Resources

The Upper McKenzie watershed consists of many interesting and unique non-forest plant communities. Extreme ranges in temperature, wind, elevation, and soils contribute to making this a unique botanical area. A spring hike to Iron Mountain is filled with colors from the variety of wildflowers in bloom. Later in the summer as the snow melts in the wilderness areas, hikers are surrounded by meadows of lush vegetation and the majestic beauty of the Oregon Cascades. Wild huckleberry picking is an annual event for many in the late summer. A drive along Highway 20, 242, and 126 in the fall rewards the viewer to the brilliant red colors of vine maple against the stark gray background of the lava fields.

The watershed is home to many rare plants. Two sensitive plants, Newberry's gentian (*Gentiana newberryi*) and Mountain grapefern (*Botrychium montanum*) are the only known populations on the Willamette National Forest. Several botanical Special Interest Areas and Old-Growth Groves are also located within the watershed. These areas have been recognized for their outstanding biological and ecological contributions to forest ecosystems. Two Research Natural Areas in the watershed are biotic preserves of ecological and genetic diversity. There are hundreds of non-forested plant communities that range from low elevation meadows to subalpine rock gardens. The Upper McKenzie watershed is a botanical delight to be enjoyed by all.

WILDLIFE

The geological processes that shaped this landscape have heavily influenced the variety of wildlife habitat that exists here. These influences, combined with the ecotonal effects of the Cascade Crest, have created habitat that is unique on the Willamette National Forest. In the higher elevations, xeric sand blow outs provide habitat for the rare short-horned lizards and lava tubes provide homes to Townsend's Big-eared bats. In the lower elevations, mesic old-growth forests on deep soils provide habitat for high densities of spotted owls and red-backed tree voles. Volcanic eruptions dammed rivers to create lakes that are important winter stopovers for migrating water fowl; and golden eagles utilize updrafts created by the cinder cones. Harlequin ducks flourish in the amazingly clean water of the McKenzie River. Spotted frogs and sandhill cranes breed in the high elevation marshes. Other unique species, including the goshawk, great gray owl, wolverine, western pond turtle, and black-backed woodpecker help to make the Upper McKenzie the most species' rich watershed on the Forest.

HUMAN USE

The McKenzie River corridor had its scenic beauty and recreation potential noted by the earliest explorers and settlers of the area. In fact, some settlers used the recreation resources as their economic base as much as farming or ranching. A distinctive note about the town of McKenzie Bridge, when compared to most Oregon Cascade mountain settlements, is that the area did not develop around a lumber mill. Although logging eventually became a major economic feature, tourism and visitor services provided by lodges, inns, hot springs, and outfitters were the original features of the area.

This area has many major destinations that would individually be seen as the crown jewels of other regions: all within an hour drive of each other. Places such as Sahalie, Koosah, and Proxy Falls are often featured on calendars and advertising photos. Dee Wright Observatory, the historic stretch of Highway 242, and the lava fields are unique features in Oregon. Fish Lake Guard Station has been in continuous use as a commercial station and later as a Forest Service working station since the 1870's. Clear Lake, with its outstanding water clarity, allows views of the submerged forest flooded during the lake's formation 3,000 years ago. The McKenzie River itself is an outstanding feature with white water rafting, fishing, and recreation facilities that have been the focus of visitors since the earliest travel routes allowed access.

Prehistoric heritage resources are not well-understood at this time. This portion of the Cascades was occupied primarily by people indigenous to the Cascades, probably ancestral to the Molalla people.

CONTEXT OF THE WATERSHED

It is important to understand how a particular watershed functions within a larger landscape. Watersheds are not closed systems. The condition of the surrounding area will influence patterns and processes within the watershed. The following is a brief overview of the context of the Upper McKenzie Watershed as it lies in the McKenzie Subbasin and Willamette Basin.

LANDUSE—McKenzie Subbasin

The Upper McKenzie Watershed contains the headwaters of the McKenzie River Subbasin, which is part of the Willamette River Basin. A Watershed Council for the McKenzie Subbasin has been in existence since June of 1993. The purpose of this group is to provide a consensus-based forum to address issues affecting the watershed. Council partners include representatives from local, state, and federal agencies, special interest groups, and residents.

In 1990, 22,648 people lived in the McKenzie Subbasin; 9,512 in rural areas and 13,136 in urban areas (McKenzie Watershed Council 1994). Approximately 61% of the subbasin is managed by the USFS and 6% by the Bureau of Land Management. Other government agencies manage 1%; industrial forest land comprises 22%; and other private uses including residential areas and agricultural lands fall on 10% of the subbasin.

Harvestable forest lands account for 49% of the McKenzie Subbasin. Industrial forest companies manage approximately 45% of the harvestable base. These figures are approximate due to portions of industrial forest land subject to restrictions on harvest, such as riparian buffer zones, and some acres small woodland owners may log. One third of USFS lands within the subbasin are in harvest allocations.

Development and demands for recreation along the river is widespread and growing. People use the McKenzie river and its adjacent lands for fishing, hunting, hiking, biking, photography, picnicking, boating, and swimming. Fishing and boating are the most popular uses.

WATER MANAGEMENT—McKenzie Subbasin and Willamette Basin

The Upper McKenzie Watershed represents 25% of the McKenzie River Subbasin. The water of the McKenzie River is one of the most cherished resources of the subbasin. In addition to providing habitat for fish and other aquatic species the McKenzie River provides drinking water for over 200,000 people in the Willamette Valley.

Five dams lie within the Subbasin: three on the mainstem and two on tributaries. There are eight additional dams in the Willamette Basin. The dams were constructed for flood control within the Willamette Valley. During flood season, the dams provide maximum flood control storage space. In February, the space reserved for flood control storage is gradually filled. Flood control regulation is based primarily on downstream channel capacities and reservoir storage space available (US Army Corps of Engineers 1989). Augmented flows released from the reservoirs during the months of low precipitation and streamflow helps to meet DEQ water quality standards (dissolved oxygen, temperature, dissolved solids) in the Willamette River downstream from Corvallis to Portland. The dams also supply hydroelectric power to the Eugene Water and Electric Board, which sells some to the Bonneville Power Administration.

FISH AND WILDLIFE RESOURCES—McKenzie Subbasin

Twenty-three fish species are native to the McKenzie subbasin. The bull trout has been identified as eligible but precluded for listing under the ESA. The Willamette spring chinook has been identified as a stock-at-risk.

Three hundred and twenty nine wildlife species live within the subbasin. Habitat for these species has been influenced during the past 100 years by timber harvest and residential development. In the future under the President's Plan, the eastern portion of the watershed will provide the majority of the late successional habitat. The majority of the high quality blocks are in high elevation wilderness areas. Small patches of BLM land in the western portion of the subbasin may provide some connectivity between the Coast Range and the Cascades. Intervening private timber lands will be maintained in early and mid seral stages.

CHAPTER 2

ISSUES AND KEY QUESTIONS

The development of high priority issues is critical to focus the scope of a watershed analysis. Key questions identified to address identified issues further refine the analytical task.

The following chapter lists current high priority issues and key questions identified for the Upper McKenzie Watershed. The issues were organized by domains as recommended by the Watershed Analysis Handbook (1995). The intent of Domains is to provide a framework for integration of analysis.

AQUATIC AND RIPARIAN DOMAIN

1 Management practices such as road building and maintenance, timber harvest, and slash treatments may have changed the frequency and spatial distribution of mass wasting and surface erosion. This can result in increased turbidity and filling of large pools with sediment.

a. Question: What is the range of variability, temporally and spatially, of natural and management-induced disturbance regimes?

b. Question: What are the processes operating within the uplands and riparian areas? What are the sediment delivery mechanisms and relative rates of delivery to streams stratified by landform or slope position?

2 Increases in peak flows resulting from timber harvest and extension of the drainage network by road systems may have reduced channel complexity through scouring and downcutting of the channel; isolating side channels; and transporting large woody debris out of the system. The overall effect may be a reduction in pool numbers and sizes, less diverse sediment distribution within the channel, and a more uniform water velocity distribution along the stream channel.

a. Question: Have management activities affected the magnitude and frequency of peak flows? Have increased peak flows reduced channel complexity or modified aquatic habitat beyond the range of historic variability?

3 Harvest of riparian vegetation, establishment and maintenance of recreation sites, and roads within the active floodplains may have: altered processes and functions of the riparian ecosystem; reduced amounts of large woody debris; increased stream temperatures; or reduced channel complexity.

- a. Question: To what extent and degree have riparian areas and floodplains been altered by management? Have alterations affected the aquatic ecosystem?
 - b. Question: Where is there a deficit of large wood in or adjacent to stream channels in the Upper McKenzie watershed?
 - c. Question: How has the quantity of in-stream wood changed over time in the Upper McKenzie River?
 - d. Question: What riparian areas are inadequate as future, long term sources of wood?
 - e. Question: Where have stream temperatures and streambank instability exceeded the historic range of variability?
- 4 Highways 126, 242, 20, and 22 pass through the watershed, often through riparian areas. All highways are managed and maintained by the Oregon Department of Transportation (ODOT). Management techniques used by ODOT may have affected the condition of the riparian habitat.
 - a. Question: In what ways have maintenance of these highways altered the riparian habitat? (Considering activities associated with surface maintenance, winter gravelling, use of de-icers, and roadside vegetative management)
 - b. Question: What management practices currently foster invasion and establishment of noxious weeds?
 - c. Question: How affective are current management strategies to reduce the invasion and establishment of noxious weeds?
- 5 The location of facilities, boat access points, and dispersed camp areas (within and outside of wilderness) may be causing negative impacts or mitigating potential negative impacts caused by people using river, lake, and reservoir shorelines.
 - a. Question: What impacts are occurring and where?
 - b. Question: Where are the impacts unacceptable for the future maintenance of the resource?
- 6 Potential negative impacts to water quality could occur from accidental point-source pollutants such as spills, leaks, draining hot springs, cleaning boats, rock sources, or from ODOT rock piles. Non-point-source pollutants such as nitrogen also have potential to enter streams from forest fertilization activities.
 - a. Question: What are some of the probable contaminants that could potentially enter, or are currently entering, the McKenzie River and what are their sources and effects on the aquatic ecosystem?

7 Roads, dams, channelization, and slides may have isolated and fragmented components of the Upper McKenzie aquatic refugia system.

a. Question: What is the historic and current distribution and abundance of trout, salmon, and non-game fish in the Willamette basin?

b. Question: Where and what elements have isolated and fragmented trout, salmon, and non-game fish habitat?

c. Question: What role does the Upper McKenzie watershed play in providing refugia for aquatic organisms?

8 The 3 dams within the Carmen-Smith Project may have had an impact upon the aquatic ecosystem by disrupting substrate and large woody debris transport to the McKenzie and Smith drainages. This may have resulted in coarsening of bedloads, downcutting, and channelizing below the dams. The hydrologic regime downstream of the dams may be affected by dam-caused changes in the timing of flow, rates of flow, and de-watering portions of the McKenzie River channel.

a. Question: Have changes to the flow regime altered the timing of migration for historic juvenile or adult spring Chinook?

b. Question: To what extent have the dams modified the average spring through late-fall flows; average daily maximum flow; and instantaneous peak flows? If flows have been modified, how has the change affected floodplain processes and function? Have changes occurred to aquatic habitat or sediment transport/distribution?

9 The stocking of non-native stocks (e.g., rainbow trout and brook trout) in the Upper McKenzie River may have influenced wild stocks through competition, hybridization, or incidental catch mortality. Stocking of hatchery trout in the McKenzie and naturally fishless wilderness lakes may have effected the terrestrial and aquatic ecosystems by concentrating recreational use and influencing predator and prey populations.

a. Question: Where have non-native fish impacted wild fish stocks in the Upper McKenzie watershed?

b. Question: What is the distribution and abundance of non-native aquatic species in the Upper McKenzie?

c. Question: Where and how have terrestrial and non-fish aquatic components of the ecosystem been impacted by non-native fish stocking?

d. Question: How do current sportfishing regulations influence recreational use and wild fish stocks in the Upper McKenzie watershed?

e. Question: Where is there risk of extinction of wild fish populations in the Upper McKenzie?

10 Bull trout populations are being suppressed in the Upper McKenzie watershed. Factors influencing the population may include passage barriers, overharvest, hybridization, and competition with brook trout, and habitat degradation.

- a. Question: Which of these factors have the greatest influence on the risk of bull trout extirpation in the Upper McKenzie?
- b. Question: Are areas essential to bull trout life history requirements adequately protected from the effects of disturbance?
- c. Question: Do current fishing regulations offer bull trout adequate protection to allow full recovery?

11 Simplification of channels, habitat degradation, and passage barriers may have resulted in loss of spring Chinook spawning and rearing habitat in the Upper McKenzie watershed.

- a. Question: Are areas essential to spring Chinook life history requirements adequately protected from the effects of disturbance?
- b. Question: Have utility mitigation efforts adequately supplemented loss of habitat from dam construction?
- c. Question: Is the current spring Chinook population genetically diverse enough to be successful in a changed environment?

12 Existing riparian habitat may not be adequate in quality or quantity to support viable populations of riparian dependent species.

- a. Question: What was the historic composition of the riparian vegetation? How does that compare to current conditions?
- b. Question: What is the historic role of disturbance in the riparian areas? How do historic disturbances compare to the current processes?
- c. Question: Will the riparian reserves adequately function to meet all objectives outlined in the ROD?
- d. Question: What criteria could lead to interim riparian reserve adjustments, and where are some of the areas that fit these criteria?
- e. Question: What are the appropriate riparian reserve boundaries for this landscape, if different from the ROD?

13 Grazing of pack animals in wilderness areas may be impacting riparian habitat to an unacceptable extent outside of wilderness objectives.

- a. Question: Where and what kind of disturbance has occurred to riparian habitat from grazing in the wilderness?
- b. Question: Where are areas with the highest potential for degradation in from grazing the future?

14 Grazing of Forest Service pack animals at Fish Lake is occurring, and historic grazing of permittee cattle at Lava Lake has occurred. These impacts, combined with past manipulation of the stream channel and riparian vegetation, may have resulted in: degradation of stream channel conditions and fish habitat; degradation of wetlands; and alteration to the vegetation composition of the area.

- a. Question: What are the natural functions and processes occurring within these areas?
- b. Question: In terms of the ROD's objectives for riparian reserves, what is the current biological condition of these areas?
- c. Question: What roles do these areas play in a larger landscape?
- d. Question: What effects have grazing and channel manipulation had on stream channel condition, function, and aquatic habitat?

TERRESTRIAL DOMAIN

1 Insects and diseases are affecting resilience of many of the forested stands within the watershed. The spruce budworm, Douglas-fir bark beetles, root rots, and dwarf mistletoe are of particular concern because of their affects on the forested resource.

- a. Question: To what extent and severity have these insects and diseases affected the forest resource?
- b. Question: How do current conditions of these forests at a stand and landscape scale compare with historic conditions?
- c. Question: Does the current condition of these forests increase the risk of large-scale fire?

2 Management activities within these forests, including timber harvest, road building, and fire exclusion, may have altered species' composition or created patterns and conditions that are outside of the historic range of variability. The biological diversity of the watershed may have been altered.

- a. Question: How does the current condition of forested vegetation compare with the historic range of variability?
- b. Question: Does the current condition affect future land management objectives or ecosystem function?
- c. Question: Are there individual plants or plant communities that are decreasing or increasing due to past management activities?
- d. Question: Are there wildlife species associated with these plant communities?
- e. Question: What was the role of human-caused fire in altering the vegetation patterns in the prehistoric past? Is there any evidence for this in the archaeological record?

3 Levels of large woody debris and snags in managed forests, including plantations, campgrounds, roadsides, etc., may be outside of the range of historic variability for unmanaged forest systems. This could impact a variety of species that depend on these structural elements for habitat.

- a. Question: What is the historic range of variability for LWD and snags on this landscape?
- b. Question: Have management activities altered the landscape condition significantly outside the historic range for snags and LWD?

4 The public expects a variety of commodity outputs from this area, however, meeting those expectations may conflict with other objectives or may not be sustainable.

a. Question: What are the suitable and available acres for harvest in the watershed?

b. Question: Where are the potential areas for harvest of special forest products in the watershed?

5 Future land management strategies focused on the maintenance or development of late-successional forest species may result in diminished availability of habitat for early seral species.

a. Question: What is the historic and projected future availability of early, mid, and late seral habitat over time in this watershed?

b. Question: How will the availability and distribution of these habitat types affect species associated with them over time?

6 Road management strategies for the watershed may be affecting the quality of wildlife habitat and hunting opportunities.

a. Question: What are the current road densities within the watershed? How do they currently impact wildlife habitat and hunting opportunities?

7 Some current recreation uses conflict with the ability to maintain wildlife habitat. For example, areas such as Sawyer's Cave provide both recreation opportunities and important wildlife habitat.

a. Question: Where are recreation uses conflicting with the maintenance of wildlife habitat?

8 Diversity (i.e. horizontal structure, species mix, stocking levels) in past harvest areas may be providing low quality habitat for species that rely on early seral stages.

a. Question: What is the current diversity level within managed plantations? How does this compare with early seral habitat that resulted from natural disturbances?

9 The ROD requires surveys and management for numerous species of wildlife, fungi, lichens, bryophytes and vascular plants (ROD Table C-3). The location and potential distribution of many of these species within the watershed is unknown, and the Standards and Guidelines in the ROD need to be evaluated for their ability to maintain these species at a site-specific level.

a. Question: What C-3 species potentially occur in the watershed based on their known range and habitat requirements?

b. Question: What Table C-3 wildlife and plant species are known to occur in the watershed?

c. Question: Do the ROD standards and guidelines adequately protect existing habitat and provide long-term habitat for species of concern listed within the ROD?

d. Question: What is required for the maintenance of these species or their habitat?

10 Because a portion of this watershed lies along the crest of the Cascades, it functions as an ecotone between east and west-side ecosystems. Standards and Guidelines within the ROD that pertain to westside systems may not be appropriate for this area.

a. Question: What areas within the watershed function as an ecotone?

b. Question: What S&G's within the ROD do not apply well to these westside conditions?

11 The watershed must continue to contribute to the recovery of several threatened and endangered species, and it also must maintain or increase the populations of rare or sensitive species.

a. Question: What TES species are known to occur or potentially occur within this watershed?

b. Question: What is the condition of the populations of these species and their habitat?

c. Question: What is the status of TE species recovery, and how is this watershed contributing to recovery goals?

12 Road right of ways may not be meeting all legal obligations ("take" issues).

a. Question: Where does potential exist for conflicts between access administration and the taking of TE species?

13 The majority of sensitive and rare plant species that are known or suspected to occur in the watershed occupy non-forested areas (special habitats). These areas, though protected by S&G's, are generally unmapped and unsurveyed. It is unknown what their current contribution to biodiversity on the landscape is or what threats they may be receiving.

a. Question: Where and what kind of special habitats are present within the watershed?

b. Question: Are there special habitats within the watershed that have limited distribution across the watershed/Forest/or Region?

c. Question: What threatens the continued stability or functioning of these special habitats?

d. Question: What wildlife and botanical species of interest are associated with these areas?

14 Important geological resources may be at risk from management activities.

a. Question: Are there areas of with unique geological value (fossils or formations) that are at risk from management activities?

15 Transmission line corridors may be impacting riparian areas, water quality, recreation developments, and heritage resources.

a. Question: Where has riparian or upland vegetation, water quality, and stream channel processes been modified by maintenance of vegetation within transmission line corridors?

16 Trailbridge Reservoir flats and Carmen Reservoir, which resulted from the construction of the Carmen/Smith project, are experiencing soil compaction, noxious weed invasion, and establishment and the loss of native vegetation.

a. Question: What are the current vegetative and soil conditions of these areas?

b. Question: What actions compatible with the recreation goals for the area are needed to correct or improve these areas?

SOCIAL AND ECONOMIC DOMAIN

1 There may be conflicts between economic growth and resource conditions. Increased demands on campgrounds, wildlife hunting and viewing, and fishing may affect the resource and/or change visitor use.

a. Question: What actions in the future may change the tourism-generated economic benefits to the local economy?

2 Significant recreational use of the Upper McKenzie may be focused on the fishery resource. Conflicts over the use of this resource may occur in the future with increased demands.

a. Question: What is the economic and sociological contribution of fisheries to the Upper McKenzie watershed?

3 In some locations, conflicts exist between recreationists who participate in different recreational activities.

a. Question: Where do conflicts currently occur between recreationists?

4 Parts of this watershed are used by ATV's (all terrain vehicles), which may be impacting vegetation, soils, botanical, and wildlife resources.

a. Question: Where within the watershed is ATV use prevalent? and where and how is the use impacting resources?

5 Enforcement of heritage resource preservation and artifact protection laws is a problem. Few forest visitors are aware that even the waste material (i.e., flakes) of obsidian tool production is protected by law from illegal collecting.

a. Question: To what extent are prehistoric heritage resources being damaged by illegal collecting?

6 Administration, grazing, and recreation uses at Fish Lake may be impacting heritage resources.

a. Question: To what extent is use of Fish Lake impacting heritage resources?

7 Recreation is resulting in damage to several historic structures.

a. Question: What historical structures or areas are in the watershed?

b. Question: What damage is occurring to the structures?

c. Question: Where are unacceptable levels of damage occurring?

8 Impacts to the scenic quality of natural features may be occurring from degradation caused by rock sources, insect and disease mortality, and harvest units.

a. Question: What existing conditions are inconsistent with the Scenic Byway, Wild And Scenic River, and Forest Plans?

9 Potential prescribed natural fire (natural or management ignited) may occur within designated Class 1 airsheds. This type of management may be limited by air quality regulations. The public's desires for clean air and good visibility, and the ecological need for using PNF as an ecosystem management tool, may conflict.

a. Question: What was the historical air quality between 1850 and 1900?

b. Question: What is the current NAAQS and benchmark for our areas?

10 Allocations of funds have been too limited to accomplish all potential land exchanges. Acquisitions of some of these lands may be beneficial to resource management.

a. Question: Are there parcels that should be high priority for acquisition based on resource benefits?

PREFACE TO CHAPTERS 3 AND 4

Chapter 3 provides an overview of resources found within the Upper McKenzie Watershed. Chapter 4 provides additional, more detailed analysis on some of the resources, and the information is presented by Landform Block. The Landform Blocks were created to aid in presenting and integrating data within specific areas. Stratification considered geological processes as well as vegetation patterns, fire behavior, valley segment types, and fish and wildlife habitat. Chapter 3 uses the Landform Blocks as a basis for comparison of resources within the watershed.

CHAPTER 3

PAST & CURRENT CONDITIONS AND RANGE OF HISTORIC VARIABILITY

OVERVIEW OF GEOLOGICAL RESOURCES

Introduction

The Cascade Range is a north-south trending line of volcanoes associated with the Cascadia subduction zone off the Oregon coast. As the Pacific plate is pushed under the North American plate in this zone, melting of the rock occurs with increased depth. The molten rock is then forced to the surface as volcanic eruptions, which is the mountain-building process of the Cascades.

The Upper McKenzie Watershed is located in the Cascades where two physiographic provinces meet: older Western Cascades (9 - 40 million years old) and younger High Cascades (9 million years old to the present). The stratigraphic and time sequence proposed by Priest, Woller, and Black (Priest and Vogt 1983) is used in this analysis, except that the early High Cascade ridge-capping basalts (9-4 million years B.P.) including Avarmenko's (1981) Browder-Bunchgrass and Iron Mountain units, and Flaherty's (1981) Frissel-Ollallie units are included as part of the Western Cascade province for simplification. Figure 3-1 displays geological areas of interest and the Landform Block stratification referred to throughout Chapters 3 and 4.

WESTERN CASCADES

The Western Cascades represent the oldest rocks found on the Forest. They are generally found west of the McKenzie and Smith Rivers and north of Belknap Springs. The Western Cascades were derived from episodic volcanic vent and fissure eruptions between 9 and 40 million years ago (late Eocene to early

Figure 3-1. Major Geological Features and Landform Blocks 1-6

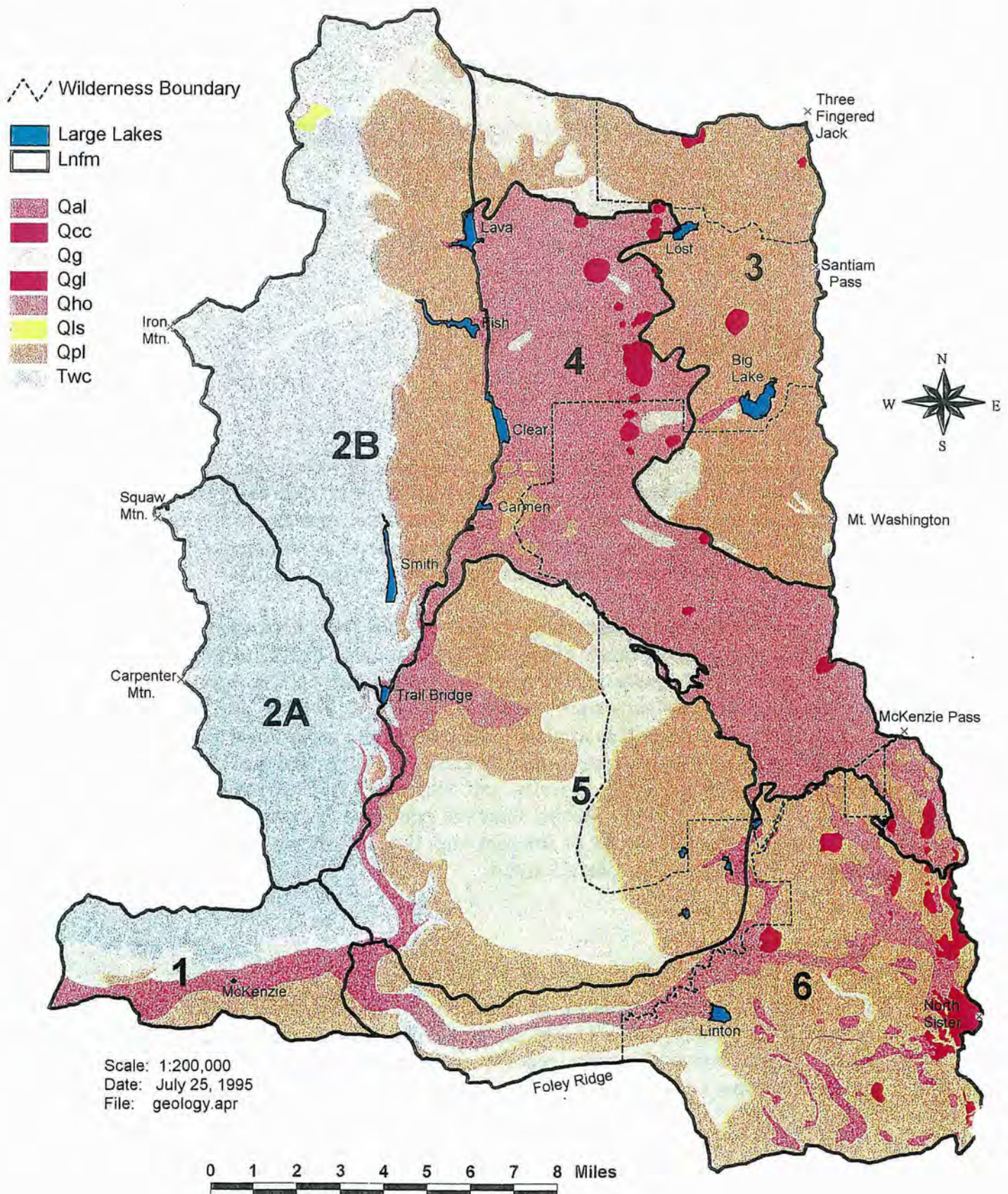


Figure 3-1. Major Geological Features and Landform Blocks 1-6

- Block 1 - McKenzie Bridge Glacial Valley
- Block 2a - Deer Creek Cirque-Ridge
- Block 2b - Western-High Cascade Transition Zone
- Block 3 - Early High Cascade Platform
- Block 4 - Recent High Cascades Lava
- Block 5 - Scott Mtn. Glacial Plateau & Valleys
- Block 6 - Lost Creek Glacial Trough

 Wilderness Boundary

 Large Lakes

 Landform Blocks 1-6

 Qal...Alluvial Deposits

 Qcc...Volcanic Cinder Cones & Composite Volcanoes

 Qg...Glacial Deposits

 Qgl...Active Glacier

 Qho...Recent High Cascade Lava <12,000 Yrs. Old

 Qls...Ancient Landslide Deposits

 Qpl...Late High Cascade Lavas Plio/Pleistocene 12,000-4 Million Yrs. Old

 Twc...Western Cascades & Early High Cascade Ridge Capping Basalts 4-40 Million Yrs. Old

Pliocene). These eruptions consisted predominantly of basalt, however rhyodacite and welded tuffs are abundant as well as some minor intrusions of diorite and scattered andisitic lava flows. This accumulation of volcanic material reached a thickness of over 5,000 feet, yet did not result in enough relief to produce the orographic effect on the prevailing westerly winds of windward rainfall and leeward desert until the Pliocene (Priest and Vogt 1983).

Uplift and Incision

In the mid to early Pliocene [3 to 5 million years before present (my bp)] regional uplift began taking place at a rate of approximately 20 centimeters per 1,000 years, which produced an increase in elevation of approximately 400 meters (Sherrod 1986). This increase in elevation was associated with an increase in stream gradient, some of which was more than twice its norm. The increased stream gradients produced deeply dissected valleys, increased relief, and produced drainage patterns now present in the western portion of the watershed. Pleistocene glacial floods and lower mean sea levels resulted in additional valley scouring. However, subsequent outwash, still water, and landslide deposition to depths of over 100 feet refilled the valleys to a base stream level that matches the existing sea level. Valley fills have been drilled to 146 ft in the Blue River area, 175 feet in the McKenzie Bridge area (Williamson 1961), and over 280 feet below the bottom of the Columbia river at the Bonneville Dam east of Portland (U.S. Army Corps of Engineers 1984). Areas within the Western Cascades contain the majority of past and present landslide activity due to the age of the rocks and their composition, hydrothermal alteration, previous uplift and faulting, and valley incision. These all produce a net decrease in resisting forces and material shear strength.

Northwest Trend Faulting and the High Cascade Graben

During the last 8 to 10 and 4 to 5 my B.P., major northwest-trending fault systems developed, especially near the present boundary of the Western and High Cascade physiographic provinces. This fault system controls the north-south direction of flow of many of the upper reaches of Cascade rivers including the McKenzie, S. Fork of the McKenzie, Smith, N. Santiam, Horse Creek, N. Fork of the Willamette, and the Metolius Rivers. The earlier faulting events between 8 and 10 my B.P. occurred along the axis of the S. Fork of the McKenzie River (Cougar reservoir). Later events (4 to 5 my B.P.) occurred along the present Horse Creek, McKenzie, and Smith River alignments on the west-side of the Cascades; and the Metolius River (Green Ridge) on the east-side. The latter event is thought to have produced at least 3,000 feet of vertical offset as a block of the central Cascades dropped between the McKenzie River and the Metolius River as a result of an extension of the Earth's crust (Priest et al 1983).

HIGH CASCADES

Early High Cascade Shield Volcanoes

The earlier major faulting event was accompanied by tremendous eruptions of basalt and basaltic andesite from the now-forming High Cascade shield volcanoes. Over the following 2 million years, this event filled the down-thrown block, now referred to as the High Cascade Graben. [Note: the word "graben" is from German referring to the depression made in a grave-site as a wooden coffin collapses due to the weight of the overlying soil] Due to its own weight, it is believed that the High Cascades have subsided and now dip approximately 5 degrees to the east.

Evidence for this now-filled "graben" is mostly indirect and not without differences of opinion among scientists as to its existence. However, gravimetric anomalies (differences in rock densities), river and hot spring alignment, north-south alignment of the major volcanic peaks, and a number of exposed fault scarps on the west and east side of the crest suggest that this model is plausible. One of the most important features of this model is the highly fluid lavas that eventually breached the western fault scarp and filled the ancient McKenzie valley. Those flows are now recognized as Foley Ridge. The Ridge's inverted topography is common to "intracanyon" flows, where surrounding rocks are eroded away, leaving the lava flows perched above the valley floor (Flaherty 1981).

Late High Cascade Composite Volcanoes

Between 2 million and about 12,000 years ago, the High Cascade composite volcanoes were actively building on the shield volcano platform. Volcanic peaks of the Three Sisters, Mt. Washington, and Three Fingered Jack fill the present horizon in the area. Basalt flows reached as far west as Smith River.

At least three periods of major alpine glacial advance and retreat interacted with this volcanic activity to scour the valleys and peaks leaving deposits of till and glacial outwash. One of the early Oregon Geologists, Edwin T. Hodge (1925) theorized the Three Sisters were a remnant of a single ancient volcano that reached over 20,000 feet high, which he named Mt. Multnomah. Hodge's theory stood for many years until the science of geochemistry and igneous petrology were developed. It was then determined that each volcano was significantly different in chemistry and origin.

Recent High Cascade Volcanic Eruptions

After the ice recession of the last major glacial episode (around 12,000 years ago), eruptions from smaller composite volcanoes and cinder cones produced more recent lava flows down the ancient valley of the McKenzie River and Lost Creek which dammed the rivers and formed lakes and waterfalls. Lava flows from the

Sand Mountain and Lost Lake chain of cinder cones, Belknap Crater, Simms Butte, Collier Cone and Scott Mtn. now cover over 50% of the Late High Cascade platform topography.

Areas that lie within the High Cascades are less prone to slope instability due to the more resistant younger rocks, relatively little faulting, and lower valley incision rates. The exception is in areas such as Lost Creek, where recent volcanic flows have been deposited over former valley side slopes and glacial deposits. Here, differential weathering takes place as the less resistant material erodes at a faster rate below the young flows. Overhangs then develop which eventually fail as debris avalanches.

Alpine Glacial Processes

During the Pleistocene (1.6 my bp to 12,000 yrs bp) at least three major changes of climate (perhaps more than a dozen) produced a High Cascade ice field that completely covered all but the highest of the Cascade volcanoes (Birchfield et al. 1981). The ice sheet eventually moved down the valleys on both sides of the Cascades. In the McKenzie valley it moved as far as the community of Blue River (Scott 1977, VanDusen 1962). These advances were followed by retreats of the ice. The cycles may have taken as long as 100,000 years each. Many theories have been advanced as to a general reason for major changes in the Earth's climate, but the one most often held now is a periodicity in the Earth's orbit that takes it further from the sun on about a 100,000 year cycle (Shackelton and Opdyke 1973).

Much of the volcanic hazard during the eruption of a composite volcano is the rapid ice melt from the side slope glaciers. The Three Sisters now contain approximately 5.6 billion cubic feet of ice in 5 major glaciers covering 3.2 square miles. However, two of the largest glaciers remaining in the High Cascades (Jefferson and Collier) have reduced in size by 50% over the last 50 years (Allen 1985).

The most recent glacial episode in the watershed is represented by fresh moraine and outwash between 7,000 and 9,000 feet elevation on high peaks. Radiocarbon ages indicate that these moraines were formed less than 2,500 years ago. The next oldest glacial stage ended 10,000 to 12,000 years ago (latest Wisconsin). During this time a broad ice field accumulated in the High Cascades which fed many valley glaciers, however none of these extended beyond the High Cascade platform and very few below 3,600 feet elevation. The oldest glacial advances have been obliterated in the area by the more recent ones, but evidence can be seen of them in deeply weathered and poorly preserved lateral and ground moraines, far removed from the Cascade Crest (Taylor 1968).

Glacial Advance

During times of extreme ice accumulation on the continent, and in the higher elevations of the Cascades, several processes interact to produce accelerated geomorphic change. As ice accumulates, the world ocean levels are lowered due to a lack of return moisture (that becomes entrapped in the ice) to the hydrologic cycle. Sea levels are estimated to have been at least 200 feet lower during the Pleistocene than today (Flint 1971). This means that in addition to the ice scour that took place in the valleys during glacial advance, the stream gradients were drastically increased. This caused stream velocities and erosive capabilities to increase.

As a glacier advances down a valley, compressional stress is applied to the valley sidewalls, which causes a temporary elastic strain, or deformation, to accumulate within the rock masses. Glaciers accumulate material from the valley bottom and sidewalls as they advance. These deposits are transported down valley in front of the glacier as terminal moraine. The material transported along the bottom of the glacier is called lodgement till and is often found in a very compacted and dense state that can be seen in the road cut slopes on the east side of Deer Creek. The material transported and deposited along the sides is called lateral moraine, and the upper glacial debris left as the ice melts in place is called ablation till (Flint 1971). These deposits all have a common aspect in that they are composed of unsorted material of varying sizes and lithologies.

Geomorphic features in the higher elevations produced by glacial scour and morainal blockage of streams include most of the high elevation lakes. Other features produced include cirques (depressions left by ice), cols (saddles between ridges formed coalescing glaciers) and tarns (peaked spires). The Middle and South Sister were active during the late Pleistocene and are much less glaciated than the other older composite cones.

Glacial Retreat

Valley side-slope instability is a result of glacial processes. The stress applied to the valley sideslopes during glacial advance may be removed by glacial recession rather quickly (geologically speaking, thousands of years). When this occurs, the temporary elastic strain that accumulated in the valley sidewall rock mass during 100,00-200,000 years of ice loading, elastically "rebounds" as the load is released. This causes rupture in the rock mass, and valley side slope collapse which results in large landslide deposits and talus slopes (Ferguson et al. 1981, Long 1994a). Earthquakes and seismic loads associated with volcanic eruptions are also a source of major landslide and debris avalanche initiation (Keefer 1993, Long 1994b).

During glacial retreat, deposition occurs along valley sidewalls from material that has fallen on top of the ice mass at the lateral margins. This material may

then may become stranded on the valley side-slopes after ice melt occurs. The material may remain in a marginal state of slope equilibrium as latent landslides, and may be susceptible to failure with very little geometric modification such as road construction or stream scour.

Ice dams may have formed at valley constrictions behind terminal moraines. Proglacial lakes then form, and still-water sediments of clay and silt accumulate in seasonal varves, or thin layers. A good example is in the road cut on the south side of US 126 about 1 mile north of Trail Bridge reservoir. This deposit is very important to geologists who can interpret the time, sequence, and climate during this period in Earth history. Ice dams are susceptible to breaching and cause massive down valley flooding, scour and deposition, and may cause major rivers to change course. A good example of this type of process is the major gravel deposits found at Pleasant Hill southeast of Eugene. Here, massive glacial flood deposits are thought to have re-routed the Willamette River around the east side of Mount Pisgah. An anecdotal account of the 1933 failure of the Skinner glacier terminal moraine on South Sister was reported in the Eugene Register Guard (Tims 1958). An unusually warm summer accelerated the melting rate of the glacier, causing the melt water to overtop the debris dam at its front. The resulting failure sent "millions of cubic feet of water" down Separation and Horse Creeks to the McKenzie, scouring out the soil and bedrock.

MCKENZIE RIVER CORRIDOR

The upper McKenzie River flows out of Clear Lake through a narrow gorge in volcanic rock. The river between Clear Lake and Carmen Reservoir is crossed by several relatively recent lava flows which formed Sahalie and Koosah falls. The McKenzie is one of the few rivers in the region that is closely associated with recent vulcanism, and these volcanic features are a unique scenic attraction. As the McKenzie flows beyond Koosah Falls, it is intercepted by the Carmen-Smith hydroelectric diversion project completed in 1963. The project consists of Carmen reservoir which diverts the upper McKenzie westward through a two-mile tunnel constructed through Smith Ridge into Smith Reservoir. From there, the water flows south and then east through two additional tunnels and out through hydroelectric turbines at Trail Bridge reservoir.

Prior to the diversion project, the river flowed in its natural channel through Beaver Marsh and into Tamolitch Valley. There the volcanic features become less dominant, and incised mountain slopes rising along the valley's edges

become the dominant landforms. Much of the river's previous course in this area was underground through porous basalt. Eventually, it resurfaces over Tamolitch falls. Some water still flows through the underground passages in the lava, emerging at Tamolitch Pool from various natural springs. The water spills over the lip of the pool, then runs as a freeflowing river until it converges downstream with Trail Bridge reservoir.

Tree casts can be found in Tamolitch Valley within the lava flows. These hollow areas were formed when lava cooled around the trunks of standing trees before the wood could be completely burned away. The casts are relatively unusual because the lava must have the right consistency and temperature to be fluid enough to mold around the tree, but stiff enough to hold its shape after the tree burns.

Below Trail Bridge Reservoir, the river winds its way along the North Santiam Fault Zone which controls the North-South direction of the river. The lava flows are much older through this section and now vegetated by forest. Some of these older lava flows have been modified by hydrothermal alteration associated with geothermal activity. The river corridor within this section is within the 178,000-acre Belknap-Foley Geothermal Area. Two hot springs are the only surface expressions of geothermal activity near the river. A small hot spring emerges next to the River near Deer Creek and a second at Belknap Hot Springs.

Just south of Belknap, the river changes its course to a westerly direction as it breaches the ancient High Cascade escarpment and flows into the McKenzie Bridge-Blue River glacial valley. Through this area, the valley is wider due to glacial scouring, but still constrained by Foley and Lookout Ridges.

FOSSILS AND AREAS OF UNIQUE GEOLOGIC RESEARCH INTEREST

According to Dr. William Orr (personal communication), professor of paleontology and, curator of the University of Oregon paleontological museum, there are no known sites in the watershed of fossil-bearing strata. However, the tree casts in Tamolitch Valley and a pro-glacial lake deposit one mile north of Trail Bridge Reservoir on the east side of the highway are two areas which should be protected for further research. Other well-known areas of geologic research interest are well within the Wilderness boundaries or in Special Interest Areas such as Sand Mountain.

SLOPE STABILITY AND DISTURBANCE HISTORY

Mass Wasting

Mass wasting, or slope instability, is initiated when the sum of the driving forces on a slope (gravity, earthquake loads, construction loads, valley stress relief, pore water pressures, changes in geometry) exceed the resisting forces (soil and rock shear strength, root cohesion, tree surcharge). Natural events such as fire, precipitation, and earthquakes and human-caused disturbances such as road construction and tree harvesting can cause rapid changes in slope equilibrium (Koler 1994).

In general, the highest number of incidents of mass wasting have occurred in the UPMAKWA in Landform Blocks 1, 2A, and 2B. This is due to the nature of the landforms being located in Western Cascade and Early High Cascade ridge-capping volcanics which consist of much older and hydrothermally altered basalts and pyroclastic rocks which are more susceptible to weathering and decomposition. The valleys are much more incised than those of the High Cascades, exhibiting sideslopes in most cases greater than 70%. The majority of mass movements have occurred in elevation bands of 2800-3200 feet and 3800-4200 feet, which may represent glacial valley stages, or elevations of glacial equilibrium on the valley sideslopes where kame terraces developed. Similar elevation bands of valley benches were observed by Van Dusen (1962) and Williamson (1987) in west-side central Cascade valleys. To some extent, Landform Block 6 is prone to debris avalanche failures due to differential weathering at the base of the intracanyon basalt flows that are located on the valley side slopes.

Valley Stress Relief

Valley sideslope collapse and resulting talus and deep colluvial toe slopes can be the result of valley stress relief and elastic rebound (Matheson and Thomson 1973). Valley stress relief and the resulting rebound is a function of the elastic modulus of the rock, deviator stress, and cyclic intervals. Stress application to valley sidewalls and floors can result from alpine glaciation or outwash sediment accumulation. In alpine glacial environments, these events are usually recompression cycles, as a function of glacial advance and retreat in response to global warming and cooling trends. This cyclic deviator stress tends to have a more adverse effect on rock slope stability than single valley-stage alluvial development by erosion and deposition. These conditions conducive to mass wasting are prevalent in Landform Blocks 1, 2a, 2B, and 6, and in the steeper areas of Landform Blocks 3, 4, and 5.

In alpine glacial sequences, lateral and vertical compression is applied to the valley during glacial advance. Stress removal takes place during glacial retreat, which causes buckling in the side slopes, defined as zones of extension or tension, and arching in the valley floors, defined as zones of compression

(Ferguson and Hamel 1981). Young and Shakoor (1987) completed a study of valley stress-relief-induced slope failures along the Ohio River in West Virginia and Ohio. They found that the most prominent joint sets in this area were those paralleling the river and were a result of release of residual stress, normal to the valley, caused by river downcutting.

In their study of valleys in western Canada, Matheson and Thomson (1973) recognized that upwarping of the valley floor influences the dip of bedding in sedimentary rocks and may produce interbed slip and gouge zones that influence slope stability when they are located at the toe of slopes. They also concluded that valley rebound (strain) may be up to 10 percent of the valley's depth, but more typically is found in the range of 3 to 5 percent.

Minor structural features may be an indication that valley sidewalls are in tension. Features such as minor anticlinal structures in valley floors, inflated or "diced" rock masses caused by cooling joints in igneous extrusive rocks being intersected by stress relief joints, near-vertical stress relief joints parallel to the valley, tension cracks, and overhangs are all indicators of stress relief or differential weathering. Natural processes which can accelerate the rates of failures in these terrains include freeze-thaw cycles, wind-levering of trees, root-wedging, elevated pore water pressures in discontinuities, and rapid drawdown of reservoirs.

Differential weathering occurs in rock masses that are layered with sequences of alternating rock of different strength, such as sandstone and shale sequences, basalt flows over glacial till (such as in Landform Block 6), or andesite flows with pyroclastic interbeds. In these situations, the lower-strength material weathers at a faster rate than the overlying material, resulting in an overhang. This force imbalance eventually results in failure of the overhang, which may precipitate mass failure of the slope (Arambarri and Long 1993).

Fire Impacts on Slope Stability

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

Disease

Insects and disease that lead to tree mortality has similar effects on slope stability as clear cutting and fire through loss of root cohesion and wind levering, though to a much less extent. Areas in Landform Blocks 2A and 2B have been affected in some cases to as much as 20 acres of dead and dying trees on steep slopes (Gene Skrine, personal communication), and are mapped annually.

Precipitation

Local storm events that depart from normal precipitation can be a triggering mechanism for slope failures, especially if the prior rainfall has been above average, and the soil is already near saturation such as the 1964, 100-year event and the 1973, 7-year event. If other compounding factors such as a recent high intensity fire, roads under construction, or clearcut units that are over one year old are present, the probability of failure is greater.

Earthquakes

Earthquakes are a daily occurrence in the Pacific Northwest, and they have triggered many of the ancient landslides in the watershed, especially slopes that contain loose glacial deposits. The majority are below 3.0 magnitude, but due to our proximity to the Cascadia Subduction Zone off the Pacific Coast, magnitudes of 8 to 9 have been recorded in the geologic record (Heaton and Hartzell 1987).

On the Oakridge Ranger District a 2 million cubic yard earthquake-induced landslide that displaced the North Fork of the Middle Fork of the Willamette River has been dated at 4,700 years before present (Long, unpublished report). Anecdotal reports include blockage of the Columbia River for several days after a major earthquake struck western Washington in 1872 and triggered a landslide dam (Oregon Geology 1994); and the great Bonneville landslide which blocked the Columbia 700 years ago (Palmer 1977). The 5.6 magnitude Scotts Mills earthquake in March of 1993, and the Klamath Falls 6.0 earthquake in September of 1993 are just two examples of recent seismic events that are becoming more frequent. Darienzo and Peterson (1995) have dated at least six occurrences of great earthquakes along the Pacific Northwest coast with an average magnitude of 8.0 and an average recurrence interval of 400 years with some as low as 200 years.

The proximity of the watershed to the probable focal point of a subduction earthquake is over 75 miles. This distance provides a certain amount of attenuation for primary and secondary shock waves. An expected peak velocity of 6-19 cm/s and a duration of shaking of less than 9 seconds reduces the risk of damage considerably (Weldon 1994), however does not eliminate the risk. The Corps of Engineers determined that the Tumalo Fault was capable of producing of magnitude 7.2 earthquake in the area; a local fault system in the Three Sisters

area a 6.0; and North Santiam Fault Zone, which runs along the McKenzie and Smith Rivers south to Belknap Springs a 5.1.

The Federal Energy Regulatory Commission (FERC) requires that dam licensees perform periodic safety inspections of all critical facilities for structural integrity and adequate stability including expected earthquake loads. Such studies have been completed for the Carmen-Smith and Trail Bridge dams in 1995.

Road Construction

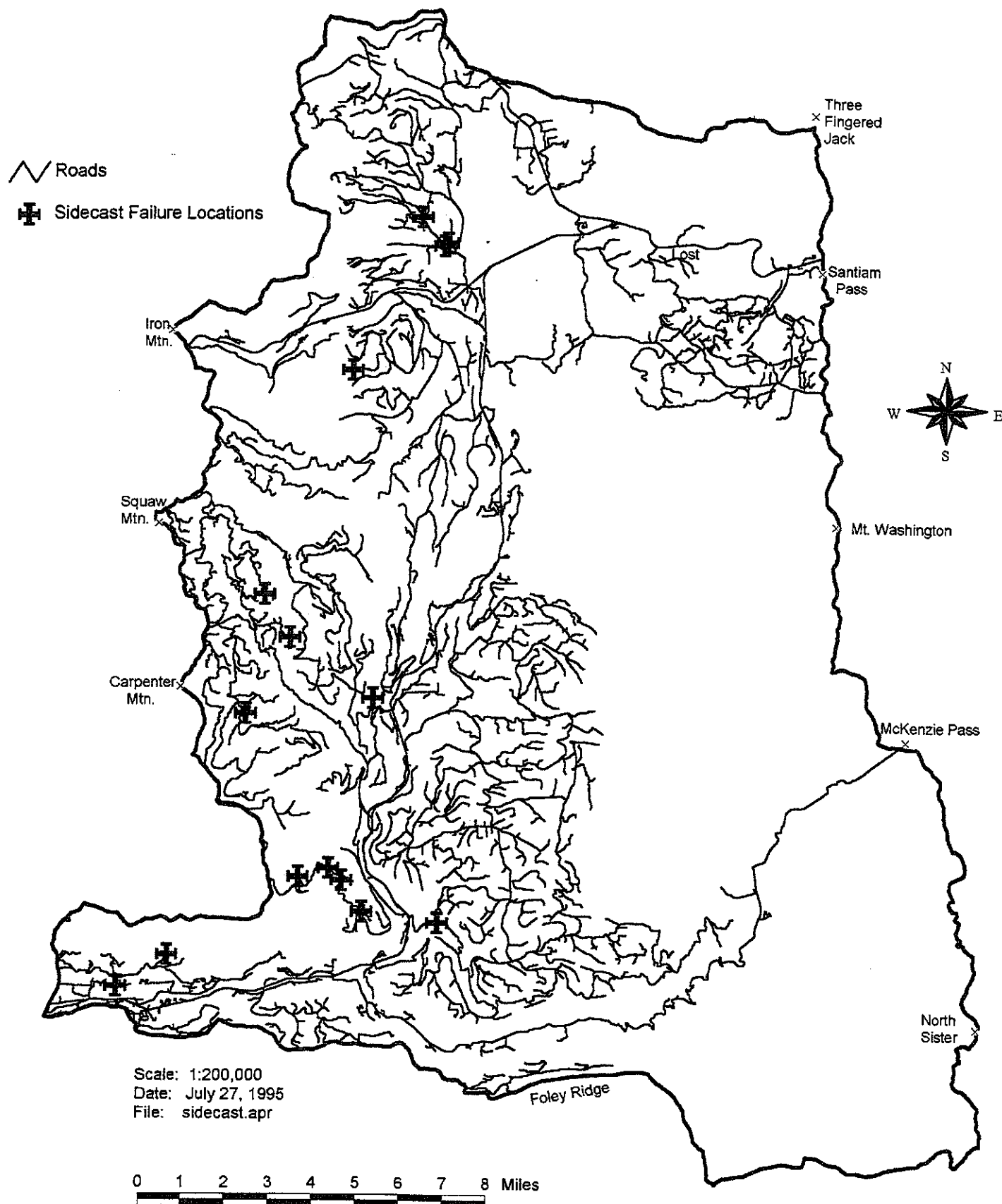
The watershed contains approximately 900 miles of roads. A review of the geotechnical engineering project files, interviews with district personnel (Larry Wilson, Pat Hutchins, and Gene Carver) concluded that there have only been 19 road related failures with historical significance (Geology Appendix). Seventy-five percent of these failures occurred in Landform Blocks 2A and 2B as a result of sidecast failures over Western Cascade volcanics (Figure 3-2). Rock aggregate for road surfacing has been of high quality in the watershed, which has kept road surface sediment contributions to a minimum. However, in the Budworm and County Creek drainages in Landform Block 2A, continual ravel from road cut slopes require yearly ditch cleaning.

Clearcut Harvest

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

Unlike intense wildfire where root cohesion loss is 100%, after clear cutting the root cohesion loss for Douglas-fir is approximately 50% by the end of the 1st year and 75% after 5 years (Gray and Megahan 1991). Ziemer (1981) also noted that "Removal of slope vegetation tends to decrease root cohesion, increase piezometric levels and decrease slope surcharge...and about 50% of the original root reinforcement is lost within 2 years after clearcutting and 90% is gone within 9 years." He also pointed out that "It may take about 15 years until the new forest provides 50% of the root reinforcement supplied by the original forest before cutting and 26 years until the soil in the harvested area returns to the strength of that in the uncut forest." Post-harvest debris avalanche initiation has occurred in the County and Conroy Creek drainages in Landform Block 2A.

Figure 3-2. Sidecast Failures



SOIL RESOURCES

The original 1973 Forest Soils Resource Inventory (S.R.I.) was updated in 1990 and placed in the Forest Geographic Information System (G.I.S.) as a Forest-wide layer. Areas newly designated as unstable, or potentially unstable were verified with aerial photos and on-the-ground where possible.

The 1990 S.R.I. was found to be reliable, and generally useful for planning purposes. Each polygon contains the following attributes: type, area, timber suitability, if unsuited why, stability classification, erosion potential, sediment yield potential, water yield, and site classification. Frequency distribution queries were made of the database to determine the areas of unstable soil types.

Frequency distribution for soils that are classified as stable, but where mass movement could be increased by management activities, were spatially identified from the database by intersection queries with slope polygons greater than 70%. These areas include those with shallow soils on sideslopes >70%; valley headwalls that have a potential for debris avalanche; areas with potential for high intensity fires or clearcutting; and areas associated with large storm events.

Probability Analysis

Similar frequency and distribution analyses were made for potentially unstable soil types. A probability analysis was made in these areas using the Level I Stability Analysis program, LISA (1991). Developed by the Intermountain Research Station, this program statistically analyzes the probability of failure within polygons under conditions of normal and extreme precipitation events, clearcut, 50% partial cut, and high intensity wildfire. Further information on the analysis process is found in the Geology Appendix.

The probability of failure for natural slopes that are classified as potentially unstable, or potentially unstable slopes greater than 70%, is about 4% (Table 3-1). This may be close to a "range of natural variability" for slopes in the Western Cascades. In the same area, under an extreme storm event, with 50% partial harvest or clearcut logging, the probability of failure increases above the range of natural variability by 1% and 6% respectively. These percentages will vary when applied to individual soil units within individual landform blocks. High intensity wildfire will have the greatest effect on slope stability in these areas. The probability of failure may increase to over 50% in most areas identified as potentially unstable (Table 3-1). Similar results were obtained in areas of western and eastern Washington and southwest Oregon in validity studies by Ristau (1988), McHugh (1991), and Wooten (1988).

Table 3-1: Summary of designated soil units and LISA percent probability of failure within the Upper McKenzie Watershed.

Potentially Unstable Areas:

SRI UNIT	NATURAL	50% CLEARCUT	CLEARCUT	WILDFIRE
Talus slopes and debris avalanche chutes <3 ft. deep				
SRI 3 (GW/GM)	24.5			63.4
Cohesive soils 6-20 ft. deep				
SRI 233/235 (MH/CL)	3.2	10.2	21.4	33.8

Potentially Unstable Areas on slopes >70%:

SRI UNIT	NATURAL	50% CLEARCUT	CLEARCUT	WILDFIRE
Granular soils <3 ft. deep				
SRI 71 (SM)	5.7	14.3	23.9	78.3
Granular soils 3-6 ft. deep				
SRI 13/61/64/610 610U/614(GW /GM)	18.8	24.8	50.0	93.8
Cohesive soils <3 ft. deep				
SRI 21/31/301/31 0U (ML/MH)	8.0	11.3	86.6	86.6
Cohesive soils 3-6 ft. deep				
SRI 16 (GMu)	16.0	22.4	32.1	48.6

S.R.I. Landtype and Stability Classification Conditions

The following describes soil types found within the Upper McKenzie Watershed.

Unstable: Areas which are prone to mass failure under natural conditions (unroaded, unharvested), and where human activities such as road construction and timber harvest are likely to increase landslide distribution in time and space to the point where this change is likely to modify natural geomorphic and hydrologic processes. (FSEIS glossary p. 18) and classified by the Forest S.R.I. as moderately (several failures observed within a polygon) to very unstable (entire polygon shows evidence of recent and past failures).

LANDTYPE	DESCRIPTION
25	Cohesive residual and colluvial soil, Sandy Silt with some Clay and rock fragments overlying pyroclastic bedrock on 20 to 40% slopes

Landtypes were identified through frequency analysis for SRI types and air photo interpretation.

Potentially Unstable: Areas which contain conditions of steep geometry, high ground water potential, and soil with low shear strength characteristics that "...considers the probability of landslide-triggering storms within the period of minimum root strength and elevated ground water (as well as slope adjustment to piping changes); the probability of channel adjustments that trigger streambank and toeslope failures (FEMAT IX-38); and classified by the Forest S.R.I. as stable or moderately stable to locally unstable. These conditions include high intensity fire and clearcut harvesting.

LANDTYPE	DESCRIPTION
3	Rock outcrops of basalt, andesite and pyroclastic material which are prone to differential weathering and stress relief from glacial unloading which produce talus slopes and debris avalanches
233 and 235	Clayey Silts to Silty Clays overlying pyroclastic bedrock on steep slopes up to 70 %

Landtypes were identified using aerial photo interpretation, a frequency query for SRI types, intersections with slope layer, and probability analysis using LISA for high intensity fire and clearcut scenarios.

Potentially Unstable on slopes >70%: Shallow soils in steep sideslope or valley headwall areas that have a potential for debris avalanche failure. Classified by the Forest S.R.I. as stable.

LANDTYPE	DESCRIPTION
13	Glacial deposits
16	Toe slopes glacial/fluvial deposits
61, 64, 610 610U, 614	Glacial till overlying basalt and adesite soil depth 3-6 feet
71	Ridges and cirque headwalls w/less than 3' of granular soil
301, 310U, 21	Sandy Silt to Clayey Silt overlying Tuffs and Breccias with less than 3 feet of slightly plastic soil.

Landtypes were identified using a frequency query for SRI types and intersections with slopes >70%.

OVERVIEW OF HUMAN USE

PREHISTORIC RESOURCES

Prehistoric heritage resources in the UPMKWA are not well-understood at this time in terms of the activities of native peoples which lead to the deposits of those artifacts. Some activities have left patterns of artifacts, which in conjunction with environmental data are straightforward and functionally clear. Debris from quarrying and preparing obsidian for toolmaking at Obsidian Cliffs is one example. Other patterns are less obvious. For instance, we know that resource processing must have taken place at many locations, yet the obsidian tools left at those sites yield little specific information about which plants or which animals were involved. Most documentation is in the form of Region Six Site Forms. Earlier years of recording (1979-86) are rather sketchy, though improvements in data occurred in recent years. In addition to this data, several contract archeological evaluations and data recovery projects (mitigations) have resulted in some furtherance of our understanding.

Prehistoric resources include chipped obsidian lithic scatters and obsidian lithic isolates, representing tool use, modification, or manufacture related to hunting and gathering. Ongoing stone tool analysis, both by agency archeologists and contractors, suggests that this portion of the Cascades was occupied primarily by people indigenous to the Cascades. Those people were probably ancestral to the Molalla people that were involved in early (but unratified) treaties of the 1850's. Some of their descendants are members of the Grande Ronde tribe. There appears to be a long period, the Middle Archaic (about 8,000-2,000 years ago) where there was marked stability in adaptation as it relates to stone tool use. Analysis of obsidian from archeological sites outside the UPMKWA area indicates that Obsidian Cliffs glass has a widespread distribution in the Northwest, demonstrating that other native people came and got obsidian or obtained it through trade with resident people.

Because much of the area is covered by recent volcanism, we can assume that there are many prehistoric resources deeply buried under those deposits. At this time, there are hundreds of prehistoric resources documented in the three Ranger Districts of the UPMKWA area. Many of these sites probably represent warm season occupation of the high elevation reaches of an ethnic group's territory, or they may be areas of probable travel route branching (such as the Parks Creek area on Sweethome District). The large number and high density of prehistoric sites at lower elevations along the main stem of the McKenzie are likely temporally-overlapping winter villages or encampments.

HISTORIC RESOURCES: MAJOR SITES AND COMPLEXES

Historic Resources are more well-documented in the watershed. They include the following major sites and complexes:

Santiam Lodge: The lodge was originally constructed by the Civilian Conservation Corps in 1939-1940. It is one of two surviving ski facilities constructed on the Willamette. It was operated under a Special User permit held by the Presbetry of the Cascades until 1987 or 1988. Then it reverted to the government, and it has been boarded up and slowly deteriorating ever since. The building complex consists of the main lodge, a garage, and pump house. The lodge is eligible for the National Register. Formal nomination has not been prepared, but a future use determination is being prepared by the District. If the existing trend continues, this historic building will be lost to vandals and the ravages of time.

Santiam Wagon Road: The SWR began as a commercial toll road, constructed in the 1860's. It reverted to Linn County ownership around the World War I era. Since then, portions of the road have been abandoned and other portions have become Forest Service roads. Its condition has been assessed along its 27 mile length across the Willamette NF. Within the UPMKWA area, its heritage integrity is classified as fair. The SWR was one of the first trans-Cascade roads, and it served to connect the Willamette Valley to eastern Oregon. Large quantities of freight and stock were driven over the road in its heyday. A skirmish in the Paiute Campaigns or the Bannock Wars (1878) may have been fought along the road in the vicinity of Sand Mountain. There is reputed to be a mass grave at the site. The SWR is eligible for the National Register. A formal nomination to the NR has not been completed. Personnel at Sweet Home RD are preparing a management plan and a Special Interest Area implementation guide for the SWR, which will prescribe protection of this resource.

Hogg Railroad: Hogg Railroad is a well-known historic cultural resource (District Number 07300h). It is located along the North Santiam River and east to the summit of Santiam Pass, about 22 air mails northeast of McKenzie Bridge. The old railroad grade forms part of the administrative boundary between McKenzie and Detroit Ranger Districts. The railroad grade continues east and beyond the Willamette-Deschutes Forest boundary.

Hog Railroad, as it is locally known, was the brainchild and scheme of a 19th century entrepreneur, T. Egenton Hogg. Hogg and others worked to develop a railroad running from Yaquina Bay on the Oregon coast to Boise, Idaho. This venture at various times was known as the "Corvallis and Yaquina Bay Railroad Company," the "Willamette Valley and Coast Railroad Company," the

Oregon Pacific Railroad," the "Oregon Central and Eastern Railroad Company," and finally as the "Corvallis and Eastern Railroad." The only operational portion of the railroad ran between Yaquina Bay to as far east as Idanha near Detroit in the western Cascades.

At the crest of the Cascades, a small amount of track was laid and a boxcar was hauled in (via the Santiam Wagon Road) and rolled along the track in a futile effort to secure financing for the failing enterprise. The Santiam Pass segment of Hogg Railroad, at Hogg Rock, was reputedly built by Chinese laborers, although no direct evidence for this has been found so far. Construction took place in 1888, 106 years ago. After bankruptcy, the Santiam Pass segment and all associated camps, construction, and most equipment was abandoned. To date, we have documented construction laborer camps, tool caches, construction dump cart parts, and of course the grade itself.

HISTORIC RESOURCES: GENERAL TRENDS AND LANDMARK EVENTS

While transportation was the dominant historic "theme" in the UPMKWA area, early recreational and extractive ventures also occurred, as well as agricultural settlement. The following lists landmark events in order of occurrence. Where several dates are shown, i.e., 1863/1869, the events are certain but sources conflict on actual date.

All sources note the first presence of Euroamericans in the early 1800s. Fur trappers and explorers from John Jacob Astor's Pacific Fur Company and the Hudson Bay Company were present in the Willamette Valley just after the turn of the century. The McKenzie River itself was "discovered" and named by a member of Astor's enterprise. Donald Mackenzie (note spelling), leading a party of trappers, may have explored the river in 1812 (Williams 1988:7).

The next 5-6 decades were characterized by migration into the Willamette Valley and settlement in present-day Eugene, Springfield, Pleasant Hill, and Thurston. As in-migration occurred in these areas, exploration pushed further up the McKenzie Valley, foreshadowing settlement to come.

1859. The so-called McBride Party, composed of George Millican, John Templeton Craig, James Stormont, and Joseph Carter were "first to seek for the headwaters of the McKenzie." A hot springs, later named Belknap Springs, is "discovered" by the McBride Party. It is possible that the McBride Party also "discovered" Clear Lake on this expedition (Walling 1884).

1860. J.H. McClung, with a party of seven from Eugene, makes a trip to the Cascade summit via an old Indian trail, later named Scott Trail.

1862/1863. Felix Scott Jr. makes crossing of the Cascades with 900 head of cattle, nine heavily laden wagons, and about 50 men. To do so, his party of 50-60 men routed and cut trail starting about 4 miles east of present-day Vida and crossing the Cascade summit several miles south of the present highway. John Templeton Craig was a member of this party.

Before the 1870's most of the activity in the McKenzie Valley was exploratory and/or extractive. From the beginning of that decade, homesteading, transportation and settlement became more emphasized. Settlement spread from Eugene/Springfield into the lower valley in the mid-1840's and '50's. From there, settlers moved gradually into the upper valley in the late '60's and afterward.

1870. Rollin Simeon Belknap begins development of Belknap Springs as a resort. The Belknap Springs resort was being served by stagecoach, run by John West Sr. from Eugene. Philander Renfrew and "Uncle" George and "Auntie" Frissell settled at Craig's Prairie (Strawberry Prairie) at about this time, which roughly corresponds with the building of the first bridge at a location now known as McKenzie Bridge.

As the nineteenth century drew to a close, use patterns in the upper McKenzie Valley shifted to reflect a stabilizing settlement situation and changes in the quality of life. Values were emerging that would shape modern land management and use of the McKenzie.

As settlers transitioned from the demands, rigors and uncertainty of frontier homesteading, they had time for activities beyond those needed to survive. And, for those who had come to the area because of its beauty and/or its bounty, the increasing population meant increased pressure on natural resources. With a de-emphasis on subsistence, settlers' values gradually began to shift to economic development, improving infrastructures, and recreational activities in the upper McKenzie Valley.

Several events occurred within a very short time that would set the stage for the future of the McKenzie.

1889. John B. Waldo proposes, to the Legislative Assembly of Oregon, forest reserves to "protect wilderness values, scenery, forests, waterflow and wildlife" along the crest of the Cascades.

1891. Congress passes Forest Reserve Act to set aside public lands covered with timber or undergrowth, whether of commercial value or not. Reserves are to "protect city watersheds, to protect salmon spawning grounds, to preserve irrigation water and amenity values."

1893. Cascade Range Forest Reserve is designated.

The next 40 years saw the transition from a land of isolated frontier habitations to a series of forest communities, including those nearest the McKenzie. Travelways were being improved to expedite the flow of commerce across the Cascades. Upper valley settlers were responding to the influx of recreational users and commercial traffic with entrepreneurial spirit. Logging became a substantial economic concern in the McKenzie Valley. In 1891, 17 million board feet of timber came down the McKenzie in the largest drive ever made. Clearcutting was the common practice.

1908. According to Manena Schwering, long-time resident of Blue River, the establishment of the McKenzie Ranger District had a significant and lasting impact on community development. The first Ranger, Smith L. Taylor, served the area for 27 years and came to be regarded as an unofficial spokesman for community projects, school and highway improvement, and later, fought for rural electrification.

1908. The Cascade Forest is one of four forests carved from the Cascade Crest Reserve.

1905. First automobile crosses Santiam Pass, and hydroelectric power comes to the lower Valley.

1911. Eugene Water Board (later to become EWEB) is created.

1915. Forest Examiner Robert S. Wallace submitted and Clyde Seitz, Forest Supervisor of the Cascade National Forest from 1908-1919, approved a significant report detailing needs for construction of what would become the McKenzie Highway. Timber is listed as the number one principal resource of Lane County, with an inventory of some "60,000,000,000 feet of high grade standing merchantable timber." Wallace also predicted that "With the completion of the State highway system and its tributaries through Lane County, this beautiful country will be a veritable paradise for sportsmen, motorists, fishers, campers, and all lovers of out-door life." Referring specifically to the "McKenzie Highway," Wallace stated: "From a County, State and National point of view, this is by far the most important portion of road needing improvement in Lane County at present." (Wallace 1915).

1919-1921. The upper valley road is improved. Highway 242, built on the old wagon road begun in the 1860's by John Craig, is completed in 1925.

During the period 1933-1945, the lumber industry made a major shift from private to public lands as a source of timber; many lumber companies went

under and others changed ownership; "sustained yield" became a goal of Forest Service management; railroad logging and river drives gave way to tractor logging and truck transportation, and cutting practices changed. Growing timber was now an industrial business.

The 1930's brought a new interest in winter sports, especially skiing, and recreation became a year-round proposition. CCC labor built a two-story lodge, cabins, water and sanitation systems, and a ski run at White Branch, off the McKenzie Highway. Unfortunately, at 3000' elevation, sufficient snow depths to support a long winter season were unlikely.

The 1950's were years of confidence and growth. However, a near tragic fire and some alleged favoritism in timber sales had created a rift between the residents of the McKenzie Valley near Blue River and the Forest Service in the late Fifties. Then district ranger Edward Anderson initiated what might be recognized as the first Natural Resource Education program ever undertaken in an effort to restore confidence in the Forest Service.

1963. Carmen-Smith hydroelectric complex is dedicated.

1964. Clear Lake Cutoff opens as modern day Highway 126. Three Sisters designated "wilderness."

Between the early 50's and the mid-'60', recreation use (primarily camping and fishing) had grown by over 300% across the Forest. Developed recreation facilities were being built both to handle the increase in use and to minimize impacts to "dispersed" sites.

In 1962, the Forest initiated a fee system at Paradise Campground, charging \$1 per day, to help fund recreation facility development, maintenance and improvement. And, in 1965, the Land and Water Conservation Fund (LWCF) was established, formalizing payment of a national fee for use of campgrounds.

By 1970, only three persons out of ten were rural dwellers nationally. But the character of the McKenzie Valley remained largely rural and agrarian until the following decade. In the mid-80's, the collapse of the timber industry in the valley forced many residents to seek employment elsewhere. Comparatively inexpensive property coupled with scenic values and recreational opportunities of the middle and upper valley appealed to retirees and seasonal visitors looking for summer homes.

Through the 1980s and into the present, development in the lower McKenzie Valley has turned many of those communities into "bedroom" communities for relatively affluent commuters from Eugene/Springfield.

1988. Upper McKenzie River, from Scott Creek to Clear Lake, designated Wild and Scenic River.

1993. The McKenzie Watershed Council forms to coordinate and integrate resource planning for the entire McKenzie basin.

CURRENT AND FUTURE HUMAN USE

People use the Upper McKenzie Watershed in several distinct ways: as an area to visit and recreate, as a workplace destination, and some use this area as their home.

Access to the Upper McKenzie Watershed is provided by three highways: US Highway 20, State Highway 126, and State Highway 242. From these highways, Forest roads branch out to provide access to the area. Visitors from many Oregon counties, other states, even other nations are attracted to this area of the Cascades Range.

The 1994 Recreation Resource Inventory System (RRIS) tracked different activities such as camping, hiking, and sightseeing. Over one and a half million separate activity-days were tabulated. This may be one person counted several times as they hiked, rode, or camped overnight during their stay on the McKenzie Ranger District within the Watershed. The Upper McKenzie Watershed contains the entire range of recreational activities found across the Willamette National Forest. Virtually all McKenzie District's campgrounds, boat launches, recreation residences, picnic areas, viewpoints, resorts, youth camps, ski areas and the vast majority of hiking trails are contained in this watershed. Activities range from white water rafting, downhill skiing, water skiing, hiking, off-road vehicle riding, wilderness travel, hot spring use, mountain biking, etc across the spectrum of recreation offerings. In the Sweethome District, an interesting anomaly occurs: recreation use patterns exist without the influence of major water ways. Here, use is focused more on a few small creeks and the trail systems accessing the major ridgeline peaks. (See Appendix ? for recreation focus on Sweet Home RD). Detroit Ranger District administers the portion of the Mt. Jefferson Wilderness that is within the watershed. This portion contains several trails including a major access point of the Pacific Crest National Scenic Trail.

According to the 1992 McKenzie Pass/Santiam Pass Scenic Byway Management Strategy :

Future recreation use within the byway (watershed) will likely be affected by changes in various socio-economic indicators (e.g., population growth,

disposable income, leisure time), the availability of opportunities, technology, weather conditions, and other variables. Due to uncertainties about the variables affecting future use, estimates become less reliable as they are extended into the future. Studies which have predicted future growth for recreation cannot anticipate fluctuations in microclimatic weather patterns nor predict regional energy shortages or economic recession. Therefore, estimates of future use generally assume an underlying demand is present and will increase with a growing population that has an ever-increasing awareness and appreciation of recreation values.

Based on these factors, general trends in past use in both the Willamette and Deschutes National Forests and current efforts to diversify local economies with an emphasis toward tourism and recreation, it seems appropriate to assume that future participation in all activities within the area of the Scenic Byway (all of the McKenzie portion is in the watershed analysis area) will increase as long as opportunities are provided.

A 1993 report conducted for the McKenzie Pass/Santiam Pass National Scenic Byway Interpretive Plan gives useful insight into a wide scope of the visitors to the watershed. Dean Rynyan Associates conducted the research entitled "Interpretive Audience Analysis, The Central Cascades, Oregon." It used data from a study on 1989 travel and tourism in Oregon conducted for the Oregon Tourism Division. For that analysis, respondents who traveled in and through Central Oregon and the southern Willamette Valley were polled. The sample consisted of 636 Oregon residents and 890 out-of-state visitors. According to the Interpretive Plan:

Two basic groups could be defined, with 65% being visitors from Oregon, Washington, and California. The remainder were visitors from other states and foreign countries. Most residents and out-of-state visitors traveled by private auto, with a significant portion of both groups using RVs. Most visitors (80-83%) to the area were traveling primarily for pleasure and/or were to visit friends and relatives. Accommodations of choice by residents equal between the use of campgrounds and commercial lodging, however out-of-state visitors choose commercial lodging twice as often as they do public campgrounds.

Residents stay in the area about four days as compared to about ten days for out-of-state travelers, who choose locations to visit based on information gathered during their trip. Most travelers are a mix of families with two children, and older couples traveling without children who earn moderate annual incomes, and who are an average age of 50

years. Travelers to this area are relatively well-educated, with most having some education beyond high school and a majority of this group having bachelors or graduate degrees. Most visitors to the area engage in a variety of travel related activities, including: relaxing and sightseeing (94%), hiking (65%), small town shopping (64%), visiting a museum or historic site (62%), wildlife viewing (60%), picnicking (52%), and visiting friends and relatives (49%).

A January 1995 report titled "Initial Social Assessment of Proximate Communities for the Central Cascades Adaptive Management Area" (Shindler, List, Smith, and Steel) produced Tables 3-2 and 3-2. These university researchers conducted a random sample survey of 931 Lane and Linn County residents in the spring of 1994 regarding uses and management preferences for the Willamette National Forest. Fortunately for this watershed analysis, the AMA requirements for a survey closely paralleled our needs. From the initial 931 contacted, 744 residents of Eugene, South Santiam River drainage, and the McKenzie River drainage responded. This survey lacks residents from the rest of Oregon and out of state visitors. However, the survey provides useful insight into a large percent of the users of this watershed.

There are 107,635 acres of privately-owned land within the watershed. Of this area, only 812 acres (0.7%) are used for residential purposes. There are 2,178 acres of industrial classified private land near McKenzie Ranger District, primarily located near McKenzie Bridge off of Highway 126 or Highway 242. One large section is also located along the Eno Road. Therefore, 97% of the privately held acres in the watershed are located in the north part of the watershed, most adjacent to Sweet Home RD, less than 500 acres near Detroit District's boundary.

Table 3-2: Recreational Uses by people in Eugene, S. Santiam River drainage, and the McKenzie River drainage.

Forest Use	Total	Eugene	Santiam	McKenzie
Visit any forest for recreation:				
Never	3%	1%	5%	1%
Occasional (few times a year or less)	64%	57%	67%	65%
Frequent (at least monthly)	33%	42%	28%	34%
Visit the Willamette National Forest:				
Never	4%	1%	4%	5%
Occasional (few times a year or less)	76%	76%	80%	69%
Frequent (at least monthly)	20%	23%	16%	26%

Table 3-2 (continued)

Forest Use	Total	Eugene	Santiam	McKenzie
Use of Willamette National Forest:				
Day hiking	77%	70%	79%	81%
Camping in developed sites	77%	77%	79%	74%
View/photo wildlife	72%	73%	74%	68%
Fishing	66%	52%	76%	64%
Hunting	48%	28%	62%	45%
Mushroom/berry picking	40%	33%	42%	43%
Overnight backpacking	37%	40%	37%	32%
Bicycling	36%	44%	29%	40%
Power boating	36%	27%	45%	30%
Woodcutting	32%	21%	35%	39%
River rafting	31%	37%	26%	34%
Downhill skiing	27%	36%	22%	25%
Cross country skiing	20%	29%	17%	16%
Motor cycling/ATV	20%	14%	24%	18%
Horseback riding	15%	15%	17%	11%
Snowmobiling	9%	6%	10%	9%

Table 3-3 shows that the average age, income, and education level for these communities tends to compare well to other populations surveyed (i.e. Oregon and national samples) (Shindler, List, Smith and Steel 1995). The surveyors also noted that older, more educated people with higher incomes tend to respond to natural resource surveys, as they tend to be more interested, have more time for questionnaires, and may have more at stake in forest management decisions. The other items the surveyors found noteworthy were the length of residence of 28 to 34 years, with relatively few individuals having moved into Lane or Linn county in the last five years. This suggests to the researchers that the public has a good sense of the landscape around them and may have a strong interest in how it is allocated and managed. Another item of note is the economic sector data. There seems to be a relatively high number of retirees in the sample, which may or may not be representative of the state as a whole. The 36% figure compares well with their statewide survey (35%), but is substantially higher than they found in an interest group membership (25%). The high number of timber dependence (33%), is not unexpected, with Eugene's figure of 22% closer to the statewide level of 21%.

Table 3-3: Community Profile within the Upper McKenzie Watershed.

Residents	Total	Eugene	Sanham	McKenzie
Age (mean)	54	52	55	56
Female	52%	55%	52%	46%
Male	48%	45%	48%	54%
Income (annual Mean)	\$21,900	\$22,200	\$21,300	\$22,700
Level of education:				
High School	26%	16%	35%	21%
Some College	48%	54%	45%	48%
college degree	16%	18%	14%	18%
Advanced degree	10%	12%	6%	13%
Years residing in Lane/Linn Co.	32	28	34	30
Less than 5 years	6%	8%	3%	8%
Economic Sector:				
Private or self-employed	44%	47%	43%	44%
Government	11%	13%	10%	11%
Retired	36%	29%	40%	38%
Unemployed	3%	5%	2%	2%
Other	5%	5%	5%	5%
Members of immediate family dependent on timber industry for economic livelihood.	33%	22%	37%	39%
Self-described ideology:				
Liberal	10%	18%	7%	6%
Moderate	71%	63%	76%	70%
Conservative	19%	19%	17%	24%
N	744	198	363	183

OVERVIEW OF UPLAND VEGETATION AND WILDLIFE HABITAT

The following section discusses existing and historical conditions and trends of the vegetative systems within the Upper McKenzie watershed. The following will include answers to questions such as "What is there now, and how did it get that way?" "What was there in historical times?" and "What processes will continue regardless of human intervention?"

DISTURBANCE

Disturbances are events that may result in change to vegetative or topographical characteristics within the landscape. They can be described in terms of their type, intensity, frequency, duration, and effect. The prominent disturbance phenomena influencing the current landscape patterns in the Western Cascades include fire (human-caused and lightning starts), wind, insects and disease, and landslides (Diaz and Apostol 1992). These disturbance phenomena can be thought of as a complex that may increase or decrease the biotic diversity on the landscape. Their interactions are dynamic, and unique combinations may exist at a forest, community, or microsite level. Because these factors are interdependent, removing or altering one disturbance factor may influence the role of the others. Glaciation and volcanism are also disturbance factors on this landscape. They created the topographical features and heavily influenced the subsequent development of vegetation.

Fire

Fire is a significant environmental process. Fire affects the environment because it:

- influences vegetative succession;
- influences age structure and species composition of vegetation;
- produces a vegetation mosaic on the landscape;
- influences population dynamics of insects and plant diseases;
- influences nutrient cycles and energy flows;
- influences productivity, diversity, and stability of ecosystem;
- and determines availability of habitats for wildlife over space and time (Heinselman 1990).

Portions of the Upper McKenzie forests appear to have a closer, more frequent relationship with fire than usually observed on the west side of the Cascades. Factors such as lightning frequency and seasonal east winds that result from the areas' position on the Cascade crest significantly affect the fire regimes within the area.

Periodic fire has been a normal and reoccurring component of the Upper McKenzie area since the retreat of the last glacier, playing an important, often dominant, role in shaping and maintaining the vegetative communities. These forests have periodically experienced both large and small disturbances that altered vegetation on areas ranging from less than an acre to thousands of acres at a time. Fire is essential to the functioning of this natural system.

The relationship between fire and this landscape has been greatly influenced by the presence of humans. Fire suppression efforts that began about 1900 altered the historical fire regimes. Prior to fire suppression activity, there is a history of human use in this area that also influenced the fire regime. White settlers engaged in road building, travel, railroad building, hunting, and recreation. These activities greatly increased the fire frequency within this area during the late 1800's.

There is little quantitative evidence that Native Americans used fire to manage the environment in the Upper McKenzie prior to European settlement. However, the area is known to have been a key east to west travelway, and the wetter more productive sites within the Pass would likely have been good candidates for semi-permanent huckleberry propagation. It is likely that Native American's also influenced the fire regime in this area, but the extent is unknown.

The result of these combined historical factors is reflected in the composition and distribution of the vegetation that we see today. The fire regimes of watershed can be best characterized by looking at the plant associations that have developed within this area. A detailed analysis of the fire regimes by plant series in the watershed will be discussed later in this chapter. Fire regimes by plant association are shown in Table 3-4. Figure 3-3 displays the different fire regimes found within the watershed.

For those plant associations dominant in wilderness areas, the role of natural fire must be allowed to function naturally to maintain and restore biological and physical processes as required by the Wilderness Act of 1964.

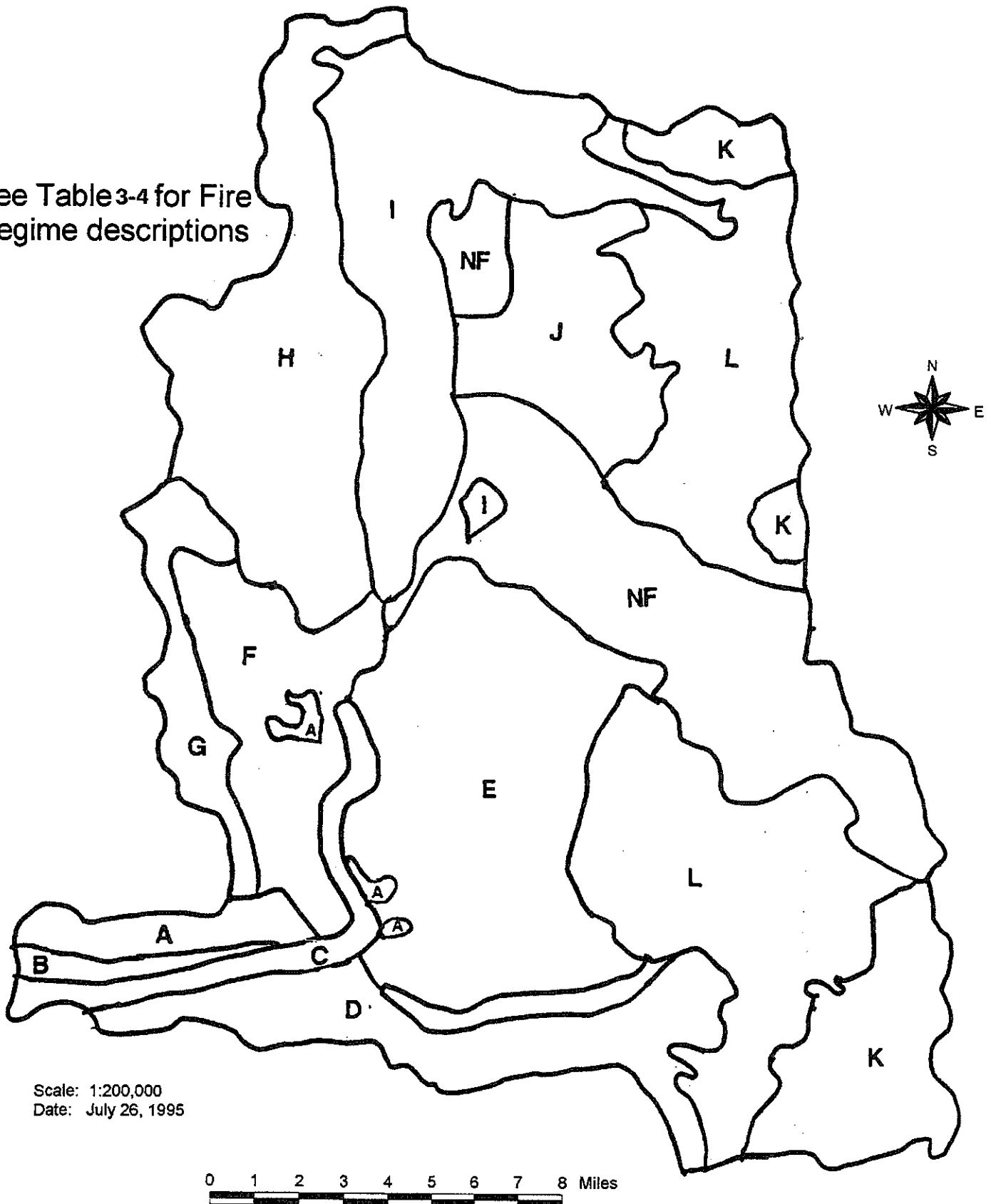
Table 3-4: Typical fire regimes in the Upper McKenzie watershed. The first line for each regime represents a stand-replacement fire. The lower line is a typical underburning type fire.

Regime	Frequency	Intensity	Size	MFRI
A	Frequent	High	Large	50-75 yrs
	Frequent	Moderate	Medium	40 yrs
B	Intermediate	Moderate-	Medium	100-130 yrs
	Frequent	High Low- moderate	Small	60 yrs
C	Intermediate	Moderate	Small	200-300 yrs
	Intermediate	Low	Small	100-150 yrs
D	Intermediate	Moderate	Medium	150-200 yrs
	Intermediate	Low	Small	100 yrs
E	Frequent-	High	Large+	90-130 yrs
	Inter- Frequent	Low- Moderate	Small	60 yrs
F	Intermediate	Moderate-	Small-	130-190 yrs
	Frequent	High Low	medium Small	80 yrs
G	Intermediate	Low-	Small	100-200 yrs
	Frequent	Moderate Low	Small	80 yrs
H	Intermediate	High	Medium-	100-150 yrs
	Frequent	Low	Large Small	80 yrs
I	Intermediate	High	Large	100-150 yrs
	Frequent	Low- Moderate	Small	60 yrs
J	Intermediate	High	Medium	100-200 yrs
	Frequent	Low	Small	18-75 yrs
K	Frequent	Low- Moderate	Small	75 yrs
L	Intermediate	High	Large	58-206 yrs

Frequency	Size	Intensity
Infrequent - >300 year MFRI	Small - <300 acres	Low - 0-30% mortality
Intermediate - 100-300 year	Medium - 350-700 acres	Moderate - 30-70% mortality
Frequent - <100 year MFRI	Large - > 700 acres	High - >70% mortality

Figure 3-3. Historic Fire Regimes

See Table 3-4 for Fire
Regime descriptions



Wind

Wind flow in and around the Upper McKenzie watershed predominately occurs from two directions: southwest and east. The majority of the time, wind blows from either direction with little to no noticeable effect. Depending on the time of year and atmospheric condition, both of these wind directions can occur on a daily basis in the area. Wind flow can change the pattern of vegetation on the landscape in two ways: by blowing over trees and influencing the behavior of fire.

Large wind events have occurred in the area, causing significant changes to the landscape through the creation of openings or gaps that increase the horizontal diversity of stands, and by increasing large woody debris. Windthrow hazard is partially based on the probability of trees being uprooted by wind as a result of insufficient soil depth and inadequate soil strength to provide anchoring of tree roots. Other site characteristics may also influence this hazard seasonally (i.e., soil moisture content and depth to water table). During the spring when soils are saturated by snowmelt and rainfall, windthrow hazard is increased. Coarse textured (sandy) soils such as those common in the watershed are less likely to be affected by seasonal moisture content because they lack the ability to hold moisture in the soil profile. Excess moisture is quickly drained.

The topography influences the effect of wind in several ways. One effect occurs on the lee-side (away from the wind) of ridges, extending for some distance down the slope. This is an area where windthrow often occurs during a storm. Several timber sales in the near Santiam Pass (Spud and Search), along Smith Ridge (Tattoo, End, and Raven), and in the Robinson Lake area (Taffy and FDR) all experienced windthrow during the winter storm of 1990. North and east edges of several units were also affected from the strong influence of the southwest wind that came through the area during that time.

In the watershed, wind is a dominant factor in fire's influence on the landscape. This is evident by examining fire sizes and shapes in the area over the last 90 years. Hundreds of lightning fires have been recorded over time in the watershed. With the advent of fire protection, the majority of these fires have remained very small, usually never exceeding 1/4 acre in size. These fires have had very little influence at a landscape level, though they have strongly influenced the within stand diversity of every plant association group through the creation of gaps. Fires that did grow to a significant size were driven by a strong east wind. East wind is the biggest factor influencing the spread, size and intensity of most of the larger fires within the watershed.

Topography combined with wind patterns also play an important role in fire's influence on the landscape. The summer of 1967 proved to be an active lightning period, with numerous lightning starts in the area. Most of the fires

that stayed small were protected from the influence of the east wind by topographic features. Only those fires influenced by east wind grew to significantly affect the landscape through stand replacement. Figures 3-4 and 3-5 display typical wind patterns in the watershed.

Lightning

Lightning is the primary source of fire ignition within the watershed, typically occurring in the summer months. During the period from 1970 to 1989, no lightning fires were recorded before June or after September in the watershed. Nearly two-thirds of documented fires occurred from mid-July to mid-August (Simon 1991).

There is a wide variance in the number and severity of lightning caused ignitions. They ranged from 0 to 29 fires per year between 1970 and 1989. Many go unnoticed because of their very small size. The average frequency of lightning storms per year is influenced by climate. Climatic variations affect the potential for thunder storms and the fuel flammability. The variation in the annual number of lightning-caused fires is great with a few lightning storms dominating the record. Records show that 1967 produced numerous fires with the majority of them occurring between August 10 and August 28. These included the Airstrip, Cupola, Peggy Creek, Squaw, and Lava Flow fires that burned approximately 6400 acres within the watershed.

There is a strong correlation between summer drought (monthly precipitation) and fire frequency in this area. When average monthly precipitation is compared to monthly lightning fire frequency, the highest occurrence of lightning fires coincides with the lowest average monthly precipitation. This is typical during the months of July and August. Under these conditions, small lightning-caused fires have the potential of becoming large stand-replacement fires.

Fire records documenting lightning fires are based on reported fires. Prior to 1949 (the start of aerial detection) it is very unlikely that all fires were reported. Lightning storms with many ground strikes probably ignited many small unrecorded small fires. Fire detection and suppression improved over time because of improved access, suppression methods, and staffing. Figure 3-6 displays lightning-caused fires per 1000 acres by plant series. The S-TSME is the subalpine portion of the mountain hemlock forests. This series has the most fires because the crest of the Cascades receives significantly more lightning strikes than the lower portions of the watershed.

Figure 3-4. Upper McKenzie Watershed Normal Westerlies

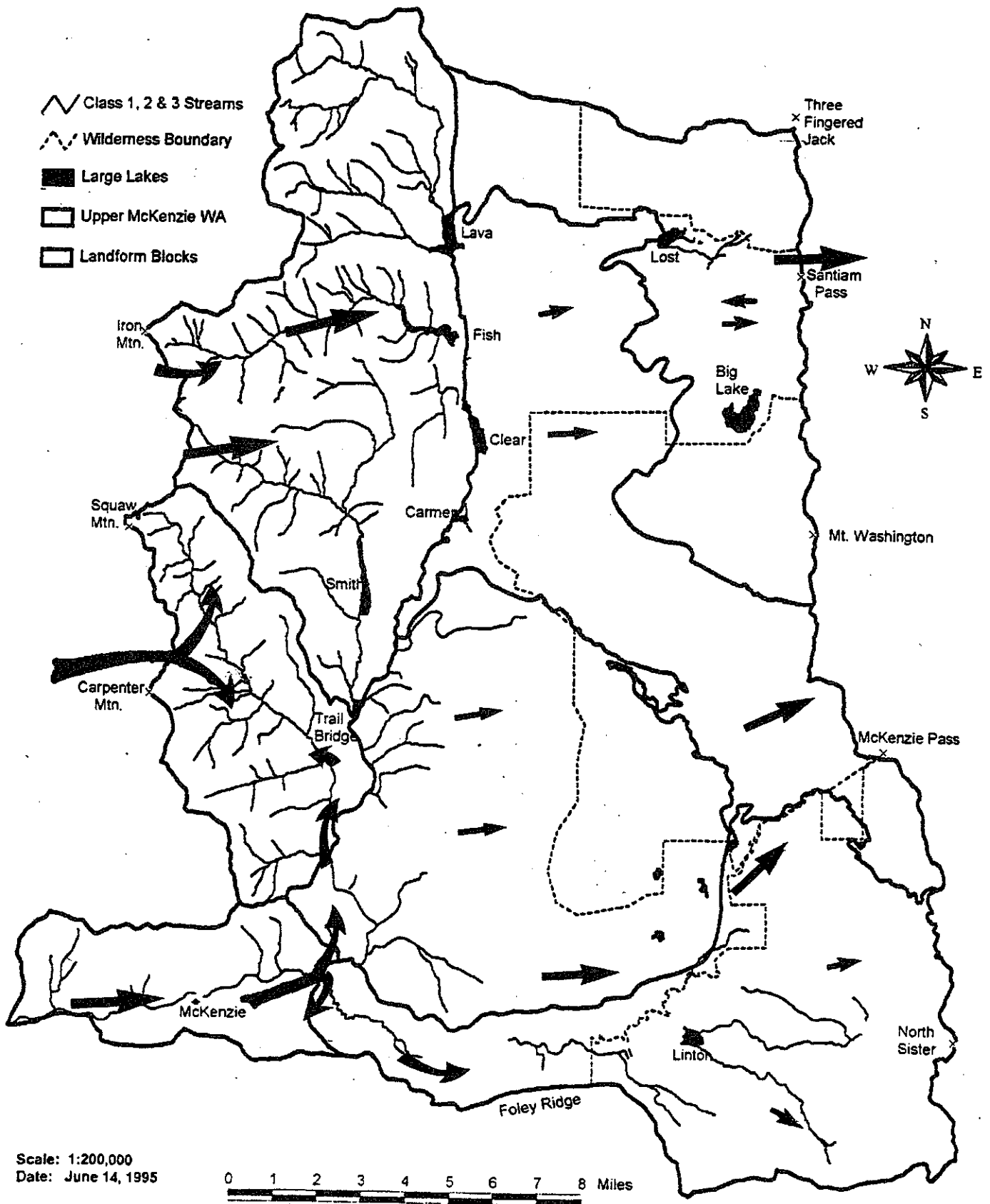


Figure 3-5. Upper McKenzie Watershed An East Wind Event

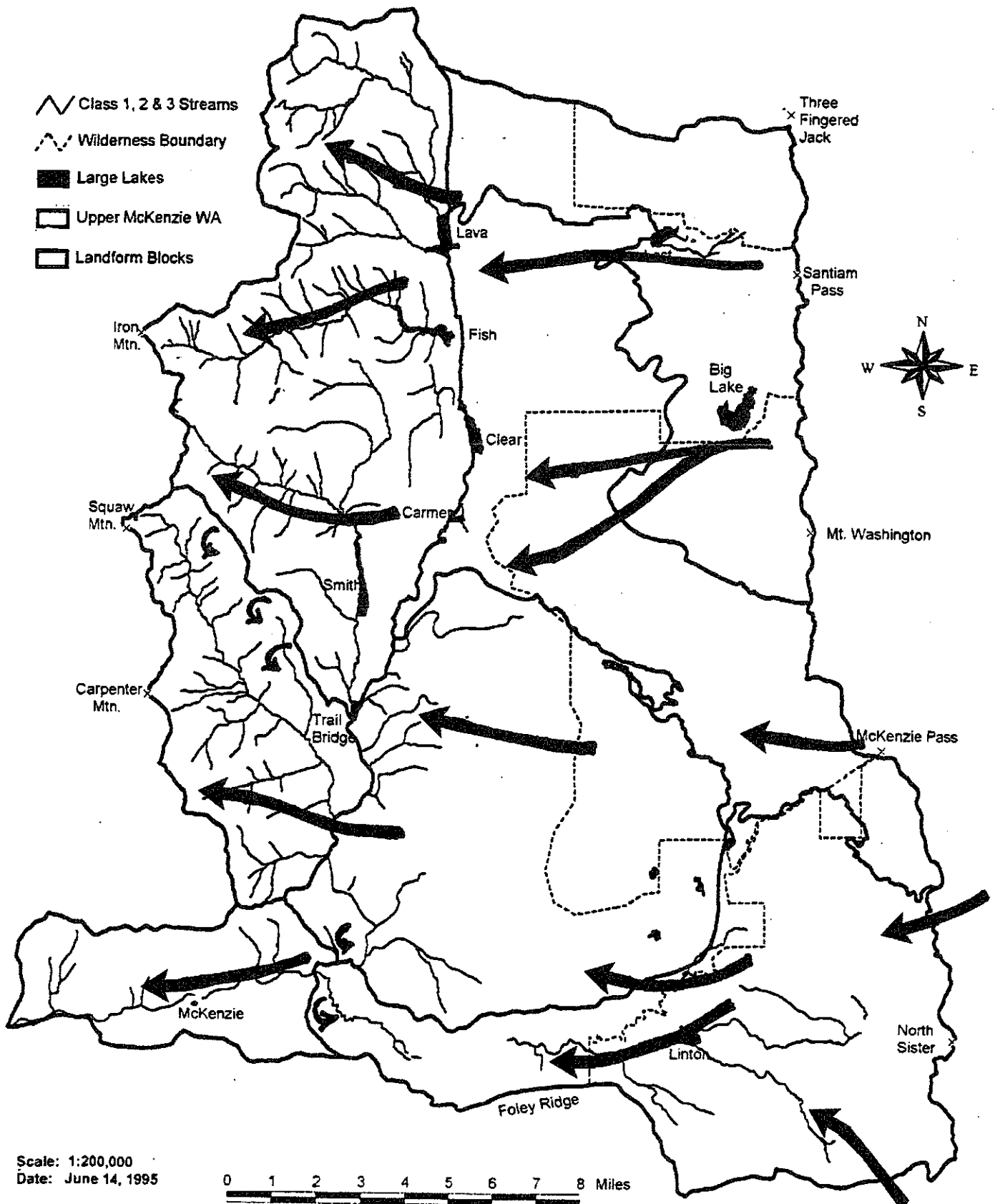
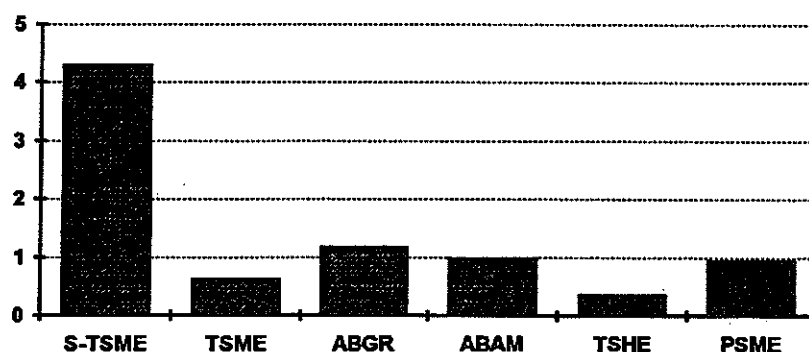


Figure 3-6: Number of Lightning Fires per 1000 acres in the UPMAKWA.



Insects And Disease

The role of insects and disease as a disturbance factor has increased within the watershed because of the increase in fire suppression since the turn of the century. There is evidence to suspect that the cycle of western spruce budworm (*Choristoneura occidentalis*) outbreaks that occur within the watershed is becoming shorter than the historical average.

The two most recently recorded budworm outbreaks are 1949-1953 and 1986-1993. There is also evidence to suspect that the fire suppression of the last 80+ years within the watershed has resulted in larger scale outbreaks than previously recorded. In the absence of fire, the western spruce budworm can play a similar role in the forest, killing tree species and age classes that would have burned if wildfire ignitions had not been successfully suppressed. Because larger outbreaks increase the number of dead and weakened trees, they also influence the magnitude of subsequent fire events.

The development of damaging budworm outbreaks at Santiam Pass depends ultimately on the availability of suitable forest habitat and favorable climate. The availability of suitable budworm habitat is directly related to fire exclusion and the development of multi-storied stands of fire susceptible true fir.

Douglas-fir beetle (*Dendroctonus pseudotsugae*) is the primary insect attacking Douglas-fir trees within the watershed. Douglas-fir beetle population increases are strongly associated with areas of fresh blowdown or dead standing timber. Once Douglas-fir beetle populations become elevated, they infest and are highly destructive to live green Douglas-fir trees. They often infest live trees that are weakened by drought, disease, or competition stress. Douglas-fir beetles can fly many miles over the landscape to find patches of weakened or stressed trees.

Root disease is a factor that affects the vegetative composition and health of the forests in the watershed. The two root diseases that have the most impact are

Armillaria root rot (*Armillaria ostoyae*) and laminated root rot (*Phellinus weirii*). Both of these diseases are widespread within the watershed and are capable of causing considerable tree mortality.

White pine blister rust (*Cronartium ribicola*) has significantly reduced the population of Western white pine within the watershed over the last thirty years. White pine blister rust is a fungus that attacks and kills all five-needle pines. It was inadvertently imported from France in the early 1900's, and it continues to kill and injure many trees. Affected trees in the watershed include western white pine (*Pinus monticola*), whitebark pine (*Pinus albicaulis*), and sugar pine (*Pinus lambertiana*). Rust-resistant strains do occur in nature, and rust-resistant Western white pine planting stock is available for reforestation.

STAND DYNAMICS AND SUCCESSION

Because of the close relationship between disturbance, particularly fire, and the development of vegetation within the watershed, an "initial floristics" model of stand development is most appropriate for this area (with the probable exception of high elevation mountain hemlock). General stages of this model are as follows: early seral, stand initiation, stem exclusion, understory reinitiation, and late-successional old growth.

The early seral stage begins after a disturbance to the preexisting plant community. During this period, seeds present in the seed bank, pioneer invader species, and regrowth from vegetative sprouts dominate the area. In the second stage, stand initiation, conifers regenerate, and shrubs and herbaceous species that were present in the preexisting plant community are usually reestablished in abundance. The next stage is stem exclusion. As saplings grow, a dense canopy develops, limiting the sunlight available to shade-intolerant species and preventing further regeneration. During this period, the natural thinning of the conifers can create openings in the canopy. Shade-tolerant trees, shrubs, herbaceous plants, and cryptogams are established in the understory. Eventually, large trees in the overstory die, creating gaps; younger trees in the lower canopy layers are released; and the stand develops into an old-growth stage with an irregular canopy (Oliver and Larson 1990).

Forest development does not typically proceed in chronological uniformity. It will vary depending on the type of disturbance and intensity, soil composition, macro and micro-environmental conditions and the preexisting plant communities. A seral stage can occupy or overlap in various sequences for an indefinite period of time until site conditions initiate change.

In the watershed, the plant associations present have evolved over time with fire as a frequent natural disturbance influencing successional changes. The effect of

fire (intensity and frequency) has created plant communities with great complexity of species and structural diversity. Many of the plant communities follow a single regeneration pattern under "normal" fire periods. However, succession patterns can change following a disturbance of very short or long fire intervals. The macro- and micro-environment of the watershed, and the dominant role fire has had in the area, have created a landscape of multiple successional pathways. One example of a common succession pattern is the post-fire seral invader species, lodgepole pine. Lodgepole pine is able to invade and dominate following a fire disturbance if it was present in the pre-fire plant community or if a seed source exists for regeneration.

PAST MANAGEMENT ACTIVITIES

Historical grazing for profit was focused on the upper parts of the watershed. Grazing in the lower part was mostly for personal use by homesteaders. Sheepmen of the late 1900's wintered their flocks in eastern Oregon and drove them into the Cascades in May and June to reach the alpine meadows by August. The areas around Mt. Jefferson and the Three Sisters were popular grazing areas and in continual use from the 1880's.

The period of Federal management of the watershed began in September of 1893 when President Grover Cleveland created the Cascade Range Forest Reserve under the jurisdiction of the General Land Office. Grazing was excluded after creation of the forest reserve. However, there were instances of trespass. In 1896, at least 16,000 head of sheep were known to be grazing illegally in the area of the watershed. In 1898, the reserve was reopened to legal grazing using a permit system to regulate the size and range of the sheep herds. The area supported 6 herds of 2000 head each. The grazing agreement required the sheep owners to suppress human-caused fires. In addition, an area of huckleberry patches near the headwaters of the McKenzie River was excluded from grazing.

From 1898 to 1905, management in the forest reserve became more active. Activities included small timber sales, grazing, special product collection, settlement, trail building, and fire suppression. After initial fire suppression efforts in 1898, fire management increased in efficiency as other management activities increased.

Control and management of the forest reserves were transferred to the Secretary of Agriculture in February of 1905. In 1908, the bulk of the watershed was part of the Cascade National Forest; the northern part of the watershed was part of the Oregon National Forest. In 1911, portions of the Oregon National Forest were renamed Santiam National Forest. That Forest included all portions of the watershed north of the Linn County border.

Automobiles first crossed the Santiam Wagon road in 1905. The Santiam Wagon road was built by paying for the construction with alternating sections of land. Some of those sections were later sold to timber companies. Most of this land was later exchanged for property closer to the valley. However, several of the sections of private land in the watershed are holdovers from the original transaction. Grazing reached its legal peak in this area in 1909 and 1910; the grazing tapered-off as old burns and cutover areas were reforested, thereby reducing the available forage. In addition, this was a time of general decline for the grazing industry. Partly in response to grazing competition from sheep, a game refuge was created in the 1920's around the Three Sisters big game summer range where grazing and hunting were forbidden.

In 1933, the Willamette National Forest was created from the Santiam and the Cascade forests. This marked the joining of the watershed under a single administrative unit. After World War II, timber management became an active part of the Upper McKenzie area. Forest Service records indicate that less than 500 acres of federal land in the watershed were harvested before 1950. About 2,800 acres were harvested during the 1950's. This amount is relatively low when compared to the neighboring watersheds.

In the 1960's, timber management in the watershed began in earnest. Between 1960 and 1969, a total of 9,886 acres of timber were harvested. The 1960's figure includes portions of the 5,400 acres that burned in the Airstrip fire of 1967. The harvest amount dropped in the 1970's to 7,400 acres harvested during the decade, as harvests in the Willamette National Forest were focused in other areas. Harvests in the watershed peaked in the 1980's at 14,227 acres total. Acres harvested in the 1980's were concentrated in the later half of the decade because timber sales that defaulted in the early 1980's were re-offered. In addition, market conditions encouraged the timber purchasers to accelerate harvest of sales already under contract. Timber harvest in the first half of the 1990's was 3,453 acre. This is a reduction by more than half from the previous decade because of the new Willamette Forest Plan, various litigation, and the ROD for the President's Plan.

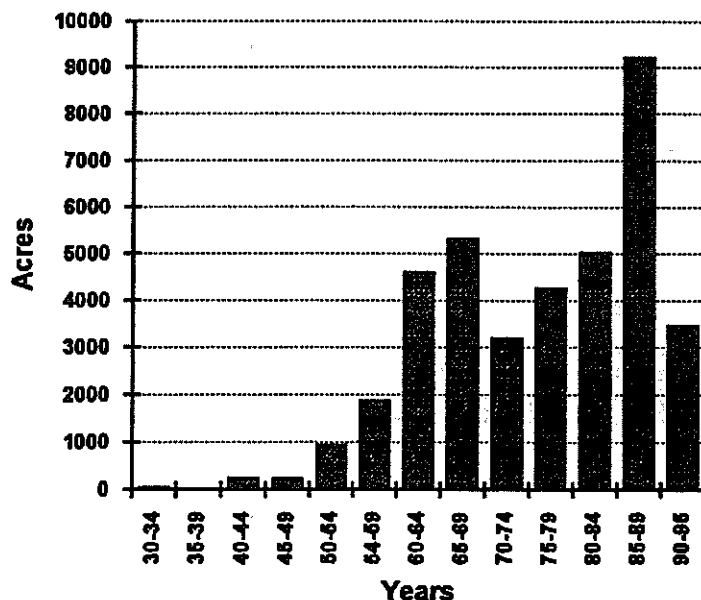
Cumulatively, 38,257 acres of Federal timber have been harvested within the Upper McKenzie area to date. This is about 17% of the total federal watershed area. With private land included, harvested acres in the watershed are about 19.5%. If wilderness areas and non-forest areas are excluded, about 33.6% of the watershed has been harvested, including private lands. Almost all of the harvested acres have been replanted and are currently fully stocked with conifer trees.

The majority of the past timber harvest units have been clearcut. However, differing forest practices have left a varied legacy. Harvests in the early 1960's and before did not remove material that was considered unmerchanable. The

result is the "cull" logs left behind provide a significant source of large woody debris. Timber harvests in the late-60's, 70's, and early 80's were "clean" logging; the purchaser was required to yard most of the down material. Units from the late 1980's to the present have had requirements to leave large woody debris and snags.

Most of units that were treated with a shelterwood harvest were later treated with an overstory removal. The result is much the same as a plantation created by clearcutting. However, about 3300 acres in the watershed received a shelterwood harvest and the overstory trees were not removed. About 60% of these units are in Landblock 5 and about 20% are in Landblock 2B. Plantations that develop under an overstory will grow more slowly and the stand will eventually develop a two-layered canopy. Approximately 37% of the watershed is currently in a late successional condition.

Figure 3-7: Acres harvested in the Upper McKenzie Watershed by Half-decade



FUTURE TIMBER MANAGEMENT

The Upper McKenzie Watershed contains 230,000 acres. After subtracting areas set aside by Congress, areas set aside by the Willamette Forest Plan, and areas set aside by the President's Forest Plan (including riparian reserves), the watershed contains approximately 85,453 acres of suitable and available land that could potentially be harvested. This amount is approximately 37% of the watershed.

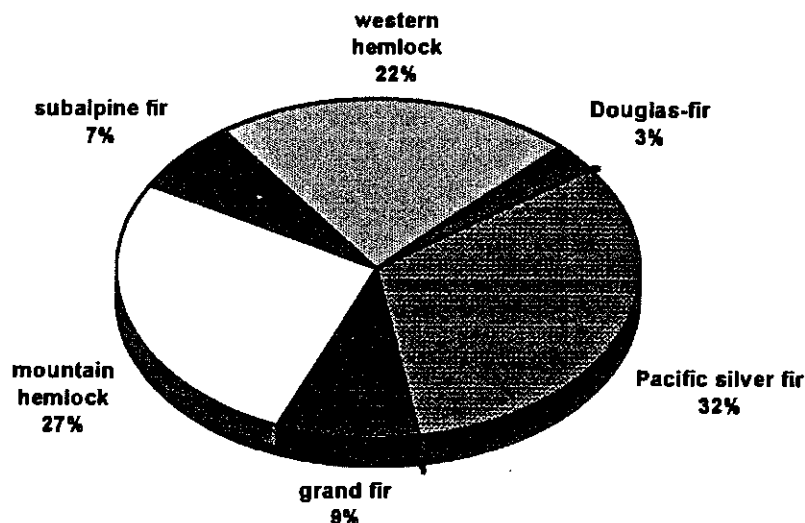
STRATIFICATION BY PLANT ASSOCIATION

The current forested vegetation of this watershed can be best understood by stratifying and discussing the "plant associations" that have developed within this area. Plant associations are the plant communities that have developed or could develop on specific forest sites, given relatively stable environmental conditions and no disturbance. Plant associations can be used as indicators of specific environments. The following summary (Table 3-4a) displays Upper McKenzie plant associations and fire regimes. It was produced from recent stand exam data and a review of literature available on fire and natural disturbance in similar forest types. Figure 3-8 displays the percentage of each plant association within the watershed, and Figure 3-9 displays their location.

Table 3-4a. Upper McKenzie plant series with associated fire return intervals (FRI) and fire intensity regimes.

Upper McKenzie Watershed Plant Series	Site Characteristics	Characteristic Fire Regime
Douglas-fir	Hot, dry sites, on droughty, south-facing slopes. Elev. 3200' to 4400'	High Intensity FRI 52 - 76 yr. Low Intensity 20-40 yr.
Grand fir	Cool, dry sites, on relatively flat/gentle slopes Elev. 3200' to 4400'	High Intensity FRI 100 - 200 yr. Low Intensity 18-75 yr.
Western hemlock	Warm, moist sites on a wide variety of slopes & aspects, valley bottoms Elev. 1200' to 3800'	Medium to High Intensity FRI 130-150 yr. Frequent low intensity under-burns with patchy flair-up
Pacific silver fir	Cool, moist sites, on a variety of slopes and aspects. moderate winter snowpak. Elev. 3600' to 4600'	Mod & High Intensity FRI 58-206 yr. Low intensity 43-108 years
Mountain hemlock	Cold, dry sites, on flat upper slopes. Deep snowpak. Elev. 4400' to 5600'	Mod & High Intensity FRI 87-248 yr.

Figure 3-8: Percent of each plant series represented within the watershed



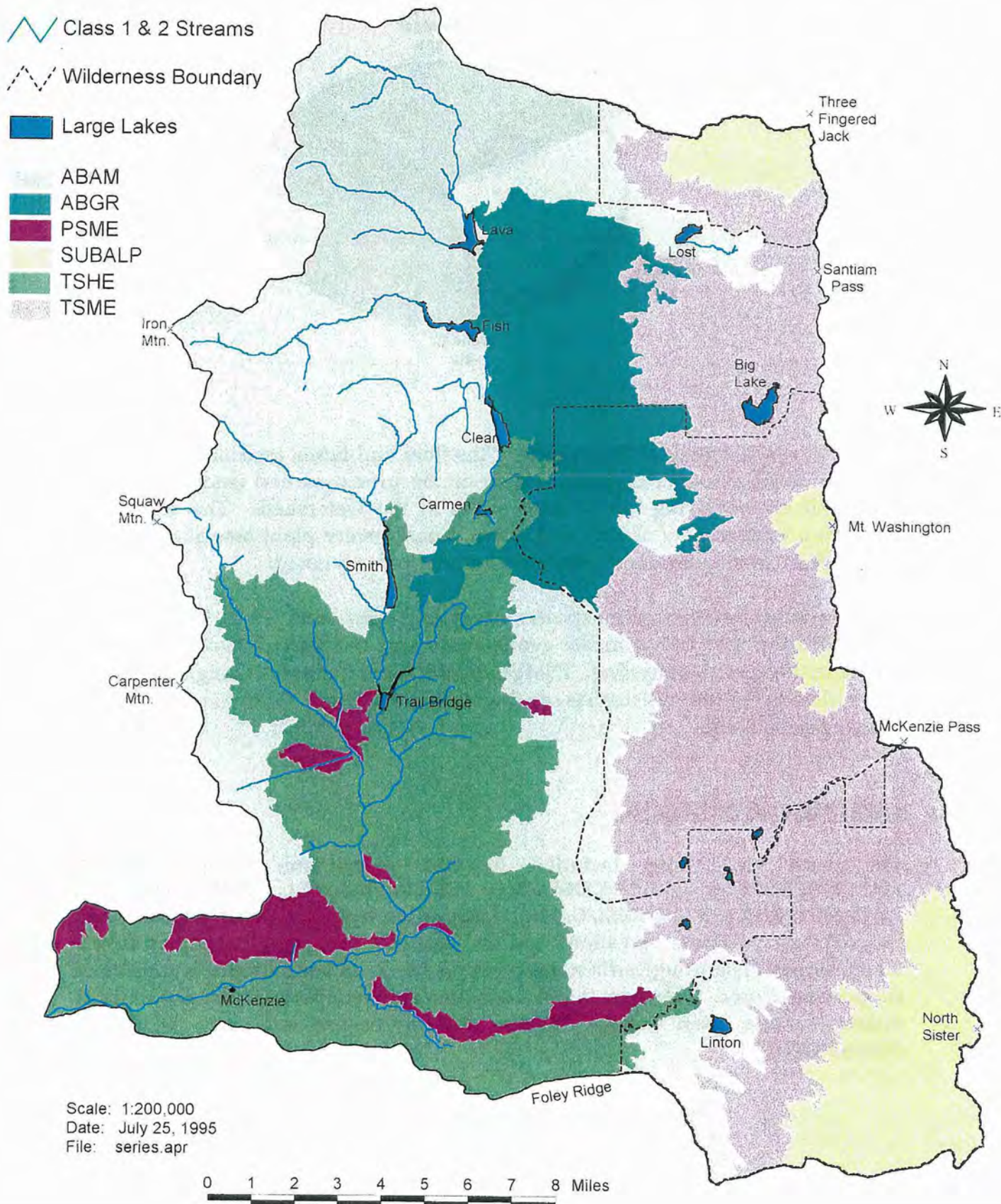
What follows is a general description of the flora and fauna associated with each vegetation series and a characterization of the processes and interactions that have and are occurring within each series in the watershed. The watershed contains a wide variety of site conditions. Nearly every plant association found on the Willamette Forest is represented within this watershed.

For shorthand notation, plant species are given a four letter code. The first two letters are the first letters in the genus name and the second two are the first letters in the species name (e.g., PSME= *Pseudotsuga menziesii* = Douglas-fir). For a complete list of the code names see the Willamette Forest Plant Association and Management Guide.

DOUGLAS-FIR (PSME) SERIES

The plant associations included in this group are: PSME/HODI-BENE, PSME/HODI/GRASS, PSME/HODI-WHMO, PSME/SYMO-WILL, PSME-TSHE/BENE, PSME-TSHE/RHMA, PSME-TSHE/GASH. These sites typically occur on relatively hot, dry sites at lower elevations and on relatively steep south and southwest facing slopes. The Douglas-fir series occupies the driest environments capable of supporting closed forest on the Willamette National Forest. Predawn plant moisture stress often exceeds 15 bars during August and early September (Means 1980).

Figure 3-9. Vegetation Series



Fire Disturbance - Douglas-fir

The growth and development of the Douglas-fir forests within the watershed have been dictated to a large degree by fire. The fire regime for Douglas-fir forests is characterized by moderate to high fire intensity, which generally results in partial or total stand replacement fires.

Lightning is common in these forests and the fire return interval is relatively low. Agee et. al 1990 found a 52 - 76 year mean fire return interval for these forests.

The effect of fire on Douglas-fir forests depends on the species composition and the structure of the vegetation at the time of the fire (Agee 1993). Douglas-fir is moderately resistant to fire, especially at mid to late age. Douglas-fir has thick bark that insulates the cambium against damage. In mature stands its height helps it to avoid crown scorch (Agee 1993). Low intensity fires generally only kill the thinner barked, less fire resistant trees and shrubs.

Woody Debris/Fuel Loading - Douglas-fir

Because of the frequent fire return intervals, levels of woody debris and fuel loadings do not get very high. Most of the woody debris is large Douglas-fir logs that are capable of surviving low intensity fires. Although the Logs are large, the average tonnage per acre is not great. Fuel loadings less than 20 tons per acre are common.

Comparison of Historic Versus Existing Landscape Vegetation - Douglas-fir

Using old timber inventory maps and past fire history information, we were able to develop an approximation of the vegetation within the watershed area in the year 1900. Figures 3-10 and 3-11 displays the change in vegetation from the years 1900 to 1995 within the Douglas-fir.

Figure 3-12 graphically displays a shift of the overall vegetation from a predominance of early seral (1900) to a dominance of mid to late seral condition (1995). This shift in dominance to mid to late seral corresponds to our era of fire suppression, approximately 1910 to the present. Historic information on the composition and distribution of vegetation was not compiled specifically for Douglas-fir forests during the Regional Ecosystem Assessment Project (REAP). forests. Early seral stages include grass/forb, open sapling/pole, shelterwood, and shrub conditions; Mid-1 includes closed sapling/pole, Mid-2 includes open small saw and closed small saw conditions; Late includes large saw and old growth.

Figure 3-10. Existing Vegetation Current Structural Stage

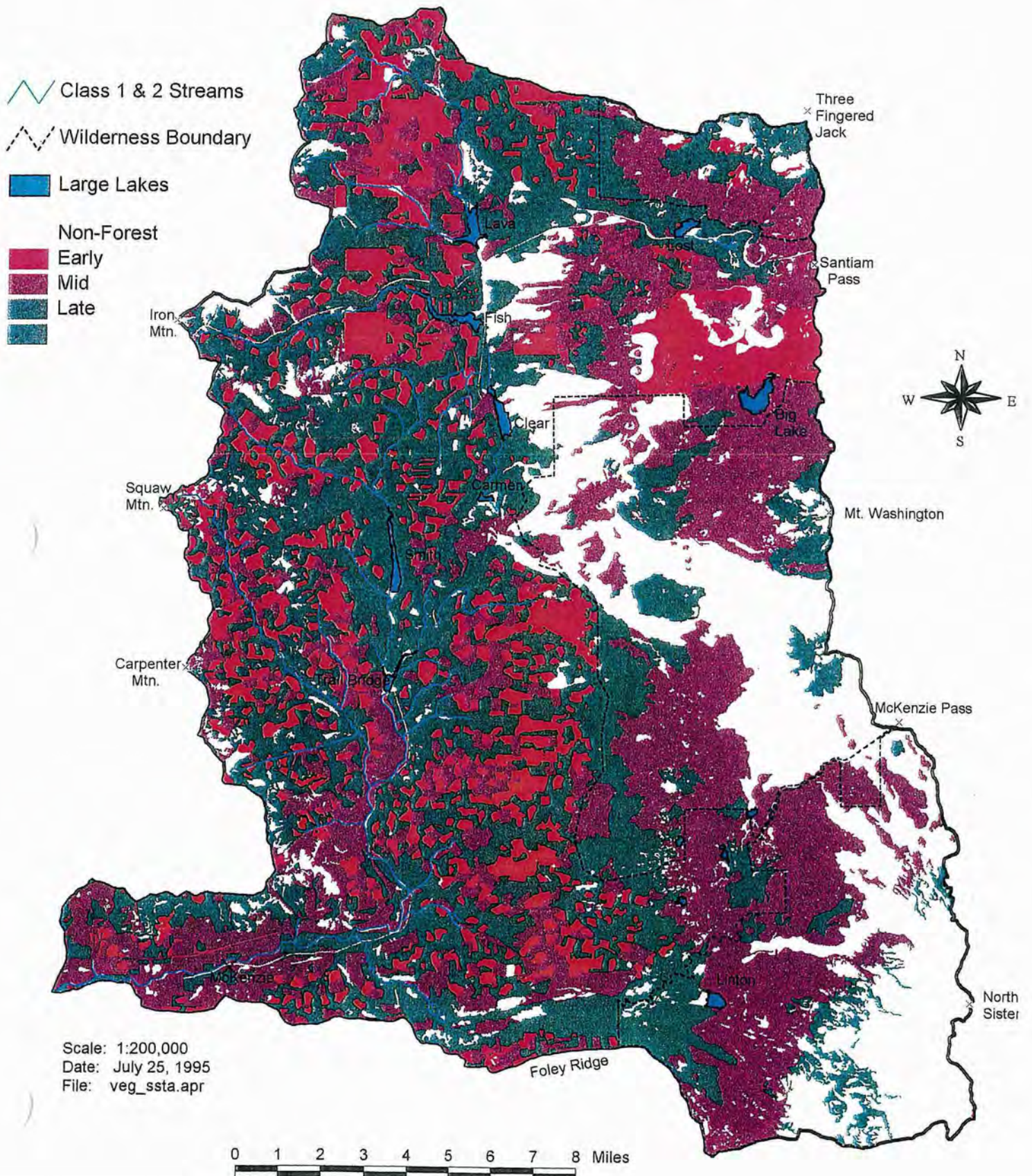


Figure 3-11. Historic Vegetation Historical Structural Stage

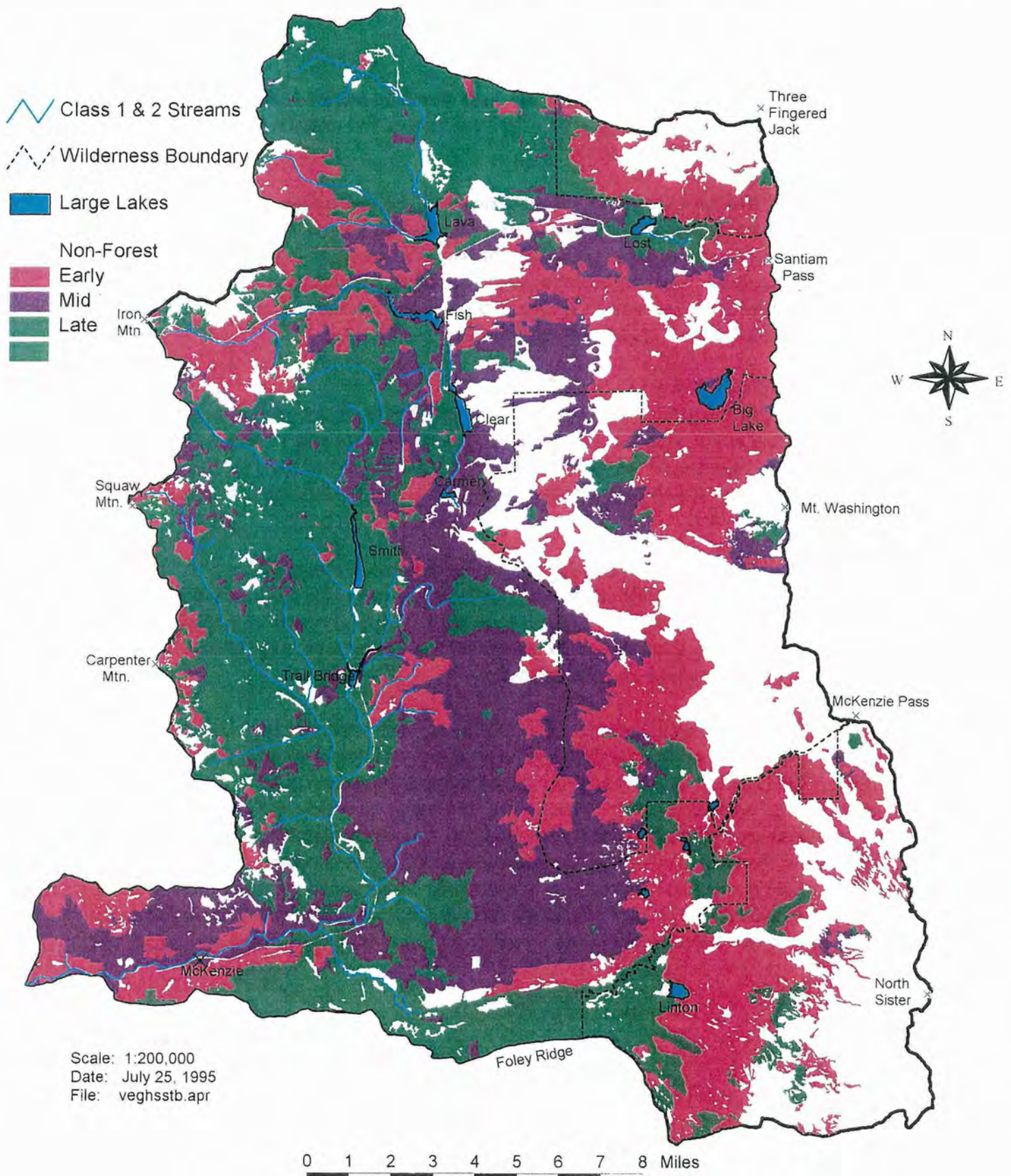
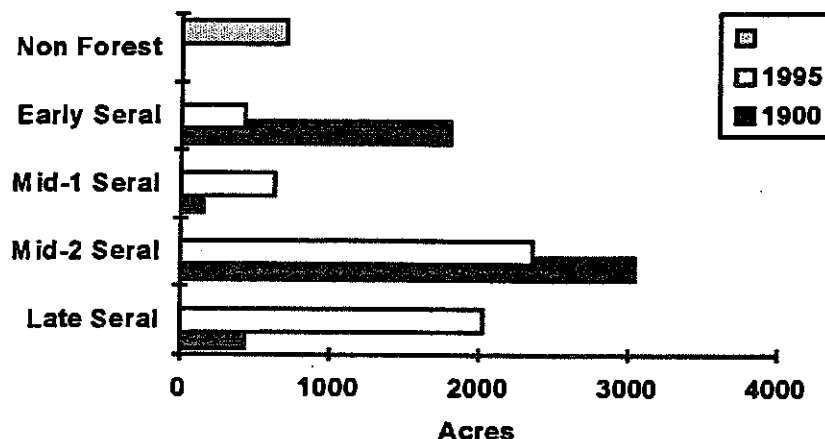


Figure 3-12: Acres of Current and Historic Douglas-fir Seral Stages**Wildlife Use - Douglas-fir**

These forests only comprise 3% of this watershed. Their contribution to wildlife habitat is limited. Therefore, the discussion on these forests will be limited. Douglas-fir forest habitat in this watershed consists of 6 small, mature to late seral islands on harsh slopes. Patches range from 50-900 acres in size. These areas were frequently burned over, providing intermittent early-seral habitat. They are slow to regenerate because of the harsh conditions, so an open habitat was prolonged. Frequent fire return intervals probably restricted their ability to develop into late-successional habitat. Because of the prolonged open stage, these areas may have functioned as reservoirs for early seral species. There is no available data on snag or down woody debris levels for these stands. Snag levels are probably low because of the high falldown rates on the steep slopes. Large woody debris levels are probably higher than historical levels since fire exclusion has allowed build-ups in these areas.

Management of these patches has not included clearcut harvesting. Difficulty in regeneration will heavily influence future management. These are areas where future influence of fire should be allowed to maintain their health.

Botanical Resources - Douglas Fir

Four Douglas-fir associations found Landform Blocks 1,2A, 2B, 4 and 4 are more commonly found in forest communities and environmental conditions typical of the Cascade range to the south. The distribution and occurrence of these and other uncommon forested plant associations contribute to the biological and ecological diversity of the watershed. One documented occurrence of *Allotropa virgata*, a species listed in Table C-3 occurs in the Douglas-fir-western hemlock/Oregon grape plant association. *Allotropa virgata* is discussed in more detail in the Botanical Overview Section in this chapter.

GRAND FIR FIR (ABGR) SERIES

The plant associations included in this group are: ABGR/BENE, ABGR/CHUM, and ABGR/ARUV. These sites typically have more moisture than Douglas-fir plant associations, less moisture than Pacific silver fir sites, and they are warmer than mountain hemlock sites.

Grand fir forests on the west side of the Cascades are relatively uncommon, but do exist in several other areas of the Willamette National Forest, particularly areas of the Rigdon Ranger District. Grand fir forests are typically associated with the drier, colder environment on the east side of the Cascade Crest. West-side grand fir sites occupy relatively cool, dry, well-drained, rocky, or ashy soils in Eastside to Westside transition areas. The topography of the grand fir forests in the watershed is relatively flat to gently sloping, with an elevation ranging from 3200 to 4400 feet. These grand fir forests are fairly contiguous and uniform in age and structure.

Fire Disturbance - Grand Fir

The growth and development of the grand fir forests within the watershed have been largely influenced by natural fire. Fire events within the grand fir forest, identified through tree age data, old inventory maps and literature review occurred in: 1950, 1925, 1905-1915, 1880-1885, 1860, 1775-1780, 1745, 1705.

The fire regime for grand fir forests is characterized by low to moderate fire intensity, which generally results in ground fires or partial stand-replacement fires. The fire regime can be characterized as relatively frequent low intensity burns (18-75 years) and less frequent moderate to high intensity stand replacement events (100-200 years).

The effect of fire on grand fir forests depends on the species composition and the structure of the vegetation at the time of the fire (Agee 1993). Grand fir is moderately susceptible to fire. Its low branching habit, flammable foliage, heavy lichen growth, relatively shallow roots, and high stocking density, all tend to increase its susceptibility to fire damage. High intensity fires kill grand fir and favor the regeneration of shrubs and lodgepole pine by creating a hot, dry, mineral-soil seed bed. Fires of moderate intensity often kill grand fir and increase the dominance of Douglas-fir relative to lodgepole pine or grand fir. Douglas-fir has thick bark that insulates the cambium against damage. In mature stands its height helps it to avoid crown scorch (Agee 1993). Low intensity fires generally only kill the thinner barked, less fire resistant grand fir (especially young grand fir seedling and saplings).

Historically, low intensity burns that remove the stands' understory layer, have been common in these grand fir forests. Several years following low intensity burns, a new cohort of regeneration will develop. Depending on the intensity of

the fire, this new cohort generally develops as shade-tolerant grand fir (Larson 1982) beneath an overstory of older, residual Douglas-fir that had survived the fire.

Substantial understory development, whether it occurs because of low severity fire or after the breakup of early seral lodgepole pine in the canopy, will encourage an "understory reinitiation" stage in stand development (Oliver 1981). Because of the "fire ladder" nature of this understory structure, it is closely associated with increased crown fire potential (Agee 1993). A long interval between underburns promotes the development of a tall understory, which has a higher probability of crowning (Davis et al. 1980), especially under severe burning conditions. Severe conditions often occur in late summer or early fall, and are associated with east winds.

The majority of the grand fir sites within the watershed are in this "understory re-initiation" phase of stand development. Eighty years of fire suppression has allowed a moderately high level of fuel and understory to develop in the grand fir stands in the watershed. This condition was historically transitory as a precursor to large, stand replacement fire events.

Woody Debris / Fuel Loading - Grand Fir

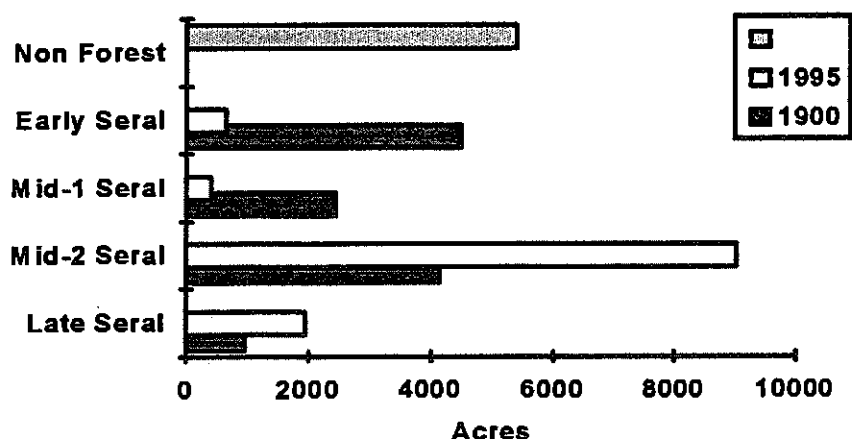
Site specific, quantitative descriptions of woody debris levels on grand fir sites are scarce. Downed, woody fuel on similar habitat types inventoried by Fischer (1981) in Western Montana ranged between about 13 and 38 tons per acre. The heavier levels tended to occur in very moist stream-side locations. Drier upland sites varied between 13 and 20 tons per acre. Natural debris loadings taken from limited field exams in the Upper McKenzie area show fuel loadings of 25 to 45 tons per acre. These loading are relatively high for this type. Much of this fuel is lodgepole pine mortality that occurs naturally during the "understory reinitiation" phase of stand development.

Comparison of Historic Versus Existing Landscape Vegetation - Grand Fir

Using old timber inventory maps and past fire history information, we were able to develop an approximation of the vegetation within the Upper McKenzie area in the year 1900. Figures 3-10 and 3-11 display the changes in vegetation from the years 1900 to 1995 within the grand fir forests.

Figure 3-13 graphically displays the shift of the overall vegetation from a predominance of early seral (1900) to a dominance of mid and late seral condition (1995). This shift in dominance to mid and late seral corresponds to our era of fire suppression, approximately 1910 to the present. Historical information on the composition and distribution of vegetation was not compiled specifically for Grand fir forests during the Regional Ecosystem Assessment Project (REAP).

Figure 3-13: Acres of Current and Historic Grand fir Seral Stages



Wildlife Use - Grand Fir

Two hundred and seventeen species use the grand fir zone for breeding and foraging. Uncommon, non-TES species documented in the area include the N. Goshawk. Potential habitat for TES such as the Townsend's big-eared bat, wolverine, and spotted owl occurs in the area. ROD species of concern that may occur in the area include the black-backed woodpecker, great gray owl, and red tree vole. Underlined species have been documented in the area.

Habitat - Grand Fir

These forests are at a moderate elevation sandwiched between Pacific silver and Mt. Hemlock forests. The species that occur in this area vary by forest developmental stage. Species such as mountain quail, white crowned sparrow, and western pocket gopher are associated with early seral conditions, while three-toed and black-backed woodpeckers are associated with mid to the late seral conditions with large diameter Douglas-fir and grand fir overstory.

Early Seral - Grand Fir

Historically, large patches of early seral habitat were periodically created by stand-replacement fires. Patches created from incidental mortality associated with ground fires were more common. These patches were often small and transient. Post-fire conditions included abundant dead material in the form of snags and down, large woody material. Grand fir are moderately susceptible to fire, and most do not survive stand replacing events. Large diameter Douglas-fir, often present in these stands, survive fires to provide residual green tree structure in the developing stand. The fire disturbances resulted in a mosaic of age classes and structures.

Large patches were a major landscape component around the turn of the century because of settler activity. Reburns were probably common, resulting in a

diminished density of snag and down woody debris components. With the advent of fire suppression activity in the early 1900's, the availability of large or small patches of early seral habitat was dramatically reduced.

In the last 30 years, very little early seral habitat has been created in this forest type through clearcutting. These stands are often on unsuited soils. The clearcut patches that do exist are small and lacking in important structural components typically found after a fire event. Snags, down woody material, and residual green trees were not retained in these units.

Table 3-5 displays a comparison of the distribution and availability of this habitat during 1900 and 1994. Early seral habitat has become significantly less abundant. The number of patches has increased, but they are significantly smaller with less variability than the 1900 condition. The 1900 data indicates moderately sized patches with higher edge densities, which reflects the variable effects of fire activity. These trends can be attributed to the decrease in fire activity associated with increased fire suppression efforts. Figures 3-10 and 3-11 show the change in distribution of this habitat type on this landscape.

Table 3-5: Characteristics of early seral grand fir habitat in 1900 and 1995.

YEAR 1900				YEAR 1995			
ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
4505	25	180	2.1	654	33	20	.5
SD		390				54	

There is no data available for historic range of variability (RNV) in grand fir forests. However, the significant reduction in early-seral may indicates a trend outside of the RNV. The habitat that does exist is of extremely low quality. Very little LWD or snags were retained in the harvested areas. There are no wildlife species that are solely dependent on the early seral stage of grand fir habitat, though could be used by 216 species for breeding. It is important that this habitat type continue to exist on the landscape to maintain the distribution of early seral species. These mid-elevation forests are an important link between lower and higher elevation bands of forest. It is important that future management retain snags, LWD, and large-diameter, live residual trees, such as Douglas-fir.

Mid and Late Seral - Grand Fir

The availability of this habitat type has not fluctuated greatly over time. Mid and late seral habitat has dominated this landscape for over 100 years. The abundance has increased over this century with increased fire protection efforts. Protection efforts have also changed the structure of these stands, increasing the

vertical diversity. Table 3-6 displays data comparing the landscapes from these two time periods. Figures 3-10 and 3-11 display their change in distribution.

Table 3-6: Characteristics of mid and late seral grand fir habitat in 1900 and 1995.

Mid-seral

YEAR 1900

YEAR 1995

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
6155	34	180	2.5	7017	31	227	3.3
SD		417				670	

Late seral

YEAR 1900

YEAR 1995

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
1405	14	101	0.7	4394	34	128	2.1
SD		91				192	

Fire suppression efforts have resulted and will continue to result in a trend of increased availability of mid and late-seral grand fir habitat. This is beneficial to species that are associated with this habitat type.

The quality of this habitat type has been degraded by spruce budworm. Simplification of structure, reduction in diameter growth, and mortality has occurred. Spruce budworm is an important agent in creating biodiversity on a landscape, and it is also an important food source for many forest-dwelling birds, mammals, and insects. At epidemic levels, it can seriously reduce the quality of habitat for species dependent on large diameter trees and multi-storied canopies. At epidemic levels, local populations of wildlife have little impact on spruce budworm populations. It is critical that in stands susceptible to spruce budworm, habitat components important to spruce budworm predators be available at 100% levels. This includes abundant snags for birds such as the pileated woodpecker and abundant down woody debris that provides habitat for ants and voles.

Douglas-fir beetle is killing many of the large diameter firs in areas with high levels of standing and down dead material. Within the grand fir forests, Douglas-fir is an important structural component, exhibiting larger diameters than the grand firs. It is also important because of its tenacity through fire events, described above. With the loss of these trees, the availability of large diameter, high quality snags will increase in the short term. Snags are generally

not limiting in this area, and this surge in abundance is not expected to result in increased populations of snag-dependent species.

Snags and Large Woody Material - Grand fir

Forests in the grand fir zone are considered habitat for the three-toed woodpecker, black-backed woodpecker, and williamson's sapsucker. Forested stands in the grand fir zone can produce trees large enough to sustain snag habitat > 18" dbh. The unmanaged grand fir stands on average contain 0.5 snags/acre $\geq$ 18" dbh (Table 3-7). The snags are primarily lodgepole pine. Each tree is only counted as 1/2 a snag because of the short period of time they function as standing habitat. They typically fall over quickly, and even as standing snags, they do not display heart rots important for many PCE's. There are 4.5 snags/acre $\geq$ 12" dbh available. Smaller diameter trees will be used by black-backed and 3-toed woodpeckers and Williamson's sapsucker (Goggans et. al. 1987, Marshall 1992, Thomas et. al. 1979). Existing harvest units are contributing no snag habitat on this landscape. These areas will continue to be devoid of snags > 12" until late in their successional development (75+ years). Species that depend on snags in this zone include 2 species of amphibians, 28 birds, and 21 mammals.

Table 3-7: Snags by species and size class in unmanaged late seral grand fir stands. (SAF=subalpine fir, GF=grand fir, DF=Douglas-fir, LP=lodgepole pine, MH=mountain hemlock, WP=white pine, WH=western hemlock)

SIZE CLASS	SAF	GF	DF	LP	MH	WP	WH
11-12.9				12			
13-14.9							
15-16.9			2	2			
17-18.9				2			
19-20.9							
21-22.9				1			
23-24.9							
25-26.9							

Avg number of snags/acre for all size classes (0-25+) = 10

Because of the abundance of insect and diseases in the forests of this zone, levels of small diameter snags (<12" dbh) and large woody material are high.

Botanical Resources - Grand Fir

Two rare grand fir plant association are located in the portion of the watershed on the Sweet Home Ranger District. The sensitive plant *Botrychium montanum* is found within one of these: the grand fir/Oregon grape plant association. The grand fir/prince's pine plant association occurs frequently on the McKenzie RD,

its distribution is considered rare in the Sweet Home RD. *Allotropa virgata* is documented in the grand fir/bearberry plant association in landform blocks 3 and 4.

MOUNTAIN HEMLOCK (TSME) SERIES

The plant associations included in this group are: TSME/VAME/XETE, TSME/VASC, TSME/RHMA, and TSME/LUZULA.

The climate of mountain hemlock forests is characterized by relatively cold winter temperatures, substantial winter snowpack, and short growing seasons. Mountain hemlock sites are colder and less productive than lower elevation grand fir sites. Despite substantial rainfall, mountain hemlock sites tend to retain less moisture than Pacific silver fir sites in the Upper McKenzie area. The elevation of these forests ranges from 4400 to 5600 feet.

Franklin and Dryness (1973) divide the mountain hemlock forest into two major subzones, a lower subzone of closed forest and an upper parkland subzone. In the lower subzone, there is essentially continuous forest cover of mountain hemlock and its main associates, lodgepole pine and subalpine fir. The upper subzone (high elevation area surrounding Mt. Washington, Three Finger Jack, Belknap Crater, and the Three Sisters) is a mosaic of forest patches and tree groups interspersed with shrubby or herbaceous subalpine communities.

Fire Disturbance - Mountain Hemlock

The growth and development of the mountain hemlock forests within the watershed have been dictated to a large degree by natural fire. Fire events within the mountain hemlock forest, identified through tree age data, old inventory maps and literature review occurred in: 1968, 1945-1950, 1925-1930, 1900-1915, 1880-1885, 1860, 1835-1840, 1825.

Mountain hemlocks are not well adapted to survive fire: they are fire avoiders (Agee 1993). Most fires within the mountain hemlock zone are stand replacement fires. Because of the lack of fire resistance of the species, within-stand individual tree and small group disturbance is more likely to be related to insect and disease mortality.

Mountain hemlock forests display very complicated fire behavior. The fires within the mountain hemlock forests are often weather-driven, resulting in erratic behavior. Fire behavior estimates based on natural fuel loads generally underestimate the fire potential of these mountain hemlock forests (Agee 1993). This is evident in the mountain hemlock zone in and around Santiam Pass. The fuel loadings do not indicate a significant fire hazard, but mountain hemlock has low-hanging branches, highly flammable foliage, and a tendency to grow in

dense groups that make it very susceptible to fire injury. Mountain hemlock is easily killed by fire from root charring and crown scorching.

According to the scientific literature, the fire return interval of mountain hemlock forests is highly variable. Because dense subalpine forests transition into parkland and alpine areas, a clear delineation of zones is difficult, and estimates of fire-return intervals are often not possible (Agee 1993).

The results of a fire study on the Mt. Jefferson Wilderness indicate the fire regime of mountain hemlock forests tends to include moderate to high intensity stand replacement fires on a moderate to long fire return interval. The fire return interval for stand replacement fires from nearby east-side sites on the Mt. Jefferson Wilderness range from 87 to 248 years (Simon 1991). Considering tree age class data gathered during stand examination on the area directly around Santiam Pass, the return intervals between stand replacement events range from 28 to 48 years.

Clearly the Santiam Pass area of the watershed has burned more frequently than anticipated through the literature and probably more frequently than the higher elevation areas away from this historical travelway. This area has a history of road building, railroad building, and travel starting in the mid 1800's. This period of intense settler activity and the relatively short time period actually viewed through existing tree age class data probably does not represent a long-term historical view of the fire regime for mountain hemlock forests. Simon's (1991) estimate of a 87-248 year fire return interval for partial or complete stand replacement is probably our best approximation of historical fire activity throughout the entire zone.

Lodgepole pine is the major pioneer species in the high cascades portion of the mountain hemlock zone. Mountain hemlock does not regenerate quickly or easily following intense fire, often taking decades to reestablish. Post-stand replacement fire communities are usually dominated by shrubs, such as *Ceanothus* or *Vaccinium*, and lodgepole pine. Mountain hemlock and subalpine fir often regenerate in the partial shade of the lodgepole pine overstory. As the lodgepole pine stands grow older and lose their dominance (approximately 80 years), gaps are created, and the mountain hemlock understory responds to the additional sunlight and available resources. Mountain hemlock will then retain dominance at the site until a stand replacement fire resets this cycle. Subalpine fir, Engelmann spruce, and western white pine will form an uneven understory with a forest floor composed of shrubs and herbaceous species.

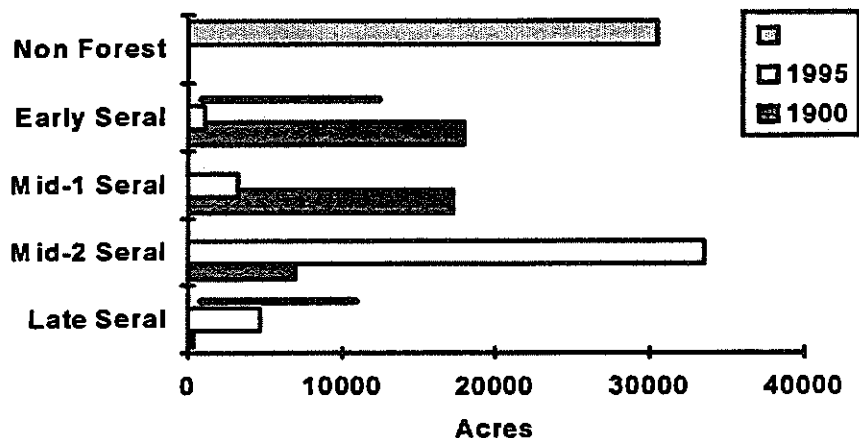
Fuel Loading - Mountain Hemlock

Eighty years of fire suppression has allowed a moderate level of fuel to develop for this forest type. Natural fuel loads taken from field exams produced 10 to 30 tons per acre.

Comparison of Historic Versus Existing Landscape Vegetation - Mountain Hemlock

The following information is patterned after the Regional Ecological Assessment Project, which used a course filter approach to investigate the range of natural historical conditions by plant series and seral stage in the region. The REAP process stratified the landscape into 3 age groups: early (1-20 years), mid (20-50 years), and late (200+ years). The age class between 50 and 199 was not analyzed during the REAP process. Figure 3-14 displays the acres of the mountain hemlock forest in each seral stage at 2 points in time. The dark solid line represents a historical range of variability from 1600 to 1850. We are displaying that information for the years 1900 and 1995 as "Mid-2" to compare the change in the landscape within this century. The overall vegetation shifted from a predominance of early seral (1900) to a dominance of mid to late seral condition (1995). This shift in dominance to mid to late seral corresponds to our era of fire suppression, approximately 1910 to the present. The dark solid line represents a historical range of variability from 1600 to 1850.

Figure 3-14: Acres of Current and Historic Mountain hemlock seral stages.



Wildlife Use - Mountain Hemlock

One hundred and fifty-six wildlife species use mountain hemlock forest for breeding and foraging. Uncommon, non-TES species documented in these forests include the N. goshawk, golden eagle, mountain bluebird, three-toed woodpecker, badger, pika, yellow-bellied marmot, and short-horned lizard.

Potential habitat for TES species such as peregrine falcon, bald eagle, wolverine, and Townsend's big-eared bat occurs here. Habitat for ROD species of concern includes the black-backed woodpecker and great gray owl. Surveys have documented the species underlined.

Habitat - Mountain Hemlock

The mountain hemlock forests fall within an ecotone between eastside and westside forest systems, resulting in high species' richness. The occurrence of species varies by forest structural stage. For example, the golden-mantled ground squirrel and short-horned lizard are associated with early seral conditions or open forest conditions, while three-toed woodpeckers and pine marten are associated with mid or late seral conditions.

Early Seral - Mountain Hemlock

In Mt. hemlock forests, early seral habitat historically resulted from catastrophic fire events. Post-fire conditions included abundant standing and down woody material. Mountain hemlocks are very susceptible to fire, resulting in few residual green trees on the landscape following stand-replacing fire events. Partial stand-replacement events occasionally create a mosaic of live patches of varying sizes. Areas protected by topography also provided patches of green tree remnants.

Historically, early-seral habitat was a major component of this landscape. Patches were generally large with irregular edges. As white settlers began to use this landscape, the increased frequency of fires in the late 1800's resulted in an extended availability of early seral habitat. Reburns were common, resulting in a diminished density of snag and down woody debris components. Fire suppression activity from 1900 on may have resulted in a decreased availability of early seral habitat in these forests. The Big Lake Burn in 1967 created a 9000 acre patch of early seral habitat. The burn area was heavily salvaged, and the majority of dead and alive woody material was removed. Snag and down woody material levels are currently low, reducing habitat quality. The majority of the burn is still in an early seral condition. Thinning prescribed for these stands were designed to increase horizontal diversity. Patches of dense lodgepole thickets were retained to provide cover and pockets of insects.

Table 3-8 displays a comparison of the distribution and availability of this habitat in 1900 and 1995. Very little early seral habitat has been created in this forest type in the past 30 years. Nineteen percent of the landscape was in early seral mountain hemlock forests at the turn of the century. Now only 2% is in this condition, and important structural components typically found after a fire event were not retained in these areas. The average patch size created through clearcutting is also very dissimilar to what was historically present. Mean patch sizes are now 209 acres, versus 886 acres in 1900. The number of patches has decreased, and they tend to have regular edges compared to the highly variable edges created by fire. The patches have also become more variable in size, which is indicated in the larger standard deviation.

Table 3-8: Characteristics of early seral Mountain Hemlock habitat in 1900 and 1995.

YEAR 1900				YEAR 1995			
ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
34651	39	886	7.4	3989	19	209	1.1
SD		2820				7577	

The abundance of this habitat is currently trending outside of the historic range of variability. Habitat that does occur is very low in quality because they lack structural elements. There are no wildlife species that are solely dependent on the early seral stage of Mt. hemlock forests, though 106 species may use it for breeding. These are some of the highest elevation early seral patches, and they are important to maintain species' distribution in the watershed.

Whether early seral habitat is created through a future stand replacement fire or regeneration harvest, it is important that future management retains habitat components such as snags and down woody material to provide a quality early seral stage condition. Thirty-two percent of the species that use early seral habitat in Mt. hemlock forests require snags for breeding. Thirty-eight percent require large down woody material.

It is important to mention that during post-fire rehabilitation efforts following the Big Lake Burn, wheat laced with 1080 strychnine was dropped at 6 pounds to the acre to reduce the rodent population. This rodent-control activity occurred for several years. The long-term effects to this environment is unknown. Impacts to the food chain, particularly predators of the rodent population that may have absorbed this chemical, is unknown.

Mid and Late Seral - Mountain hemlock

Little mid and late seral habitat was available in the late 1800's and 1900's because of human caused fires and no suppression of natural fires. Over the past 70 years, fire suppression has allowed stands to succeed, and the abundance and distribution of mid and late seral habitat has changed. Table 3-9 displays data comparing the landscapes from these two time periods. Larger blocks of mid seral stands with irregular edges are now available throughout the area. Variability in patch size has also increased, which is indicated by the larger standard deviation. Average patch size of late seral stands has not significantly changed, though there are more of them. Figures 3-10 and 3-11 display their change in distribution.

Table 3-9: Characteristics of mid and late seral mountain hemlock habitat in 1900 and 1995.**Mid Seral****YEAR 1900****YEAR 1995**

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
4162	33	126	1.8	32559	50	649	3.3
SD		304				2306	

Late Seral**YEAR 1900****YEAR 1995**

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
3742	24	156	1.6	6007	41	146	1.7
SD		333				301	

The abundance of late seral habitat is currently within the range of natural conditions. Fire suppression efforts will result in a trend of increased availability of mid and late seral mountain hemlock habitat. This is beneficial to species that are associated with these high elevation forests, such as pine marten, black-backed and three-toed woodpeckers. This habitat is currently well distributed, and patches are large enough to provide high quality habitat. Mid seral stands created from historic fires general have important structural components. Those that succeeded from previous clearcuts are not as high a quality.

In the absence of fire, insects and diseases will have the greatest effect on this habitat. At a stand level, insects and disease can simplify stand structures, resulting in reduced vertical diversity and loss of niches for wildlife. However, they also result in an abundance of snags and large woody material, which are important breeding habitat for more than 51 species in this area. At the landscape level, these diseases increase horizontal diversity as they create pockets of mortality. Mistletoe is used by several species for food, nesting structures, and cover. It can also create spike tops, which provide mini-snag habitat used by wildlife. Mistletoe infections rarely reduce habitat quality for wildlife species. In general, these diseases are not expected to reduce the overall quality of Mountain hemlock habitat on this landscape.

Snags and Large Woody Material - Mountain Hemlock

Forests in the mountain hemlock zone are considered key habitat for the three-toed woodpecker, black-backed woodpecker, and williamson's sapsucker

All three species are on the state sensitive list because of loss of mature and old growth stands within their range.

These forested stands can produce trees large enough for snags > 18" dbh, but they are not abundant. This is due to the short growing season, harsh conditions, and natural fire disturbance. The unmanaged mountain hemlock stands on average contain only 2 snags/acre $\geq$ 18" dbh. Lodgepole pine snags are counted as 1/2 a snag because of the short period of time they function as standing habitat. They fall over quickly, and even as standing snags, they do not display heart rots important for many PCE's. There are 12.5 snags/acre $\geq$ 12" dbh available (Table 3-10). Smaller diameter trees will be used by black-backed and 3-toed woodpeckers and Williamson's sapsucker (Goggans et. al. 1987, Marshall 1992, Thomas et. al. 1979). No snag habitat is being contributed from existing harvest units. These areas will continue to be devoid of snags > 12" until late in their successional development (75+ years). Species that depend on snags in this zone include 2 species of amphibians, 28 birds, and 21 mammals.

Table 3-10: Snags by species and size class in unmanaged mountain hemlock stands. (SAF=subalpine fir, GF=grand fir, DF=douglas-fir, LP=lodgepole pine, MH=Mt. hemlock, WP=white pine, WH=w.hemlock.

SIZE CLASS	SAF	GF	DF	LP	MH	WP	WH
11-12.9	9						
13-14.9	8						
15-16.9							
17-18.9				5			
19-20.9							
21-22.9				1			
23-24.9							
25-26.9		2					

Avg number of snags/acre of all size classes (0-25+)" = 50

The ROD requires retention of habitat for 100% population levels of the black-backed woodpecker. Additionally, 40% habitat levels are required for other primary cavity excavators (PCE). This would require at least 1.8 snags/acre >12" dbh in treated areas. Stand exams indicate this level of snag habitat (on average) does occur in this area. However, managing the entire primary cavity excavator guild at 100% habitat levels is critical since the majority of the PCE species feed on insects that contribute to forest health "problems" in these forests. Managing habitat at this level would require 4.2 snags/acre. Stand exams indicate that this level of snags is currently available in unmanaged stands.

The Big Lake Burn is an area of concern. Heavy cutting for firewood and salvage activities that occurred after the fire dramatically reduced the availability of snag habitat typically available after stand replacement events. The 26 year old lodgepole pine regeneration is currently < 12" dbh. This area is currently void of any snags of suitable dbh for cavity excavators, and it has low structural diversity. Large diameter snag habitat will not be available for 100+ years.

Down woody debris levels in this zone are very low in the managed stands and the Big Lake burn area. Natural stands have not been salvaged, and they are providing moderate levels of material. The abundance of down woody material is not a concern in this area.

Botanical Resources - Mountain Hemlock

One uncommon mountain hemlock plant associations occur in landform block 5. Both of these plant associations indicate very cold, high elevation sites.

Wildlife Use - SUBALPINE

One hundred and twenty-nine wildlife species use the Subalpine zone primarily for breeding and foraging. Uncommon, non-TES uncommon species documented here include the prairie falcon, rosy finch, water pipit, and yellow bellied marmot. Potential habitat for TES species such as the peregrine falcon and wolverine occurs here. Surveys have not been conducted for either species. There are no ROD species of concern in this area.

Habitat - Subalpine

Subalpine forests are a subzone of the Mountain hemlock zone. These high elevations areas surrounding Mt. Washington, Three Finger Jack, the Sisters, and Mt. Jefferson are a mosaic of forest patches and tree groups interspersed with shrubby or herbaceous subalpine communities. Because these areas are covered with snowpack until late in the summer, their use by wildlife species is limited. Most of the species that occur here also can be found in the lower Mountain hemlock forests.

Fire suppression of lightning starts probably has had the greatest impact on habitat alteration over time in this area. Fire is considered an important factor in creation and maintenance of subalpine meadows. Fire exclusion has resulted in conifer invasion, which can threaten the maintenance of these systems.

With the current policy of extinguishing fires in these wilderness areas, this system will trend outside the historic range. Meadows will continue to be encroached by conifers, and the dynamic tension that occurs in these ecotones

between tree and treeless regions will diminish. Comparing statistics on vegetation from 1900 to existing vegetation displays the dramatic changes that have occurred (Table 3-11). Between 1900 and 1994, the statistics indicate that total acres of meadow/early seral habitat has been significantly reduced, and patch size has decreased in size and variability. This is a reflection of the increased fire suppression efforts. The availability of mid and late seral habitat has increased substantially as the forest has succeeded without disturbance.

Table 3-11: Characteristics of subalpine habitat in 1900 and 1995

Early Seral

YEAR 1900

YEAR 1995

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
4878	50	97	2.6	348	15	22	0.3
SD		338				35	

Mid and Late Seral

YEAR 1900

YEAR 1995

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
484	11	44	0.4	5028	46	109	0.5
SD		62				333	

We know very little about the dynamics of wildlife populations in these complex, high elevation areas. Because of their limited and disjunct location on the landscape, maintaining the processes that occur within these systems appears critical for their sustainability through time. Surveys of the botanical communities and their associated wildlife are needed for their preservation. Though data is not available to show the historic range of variability, it appears that significant shifts in the proportion of open areas to forested areas has occurred. Fire suppression in the high elevation areas is contributing to this situation. Loss of open habitat in these areas may be critically reducing the availability of habitat for species such as the wolverine. Allowing fire to function within this system will be critical in the future.

Snags and Large Woody Material - Subalpine

Snag and large woody material levels may have increased in these areas because of fire suppression. Species that potentially breed in snags in this zone include 4 species of amphibians, 20 birds, and 17 mammals.

PACIFIC SILVER FIR (ABAM) SERIES

The plant associations included in this group are: ABAM/TITR, ABAM/VAAL/COCA, ABAM/OPHO, ABAM/RHMA/XETE, ABAM/RHMA-BENE, ABAM/VAME/CLUN, ABAM/ACCI/TITR, ABAM-ABGR/SMST, ABAM/BENE, ABAM/VAME/XETE.

The cool, temperate climate of Pacific silver fir forests is characterized by moderate winter temperatures, substantial winter snowpack, and relatively limited summer drought (Packee et al. 1981). Pacific silver fir forests are wetter and cooler than the adjacent, lower elevation western hemlock forests (Franklin and Dyrness 1973) and the adjacent grand fir forests, and they are warmer and more productive than mountain hemlock sites. The elevation of these forests ranges from 3200 to 5000 feet.

Fire Disturbance - Pacific Silver fir

The growth and development of the Pacific silver fir forest in the watershed have been strongly influenced but not dominated by fire. Of all the plant series in the watershed, the Pacific silver fir series has historically had the least distinguishable fire activity. Distinguishable fire events within the Pacific silver fir forest, identified through tree age data, old inventory maps and literature review occurred in: 1950, 1930-1935, 1910-1915, 1875-1885, 1835-1840, 1800-1805, 1775-1785, 1715.

Pacific silver fir seldom survives fire because of its thin bark and shallow roots. Pacific silver fir is a fire avoiding species throughout all stages of its life (Agee 1991). It is extremely fire sensitive and its foliage is highly flammable. Underburning tends to cause complete mortality, except in stands with a high component of large size Douglas-fir.

The fire regime for Pacific silver fir forest is characterized by infrequent fires of high severity (100-300 yr., Agee 1993) (58-206 yr., Simon 1991). Based on tree age class data gathered during stand examination, the fire return intervals between fire events in these Pacific silver fir forests within the Santiam Pass range from 43 to 108 years.

The fire return intervals reported in Simon and Agee refer to stand replacement events. The intervals calculated through stand exam data are based on a limited sample taken along the route of the Hogg railroad grade. These intervals are lower than reported in the literature. However, the events that were recorded within these stands are not necessarily the type of stand replacement events that would be picked up within a fire analysis. The events recorded through tree age analysis are indicative of disturbance, and some of these events may be markers of other disturbances (i.e., pockets of wind, disease, insect, etc.). Also, The Pacific silver fir area in the Santiam area is a relatively narrow peninsula

surrounded by mountain hemlock and grand fir types. These types have more frequent fire events that may contribute to repeated ignitions by spotting in the adjacent Pacific silver fir area.

When fires do occur in the Pacific silver fir forest, it is usually associated with summer drought and east winds (Agee and Flewelling 1983). These fires tend to be of high intensity and kill most or all of the trees on site (Agee 1993).

When Pacific silver fir forests are surrounded by drier forest types, as is the situation at Santiam Pass, longer burning fires in the adjacent drier forests may result in repeated ignitions and low intensity fire spread in the Pacific silver fir type (Agee 1993). These low intensity fires would tend to create a very diverse, patchy pattern of forests of varying ages, almost as if the fire "meandered" across the landscape. Patches come in many sizes and shapes, have curvilinear edges and offer a high degree of internal structural diversity (snags, islands of residual trees, etc.)

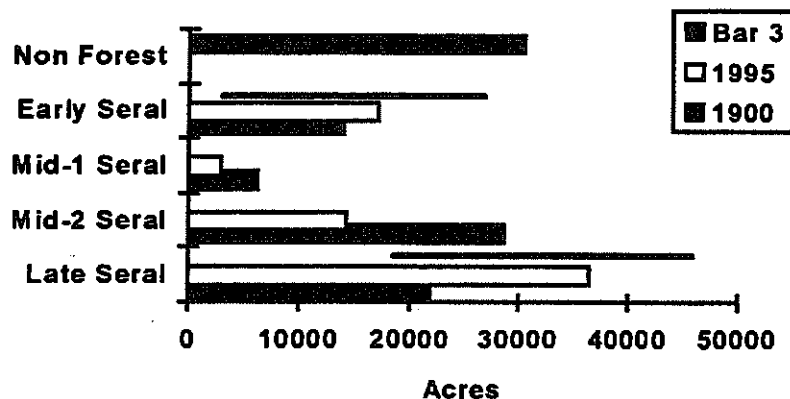
Fuel Loading - Pacific Silver Fir

Eighty years of fire suppression has allowed a relatively high level of fuel to develop in the Pacific silver fir stands in the Upper McKenzie area. The stand-replacing nature of most forest fires in the Pacific silver forests results in coarse woody debris patterns resembling a U-shaped curve over time (Agee 1993). Post-fire created snags slowly decay as the stand ages to a point where the firs start to die, then coarse woody debris loadings slowly increase again. This is basically the present condition that we see up in the Watershed. Field inventories show an average of 45-65 tons per acre of natural fuel loadings with some stands exceeding 70 tons per acre. One of the few studies showing coarse woody debris in Pacific silver forests documented 80 tons per acre in a 180 year-old stand. (Grier et al. 1981).

Comparison of Historic Versus Existing Landscape Vegetation - Pacific Silver Fir

The following information is patterned after the Regional Ecological Assessment Project. With this data, a comparison can be made between a range of "historical landscape conditions" pre-settlement conditions and a current state.

The REAP process stratified the landscape into 3 age groups: early (1-15), mid (16-50), and late (200+). The age class between 50 and 199 was not analyzed during the REAP process. We are displaying that information for the years 1900 and 1995 to compare the change in the landscape within this century (Figure 3-15).

Figure 3-15: Acres of Current and Historic Pacific Silver fir seral stages

The overall vegetation shifted from a predominance of early seral (1900) to a dominance of mid to late seral condition (1995). This shift in dominance to mid to late seral corresponds to our era of fire suppression, approximately 1910 to the present. The dark solid line represents a historical range of variability from 1600 to 1850.

Wildlife Use - Pacific Silver Fir

One hundred and seventy-three species use the Pacific Silver fir zone for breeding and foraging. Uncommon, non-TES species documented here include the N. Goshawk, three-toed woodpecker, Cascade frog, and yellow-bellied marmot. Potential habitat for TES species such as the bald eagle, wolverine, spotted owl, red-legged frogs, sandhill crane, peregrine falcon, and Townsend's big-Eared bat occurs here. Species underlined have been documented in the area. Habitat for ROD species of concern includes the great gray owl, red tree vole, and black-backed woodpecker. All but the vole have been documented in these forests.

Habitat - Pacific Silver Fir

This is the most abundant forested habitat in the watershed. Species occurrence in these forests varies by structural stage. Species such as black-tailed deer, mountain quail and brush rabbits are associated with early seral conditions containing beargrass, fireweed, and huckleberry. The spotted owl and goshawk are associated with mid to the late seral conditions, which provide multi-storied forests with a large diameter Douglas-fir and Pacific silver fir overstory

Early Seral - Pacific Silver Fir

In the Pacific silver fir zone, early seral habitat has historically been created by large, stand replacement events, or small, spot fires. Post-fire conditions included abundant dead material in the form of snags and large woody material

on the forest floor. Pacific silver fir is very susceptible to fire, whereas the co-dominant Douglas-fir is well adapted to fire events. The larger diameter Douglas-fir survived fires to provide residual green trees in the developing stand. Because of the high flammability of the Pacific silver fir foliage, PSF snags present in the post-fire stand may have been shortened from incineration, reducing their longevity and use on the landscape. Spot fires created small gaps, providing small patches of early seral habitat within an otherwise contiguous stand of mid or late seral habitat. The early seral patches were generally small to moderately sized, depending on the wind conditions that drove the flames. Small open patches were typically within stands between periods of stand replacement fires. Large patches of early seral have not been created in this zone since the fires in the 1800's.

Over the past 30 years, early seral habitat has been created through clearcutting. These patches do not resemble the complexity that occurred after natural fire or insect disturbances. Critical biological components, such as snags and large woody debris, are limited in treated areas. Table 3-12 displays a comparison of the distribution and availability of this habitat during 1900 and 1994. More early seral habitat is on the landscape at this time. The average patch size is dissimilar to what would be found after a fire event. Patches now average 69 acres, which is smaller than landscape-level disturbances that historically created this habitat type, but probably larger than patches created by fire spotting or insects/disease. Patches are also less variable in size.

Table 3-12: Characteristics of early seral Pacific Silver fir habitat in 1900 and 1995.

YEAR 1900				YEAR 1995			
ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
13990	95	148	5.4	17156	248	69	9.5
SD		408				229	

This habitat is well within the historic range of variability. There are no wildlife species that are solely dependent on the early seral stage of Pacific silver fir. Through harvest activity (and the inevitable future catastrophic fire), this habitat condition will continue to occur on the landscape. It is important that future management post-disturbance retain snags, down woody material, and live, large diameter Douglas-fir trees.

Mid and Late Seral - Pacific Silver Fir

The distribution of this habitat has fluctuated since the late 1800's, but not to a great degree. Table 3-13 displays data comparing the landscapes from 1900 and 1994. These seral stages have dominated the Pacific silver fir zone for over 100

years. Mid seral habitat has decreased over time as stands succeeded into late seral forest or were harvested. Their patch size is now smaller and less varied. Late seral forests have increased slightly, but their patch size has been reduced by half and they have more edge. This habitat has become more fragmented through clearcutting.

Table 3-13: Characteristics of Mid and Late seral Pacific Silver fir habitat in 1900 and 1995.

Mid Seral

YEAR 1900

YEAR 1995

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
17345	81	215	5.8	11658	165	72	6.5
SD		736				172	

Late seral

YEAR 1900

YEAR 1995

ACRES	# PATCHES	MEAN PATC H SIZE	EDGE DENSITY	ACRES	# PATCHES	MEAN PATCH SIZE	EDGE DENSITY
39517	51	773	8.7	41878	85	491	15.6
SD		2938				2220	

Harvest activity will be the greatest landscape altering disturbance in this zone in the future. Efforts to minimize fragmentation will be important in maintaining the contiguity of the patches left. This habitat is currently high quality and well distributed. It is the only plant association group in the northern portion of the watershed that can sustain multi-storied structure for long periods of time. It supports many of the known spotted owl and goshawk nest sites.

The abundance of this habitat is currently well within the range of historic variability. The level of fragmentation may be outside of the historic range of variability, since the pattern created by clearcutting has not mimicked the effect of historical fires. Fires may have created gaps in these stands historically, but they were typically small (1-10 acres) and highly scattered.

In the future, changes to this habitat will also occur from insects and diseases. Western spruce budworm (WSBW) populations have risen above endemic levels in recent years, causing a simplification of structure, reduction in diameter growth, and high levels of mortality. Spruce budworm is an important agent in creating biodiversity on a landscape, and it is also an important food source for many forest-dwelling birds, mammals, and insects. However, at epidemic levels, it can seriously reduce the quality of habitat for species dependent on

large diameter trees and multi-storied canopies. The understory trees provide structure in these stands, making them more valuable to species such as the spotted owl.

At epidemic levels, local populations of wildlife have little impact on WSBW populations. Changes in climate and/or stand structure are the only factors that will reduce the populations back to endemic levels. It is critical that in stands susceptible to spruce budworm, habitat components important to spruce budworm predators be available at 100% levels. This includes abundant snags for birds such as the pileated woodpecker and abundant down woody debris that provides habitat for ants and voles.

The Douglas-fir beetle is also affecting habitat. Where high levels of standing and down dead material occur, many of the large diameter Douglas-fir trees are being killed. Douglas-fir is an important structural component within these forests. Their large diameters provide important residual habitat following fire. In some areas, these trees appear to have survived multiple fires in their life time. The death of these trees will increase the availability of large diameter, high quality snags. Snags are generally not limiting in this area, and this surge in abundance is not expected to result in increased populations of snag-dependent species.

Other insects and diseases are not threatening to decrease habitat quality for wildlife. Their presence increases horizontal and vertical diversity in these stands through the creation of canopy gaps and large woody material.

Snags and Large Woody Material - Pacific Silver Fir

Forests in the Pacific silver fir zone are considered habitat for the three-toed woodpecker, black-backed woodpecker, and williamson's sapsucker. These forests are capable of producing trees large enough to sustain snag habitat > 18" dbh. The stands contain an average of 10 snags/acre $\geq$ 18" dbh (Table 3-14). Snags levels are high because of insect and disease mortality. Existing harvest units are contributing little snag habitat, and they will continue to be devoid of snags > 18" until late in their successional development (50-75 years). Species that depend on snags in this zone include 2 species of amphibians, 47 birds, and 25 mammals.

Table 3-14: Snags by species and size class in unmanaged late seral Pacific silver fir stands. (SAF=subalpine fir, GF=grand fir, DF=douglas-fir, LP=lodgepole pine, MH=mountain hemlock, WP=white pine, WH=western hemlock.

SIZE CLASS	SAF	GF	DF	LP	MH	WP	WH
11-12.9	12	2		10			
13-14.9	7	2		4			
15-16.9	6	3					
17-18.9				1			
19-20.9	1		1				
21-22.9						1	
23-24.9			2				41

Avg number of snags/acre for all size classes (0-25"+) = 39

The ROD requires that 100% habitat levels for black-backed woodpecker be retained in treated areas, as well as 40% of the other PCE's. This would require 1.8 snags/acre on the landscape. Stand exams indicate this level of snag habitat (on average) does occur in this area. However, managing the entire primary cavity excavator guild at 100% habitat levels is an intelligent, ecological move, since the majority of these species feed on insects that contribute to forest health "problems." This would require 4.2 snags/acre. Stand exams indicate that this level of snags is currently available.

Down woody material in this zone is very low in the managed stands. Natural stands have not been salvaged, and because of the high levels of insects and diseases, natural wood inputs have been high. The abundance of down woody material is not a concern in natural stands in this area.

Botanical Resources - Pacific Silver Fir

The Pacific silver fir/Cascades azalea/and beargrass plant association considered rare in occurrence is found in landform block 4. Four uncommon Pacific silver fir plant association are known to occur in landforms blocks 2A and 2B.

WESTERN HEMLOCK (TSHE) SERIES

Distribution and Description

The plant associations included in this group are: TSHE/VAAL/COCA, TSHE/BENE, TSHE/ACTR, TSHE/BENE/OXOR, TSHE/BENE/GASH, TSHE/BENE/ACTR, TSHE/RHMA-VAAL/COCA, TSHE/RHMA/XETE, TSHE/RHMA/BENE, TSHE/RHMA/GASH - WILL, TSHE/RHMA/LIBO2, TSHE/GASH, TSHE/ACTR, and TSHE/LIBO2.

Western hemlock forests are the most common forest type on the Willamette National Forest. They occur at the lower elevations throughout the watershed. Climatic conditions in western hemlock forests are considered relatively mild. Temperatures range from slightly below freezing in winter to 90 to 100 degrees F in summer. Precipitation amounts vary from about 60 to over 100 inches per year, mostly falling as rain or snow in the winter. Winter snowpack are not usually deep nor long lasting. Plant moisture stress seldom exceeds 15 bars during the growing season (Means 1980, Zobel et al. 1976). Western hemlock forests occur within the watershed below 3400 feet in elevation.

Fire Disturbance - Western Hemlock

Western hemlock is not well adapted to survive fire; it is a fire avoider. The dominance of Douglas-fir within western hemlock forests in the watershed is directly tied to fire.

The effects of fire on western hemlock forests are variable, depending on the age of stand, fire frequency, intensity and extent. Fire creates a wide variety of post fire effects and patterns in mesic to dry western hemlock forests.

Recent work suggests a higher fire frequency in the drier western hemlock forests of the Oregon Cascades. A high elevation site transitional to the Pacific silver fir zone near the H.J. Andrews Experimental Forest has experienced four fires since 1530. Some of these were in the settlement period and probably reflect settler caused fire over that period, which were used to create and maintain clearings (Stewart 1986).

At another site near the H.J. Andrews, Morrison and Swanson (1990) suggest a natural fire rotation of 95-145 years over the last 5 centuries, well below that generally quoted for western hemlock forests. Another fire frequency analysis was completed by Teensma (1987) near this same area studied by Morrison and Swanson. Using conservative methods that recognized only fires that resulted in substantial regeneration or fire scaring, Teensma estimated a natural fire rotation of 100 years over the last 5 centuries.

Working in the same area, Teensma (1987) calculated a mean fire return interval for stand replacement fires of 130-150 years, about 50 percent longer than the fire return interval that included moderate severity fires (both estimates excluded low intensity fires).

These studies in and near the watershed strongly indicate that the mesic to dry western hemlock forests of the Oregon Cascades have a variable fire regime with much higher fire frequency than that typical associated with moist western hemlock forests.

This moderate severity fire regime is characteristic of the southern portion of the western hemlock zone (Agee 1991). The landscape pattern associated with this fire regime is a complex mosaic of stands with variable date and severity of last burn. In the fire history study at Deer Creek, Morrison and Swanson found that fire created patches originating in 1800-1900 were mostly less than 10 hectares.

It is not unusual to have a long early seral tree recruitment period (40-100 years) within TSHE forests following a high intensity stand replacement fire (Franklin and Hemstrom 1981, Huff 1984, Yamaguchi 1986). Lack of seed source, brush competition, and/or reburns have been identified as factors delaying regeneration after stand replacement fires (Franklin and Hemstrom 1981). Redstem ceanothus (*Ceanothus sanguineus*) and snowbrush (*Ceanothus velutinus*) are two tall shrubs that tend to dominate early seral stands within the watershed. Douglas-fir regeneration is favored over western hemlock with high intensity fires.

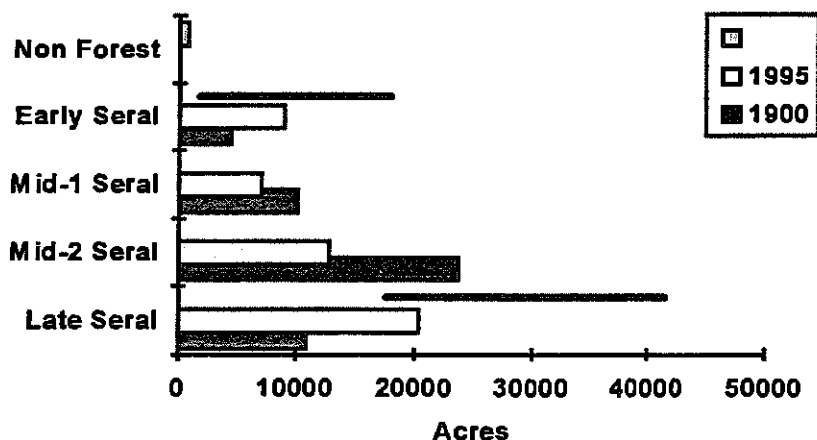
A moderate or partial stand replacement event reduces the tree recruitment period. Beargrass, fireweed, Ceanothus, big leaf huckleberry, and bracken fern are typically reestablished in the early seral stage. Douglas-fir and western hemlock reestablish in the stand initiation stage following the herbs and shrubs. Conifers, shrubs, and herbaceous species continue to grow until the forest canopy closes and prevents further regeneration. This closed sapling stage is composed of a mixture of western hemlock and Douglas-fir. Competition for site resources reduces the number of saplings and poles. Douglas-fir tends to outcompete western hemlock and dominates the site. Shrubs, herbaceous species, and cryptogams are established during understory-reinitiation, because the dense canopy of the conifers begins to open and create gaps. As the conifers mature and die, the understory develops as an uneven-aged structure with an irregular canopy. Western hemlock is the major climax species, with twinflower, vanilla leaf, dwarf Oregon grape, and big leaf huckleberry in the herb and shrub layer. If the fire is less than a stand replacement event, sufficient overstory may remain to encourage regeneration of western hemlock and western red cedar, but not Douglas-fir.

Because of their thick bark, large Douglas-fir tend to be resistant to fire and may survive ground fires that eliminate thin barked species like hemlock and red cedar, and understory shrubs and young trees. Many of the stands within the lower elevations of the watershed contain scattered residual Douglas-firs that have survived numerous ground and partial stand replacement fires. All the old-growth stands within the watershed have evolved through understory and partial stand replacement fire disturbances.

Comparison of Historic Versus Existing Landscape Vegetation - Western Hemlock

The following information is patterned after the Regional Ecological Assessment Project. The REAP process stratified the landscape into 3 age groups: early (1-10 years old), mid (11-50 years), and late (200+ years). The age class between 50 and 199 was not analyzed during the REAP process. We are displaying that information for the years 1900 and 1995 as Mid-2 to compare the change in the landscape within this century (Figure 3-16).

Figure 3-16: Acres of Current and Historic Western Hemlock Seral Stages



The distribution of the vegetation shows an increase level of late successional forest. The current level of late successional forest is within the historical range of variability. The solid dark line represents the range of historical variability from 1600 to 1850.

Wildlife Use - Western Hemlock

Two hundred and nine species use the Western hemlock zone for breeding and feeding. Uncommon, non-TES species documented in these forests include long-eared owls, snipe, wood duck, cascade frogs, and red fox. Potential habitat for TES species such as spotted owl, peregrine falcon, bald eagle, white-footed vole, wolverine, harlequin duck, pond turtle, Townsend's big-eared, and red legged frog occurs here. Surveys have verified the presence of all of these species except the vole and bat. ROD species of concern include red tree vole and great gray owl. Both species have been documented in the area.

Habitat - Western Hemlock

Western hemlock forests occur commonly across the Willamette National Forest. It is the most common low elevation forested habitat in this watershed. The species that occur in this area vary by the developmental stage of the forest. Species such as California quail, northern alligator lizard, and brush rabbit are associated with early seral or open conditions, which can extend for several

decades under certain conditions. Pileated woodpeckers and spotted owls are associated with mid to the late seral conditions, which produce a complex, multi-canopied forest with abundant large woody material and horizontal diversity.

Early Seral - Western Hemlock

In the Western hemlock zone, early seral habitat has historically been created by catastrophic fire events and spotting. Post-fire conditions usually included abundant dead material in the form of snags and large woody material on the forest floor. However, very hot fires were not uncommon, which left little woody material. Western hemlocks are very susceptible to fire, while the co-dominant Douglas-fir is well adapted. Larger diameter trees survived fires to provide residual green trees in the developing stand, much like the Pacific silver fir zone. Fire disturbance in this area has heavily influenced the development of these stands, resulting in high levels of diversity. All of the old growth has evolved through understory and partial stand replacement fire disturbances. In areas to the north, the adjacency of this habitat type to the grand fir zone has resulted in even greater complexity. "Spotting" from adjacent grand fir forests created small gaps within these stands, providing small patches of early seral habitat within an otherwise contiguous stand of mid or late seral habitat.

Over the past 30 years, early seral habitat has been created only through clearcutting. These habitat patches do not resemble the complexity that would have occurred through natural fire or insect disturbances. Critical biological components, such as snags, large woody debris, and large residual Douglas-fir, are limited in these areas. Table 3-15 displays a comparison of the distribution and availability of this habitat during 1900 and 1994. The abundance of this habitat has doubled since 1900. The patches are now smaller with less variability in size.

Table 3-15: Characteristics of early seral western hemlock habitat in 1900 and 1995.

YEAR 1900				YEAR 1995			
ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
4476	13	343	1.5	8941	219	39	6.3
SD		459				67	

The abundance of this habitat type is well within the historic range. However, the available habitat is low in quality because of the lack of structural components. There are no wildlife species that are solely dependent on the early seral stage of Western hemlock habitat. Through future harvest activity (and the inevitable future fire), this habitat condition will continue to be provided on the

landscape. It is important that future management post-disturbance retain snags, down woody material, and live, large diameter Douglas-fir trees.

Mid and Late Seral - Western Hemlock

The distribution of these habitat conditions has not fluctuated since the late 1800's. Table 3-16 displays data comparing the landscapes from 1900 and 1994. These seral stages have dominated the Western hemlock habitat for over 100 years. Mid seral habitat has decreased, primarily through clearcutting. Four times as many patches occur now, and they are substantially smaller than seen historically. Late seral habitat has not significantly changed in abundance, but the patch sizes have become much smaller. Patches historically were generally large, but highly variable in size with convoluted edges. Now they are smaller, and edge density is much higher reflecting fragmentation within blocks.

Table 3-16: Characteristics of mid and late seral W. Hemlock habitat in 1900 and 1995.

Mid Seral YEAR 1900

YEAR 1995

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
20760	37	560	4.2	6276	112	146	6.53
SD		2909				506	

Late Seral YEAR 1900

YEAR 1995

ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY	ACRES	# OF PATCHES	MEAN PATCH SIZE	EDGE DENSITY
24045	15	1603	5.0	23966	58	412	10.2
SD		304				2306	

This habitat type appears to be trending outside of its historic range of variability. There are species highly associated with this habitat type, such as the spotted owl and red tree vole. Future harvest activity will be the greatest landscape altering disturbance. Maintaining the largest blocks of mid and late seral habitat will be important to sustaining this landscape and its wildlife within the historic range of variability.

Insects and diseases are not expected to create large-scale disturbances to this habitat. They are currently increasing within-stand diversity.

Snags and Down Woody Material - Western Hemlock

We do not have information to summarize the snag and down woody material levels within these forests.

Botanical Resources - Western Hemlock

There are five uncommon western hemlock plant associations known to occur in the watershed. These plant associations are found in landform blocks 1, 2A, 4 and 5. The vascular plant, *Allotropa virgata*, a Table C-3 species, is known to occur in four western hemlock plant associations within the watershed. *Allotropa* is documented in three separate locations in the uncommon western hemlock/rhododendron-salal association and in three common western hemlock plant associations.

OVERVIEW OF RIPARIAN HABITAT

STREAMS

Figure 3-16a displays all streams by class within the Upper McKenzie. The McKenzie River Subbasin Surface Water Classification identifies the McKenzie River and tributaries upstream from Paradise Campground for domestic, livestock, commercial use for customarily domestic purposes not to exceed 0.01 cfs, and public instream uses (Oregon Administrative Rules, 1994). The McKenzie River downstream from Paradise campground is identified for the same uses, plus municipal, industrial/manufacturing, agricultural, commercial, power, mining, fish life, wildlife, recreation, pollution abatement, wetland enhancement, and off-channel power development in conjunction with storage.

A USGS gaging station approximately 2 miles upstream from McKenzie Bridge has been in operation since 1910. It has provided continuous flow records since that time. Based on 84 years of data, major flood events were recorded and recurrence intervals calculated (Table 3-17).

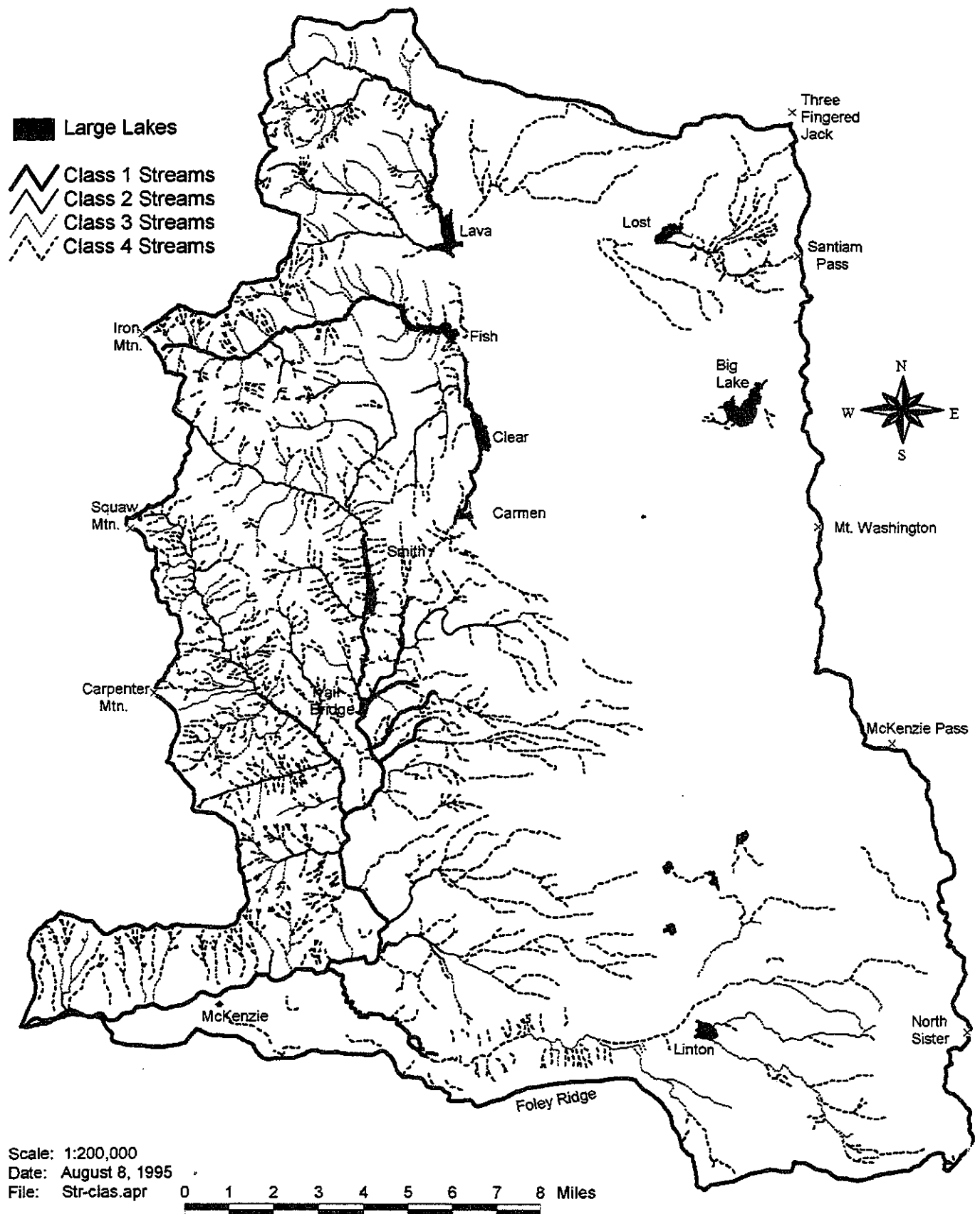
Table 3-17: Major flood events within the Upper McKenzie Watershed.

DATE OF EVENT	RECURRENCE INTERVAL
December, 1945	13 year event
December, 1946	12 year event
January, 1953	24 year event
December, 1955	35 year event
December, 1964	125 year event
December, 1977	11 year event
February, 1986	25 year event

Above normal precipitation and early melt of the high elevation snowpack on January 1, 1995 yielded the highest streamflow for nearly a decade, resulting in only a 3-year event. This followed several years of drought prior to 1995.

Peak streamflows may occur as a result of rain events or rain-on-snow events. They potentially cause transport of large channel substrate, channel widening, and bank erosion. In a large basin study on peak flow responses to clearcutting on the Willamette N.F., Jones and Grant (1994a, in review) found that watersheds ranging in size from 15,000 to 150,000 acres had increased peak discharges as cumulative area harvest and road construction increased. Their data also suggests that peak discharges may have increased by 50% or more over the past 50 years as up to 25% of the area was cumulatively harvested with

Figure 3-16a. Stream Classes



roads. Their analysis also indicates that rain-on-snow events were only 10 to 15% larger than rain events.

A relative measure of the hydrologic recovery of a watershed used by the Willamette National Forest is the Aggregate Recovery Percentage (ARP). This is the percent of the watershed considered to have large enough trees to intercept and hold snow within their canopies. Within the WNF LMP the subwatersheds in the Upper McKenzie Watershed have threshold ARP values of 65-80%. They should not fall below this level to ensure peak flows are not augmented and channel damage does not occur. Table 3-17a displays the ARP values for the entire watershed, the subwatersheds, and selected smaller drainages.

Table 3-17a: ARP values for the Upper Mckenzie Watershed, subwatersheds, and selected smaller drainages.

SUBWATERSHED NUMBER	SUBWATERSHED NAME	DRAINAGE NAME	ARP VALUE
07-01	MCKENZIE BRIDGE		96
07-02	LOST CR/WHITE BRANCH		92
07-03	BOULDER/FRISSEL		72
		SPRINGS COMPLEX	74
		TWISTY	69
		BOULDER	62
		SCOTT	73
		FRISSEL	86
07-04	KINK/INLAND BASIN		81
		KINK	75
		SWEETWATER	68
		WASHINGTON	91
07-05	HACKLEMAN		96
		HACKLEMAN	N/A
07-6	SMITH		82
		BUNCHGRASS	61
		BROWDER	N/A
		SMITH	N/A
07-7	DEER CR.		73
		UPPER DEER	77
		CADENZA COMPLEX	68
		DEER COMPLEX	78
		FRITZ	70
		CARPENTER COMPLEX	69
		COUNTY	50

Table 3-17a continued

SUBWATERSHED NUMBER	SUBWATERSHED NAME	DRAINAGE NAME	ARP VALUE
		BUDWORM	88
		SLUICE	73
07-8	PARK CR.		N/A

N/A = Entire subwatershed or drainage is located outside of transient snow zone.

Figure 3-17 and 3-17a display the subwatershed and drainage locations. ARP values calculated for the Upper McKenzie Watershed are relatively high, ranging from 96% recovered in McKenzie Bridge and Hackleman subwatersheds, to lows of 72% in the Boulder/Frissell and 73% in the Deer subwatershed. Park subwatershed did not receive an ARP rating because it is entirely within the permanent snowpack zone. Park subwatershed is dominated by true fir species of mountain hemlock, grand fir, and white fir, so it does not fall within the transient snow zone.

To determine the relative contribution of the Upper McKenzie watershed to a potential rain-on-snow event, three factors were considered: snow accumulation; snow-melt rate, and; water yield from soils. The combination of all three factors resulted in Figure 17b. Since the effects of peak flows are believed to be observed within the channels of the smaller subwatersheds and drainages (vs. the entire watershed), peak flows resulting from rain and rain-on-snow events and ARP values will be discussed by landform block in Chapter 4.

RIPARIAN HABITAT - PAST MANAGEMENT

The character of the vegetation located within riparian reserves is determined by geology, climate, valley form, aspect, channel form and gradient, fire, and floods. In addition, changes to riparian vegetation may occur through manipulation by harvest, roading, recreation, or administrative sites. Figure 3-18 describes management within riparian reserves as a percent of the total riparian area of each landform block.

Blocks 1, 2A, 2B, and 5 have the most management within their riparian areas. Harvest has been the major activity followed by roads and recreation sites. The mainstem McKenzie River has roads, harvest units, and recreation sites located within 9% of the riparian area. Recreation sites dominate these managed acres (5%), followed by roads (3%). Additional information on management within riparian reserves is discussed in Chapter 4 by landform block.

Figure 3-17. Subwatersheds

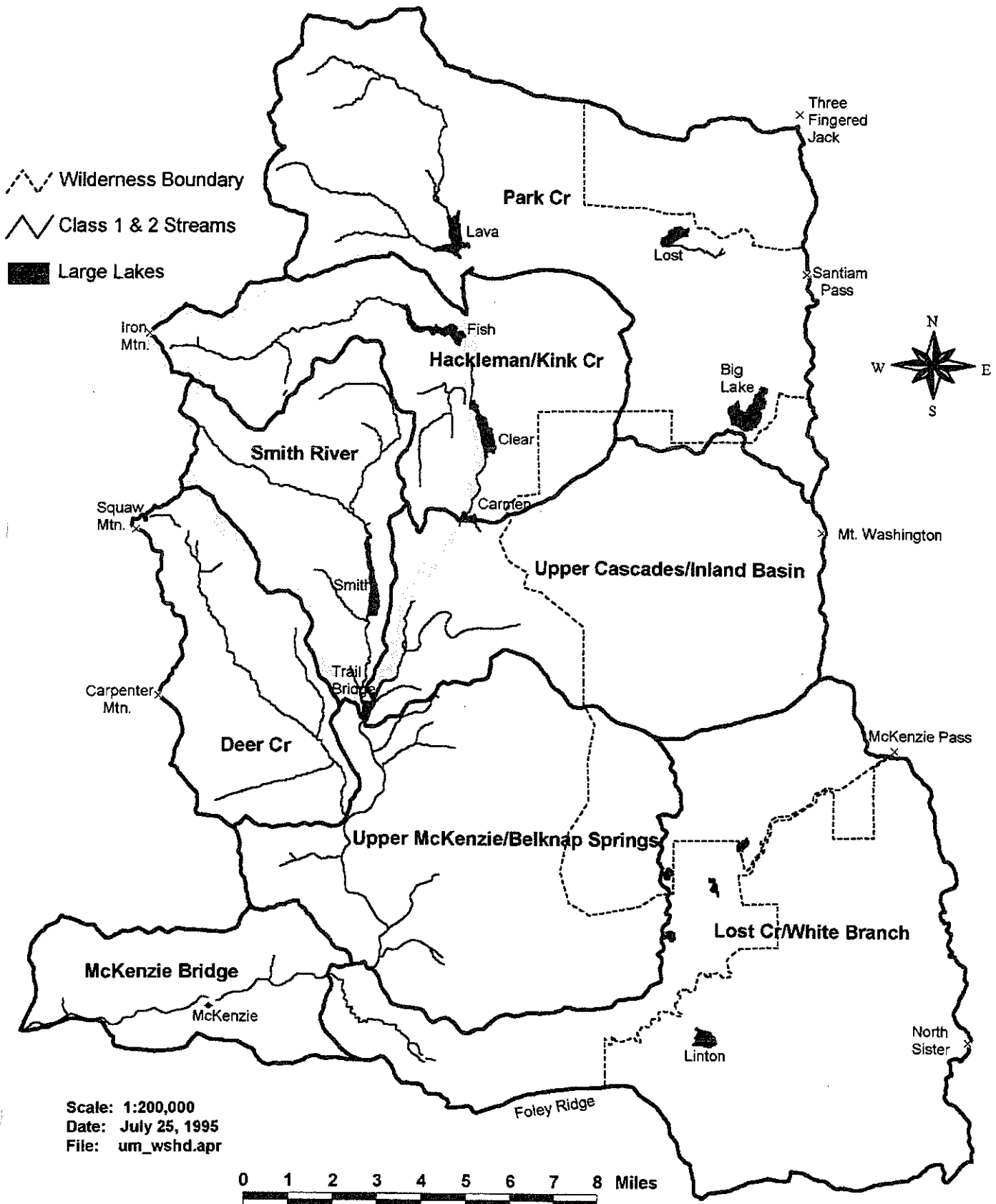


**Figure 3-17a. Drainages Selected for
Aggregated Recovery Percentage Values
(ARP Values)**

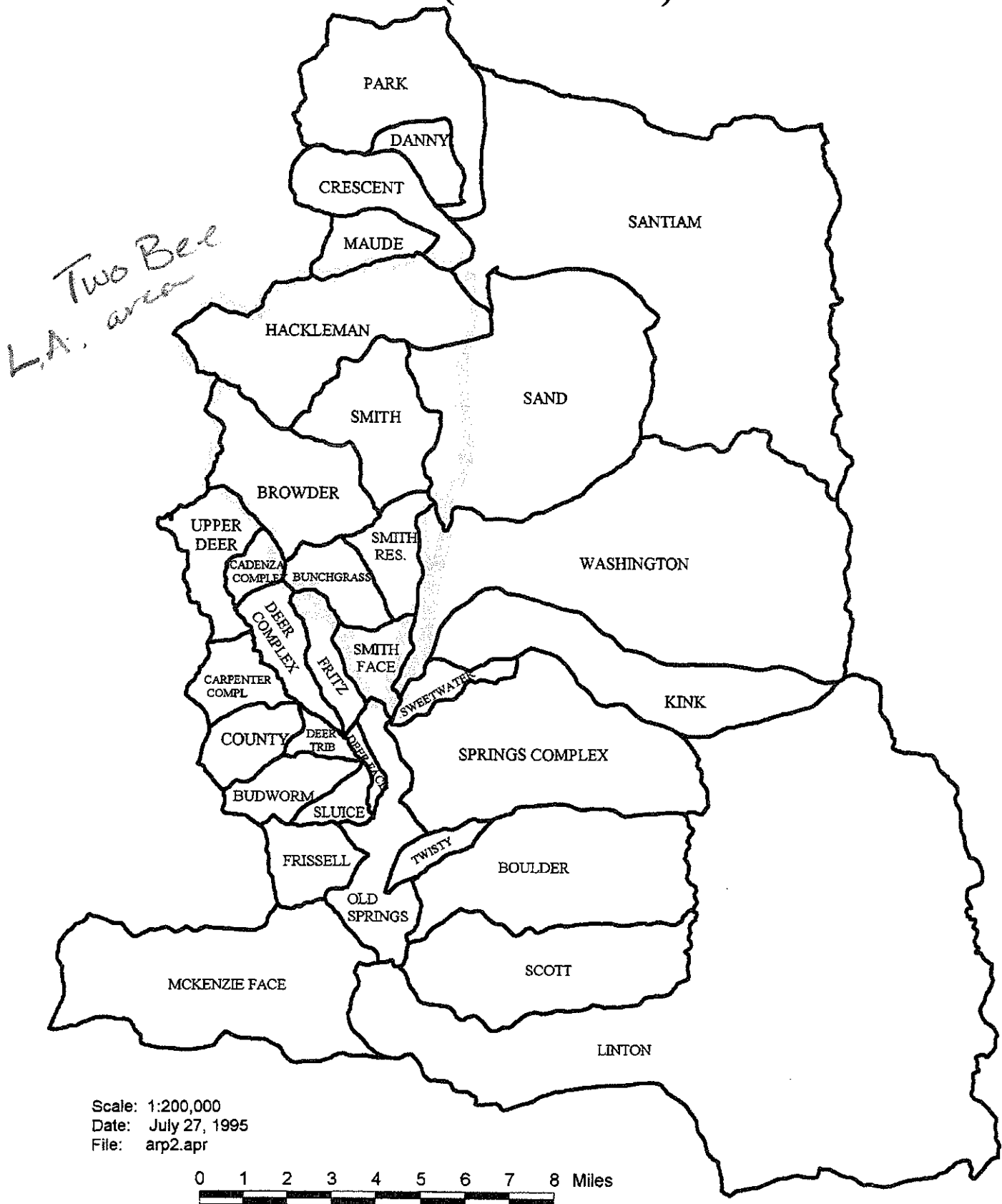
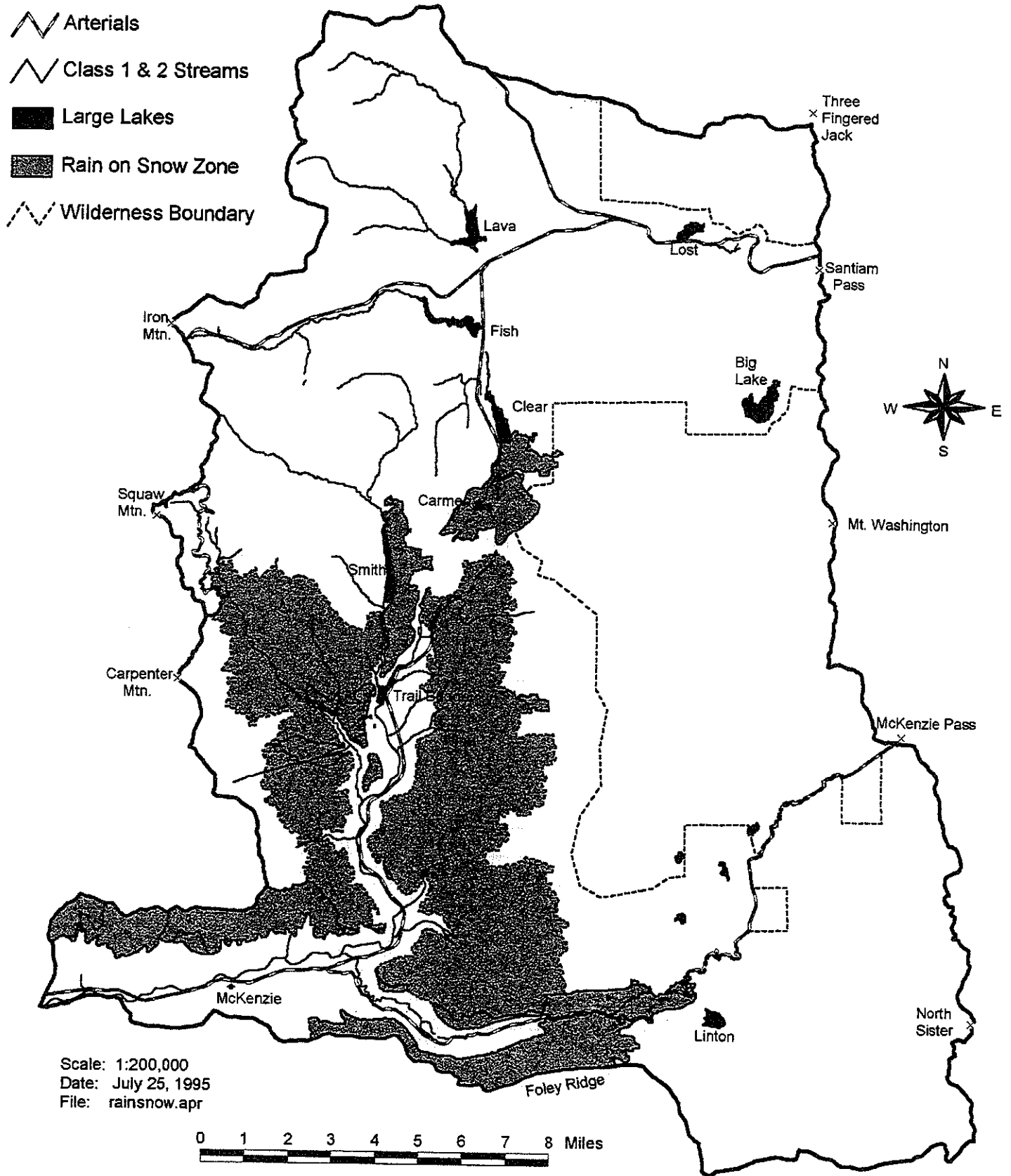
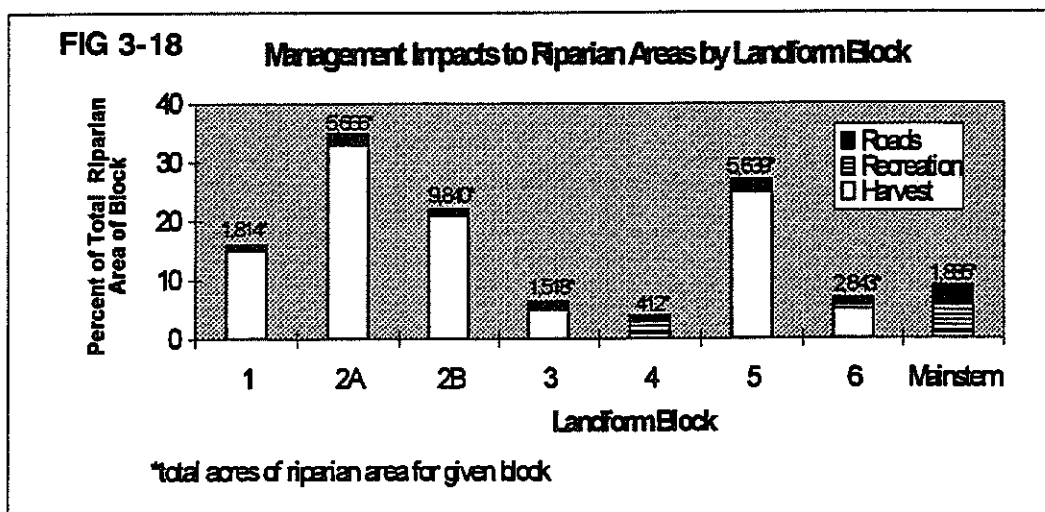


Figure 3-17b. Rain on Snow Zones





RIPARIAN HABITAT - FISH

The Upper McKenzie supports approximately twenty species of fish (Table 3-18). This analysis focused on at-risk salmonids, bull trout, and spring Chinook salmon because of their cultural, scientific, or economic value. The main stem McKenzie River and larger, historic anadromous tributaries have been designated a Tier 1 Key Watershed due to the importance of this habitat to bull trout and wild spring Chinook salmon. The habitat will be identified as we try to restore populations through application of the Aquatic Conservation Strategy. Lesser known species in the area will be included briefly in discussions, and future additions should update our current knowledge of all fish species in the Upper McKenzie.

Table 3-18: Fish species found within the Upper Mckenzie Watershed.

COMMON NAME	SCIENTIFIC NAME
Pacific lamprey	<i>Lampetra pacifica</i>
W. Brook lamprey	<i>Lampetra richardsoni</i>
Longnose dace	<i>Rhinichthys cataracta</i>
Blacksided speckled dace	<i>Rhinichthys osculus nubilus</i>
Redside shiner	<i>Richardsonius balteatus</i>
Mottled sculpin	* <i>Cottus bairdi semiscaber</i>
Paiute sculpin	<i>Cottus belidingi</i>
Shorehead sculpin	* <i>Cottus confusus</i>
Reticulate sculpin	<i>Cottus perplexus</i>

Table 3-18 continued

COMMON NAME	SCIENTIFIC NAME
Torrent sculpin	* <i>Cottus rhotheus</i>
Largescale sucker	<i>Catostomus macrocheilus</i>
Mountain whitefish	* <i>Prosopium williamsoni</i>
Chinook salmon	* <i>Oncorhynchus tshawytscha</i>
Cutthroat trout	* <i>Oncorhynchus clarki</i>
Rainbow Trout	* <i>Oncorhynchus mykiss</i>
resident and steelhead	
Bull trout	* <i>Salvelinus confluentus</i>
Brook trout	* <i>Salvelinus fontinalis</i>
Brown trout	* <i>Salmo trutta</i>
Atlantic salmon	* <i>Salmo salar</i>
Kokanee (sockeye salmon)	* <i>Oncorhynchus nerka</i>

introduced species

*confirmed sitings

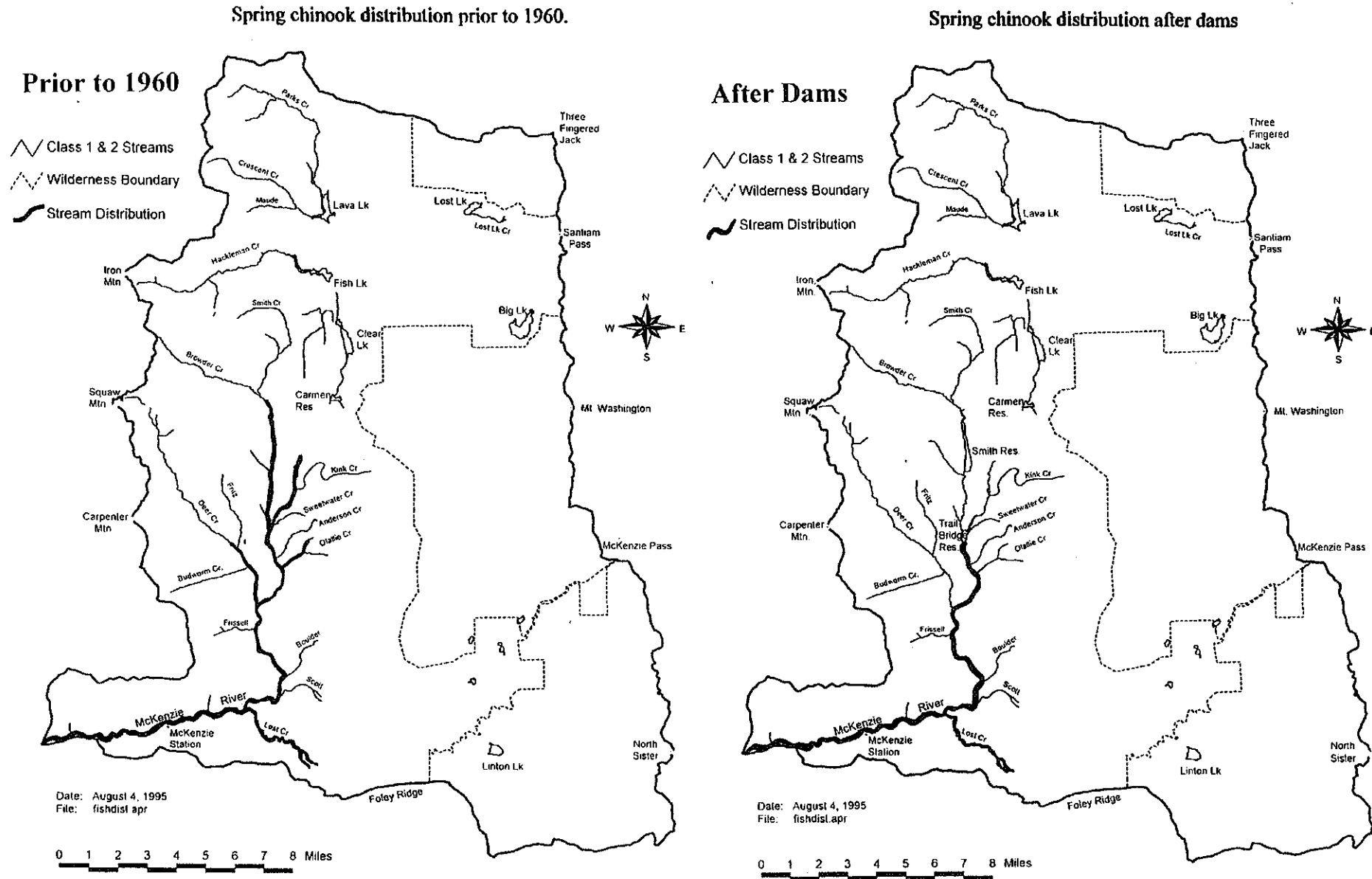
Willamette Spring Chinook**Status: of special concern****Production**

The McKenzie River is considered the best source of natural production for spring Chinook within the Willamette basin (Smith and Zakel 1981).

The McKenzie run of Willamette spring Chinook, the only native anadromous salmon in the watershed, utilizes many larger tributaries and the mainstream as spawning habitat (Figure 3-19). Other than the main stem, tributaries with greatest production are Horse and Lost Creeks, South Fork McKenzie River, and Gate Creek. Other tributaries such as the Mohawk, Blue, and Smith Rivers, and Upper Deer Creek also provided Chinook with spawning habitat. Although salmon return estimates have not been made until recently, declines in returns were evident during egg-collections in the McKenzie River in the 1940's. The average return to the McKenzie from 1945-60 was about 18,000 adults. This average was observed after significant loss of spawning and rearing habitat had occurred in the Willamette and Lower McKenzie from channelization, diversion, timber harvest, and agricultural development. Prior to construction of dams in the subbasin, the McKenzie run contributed approximately 40% of the Willamette spring chinook return (Howell, et al. 1988).

Significant loss of chinook spawning habitat occurred with construction of Cougar Dam on the South Fork McKenzie. Spawning habitat for about 4,000

**Figure 3-19. Spring Chinook Distribution
Prior to 1960 & After Dams**



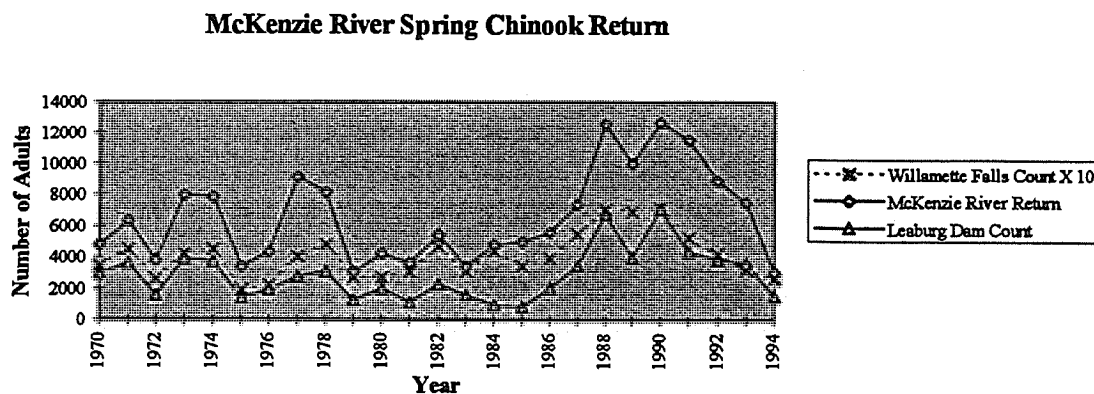
Historic and current spawning and rearing habitat of spring chinook salmon in the Upper McKenzie Watershed Analysis Area.

chinook was blocked. Loss in natural production was substituted using hatchery programs. Within the Upper McKenzie, Trail Bridge Dam blocked access of 100-200 spring chinook to about 4 miles of main stem McKenzie River. Carmen Spawning Channel was built as mitigation for the loss of production after completion of the dam in the early 1960's.

A large hatchery program, located downstream of Leaburg Dam, supplements the wild run from McKenzie Salmon Hatchery. Currently the hatchery produces about one million smolts to achieve an 8,000 adult return. About half of the McKenzie Hatchery's production is to mitigate for losses above Cougar and Blue River dams. State management goals seek natural production of 10,000 or more adults to reach a subbasin production goal of 18,000 annual return.

Current spring chinook runs in the McKenzie River reflect a continuing depressed return (Table Figure 3-20). The late 1980's through early 1990's saw an increase in the number of salmon returning to the McKenzie, although not approaching 18,000 adults per year. The 1994 return was the lowest return of spring chinook to the McKenzie River in the 25 years that estimates have been made (ODFW 1995). Anticipated poor returns in 1995 initiated emergency fishing regulations requiring release of sport caught chinook without fin clips in the McKenzie River.

Figure 3-20: Counts of spring Chinook from Oregon Department of Fish and Wildlife (ODFW) 1994. (McKenzie spring chinook return = Leaburg count + hatchery return + sports catch + (redds below Leaburg X 4.5 fish/redd)).



Natural production in the river appears to be heavily influenced by hatchery chinook adults. Recent estimates of the proportion of hatchery origin chinook passing Leaburg dam indicate approximately half of the adult fish passing the dam originated from McKenzie Hatchery (ODFW 1995[a]). The proportion of naturally produced adults used in hatchery brood stocks is unknown. The

effects of hatchery stock hybridization with wild stock have been shown to weaken local adaptations to local conditions and alter wild stock's ability to persist in their native environment (Waples 1991).

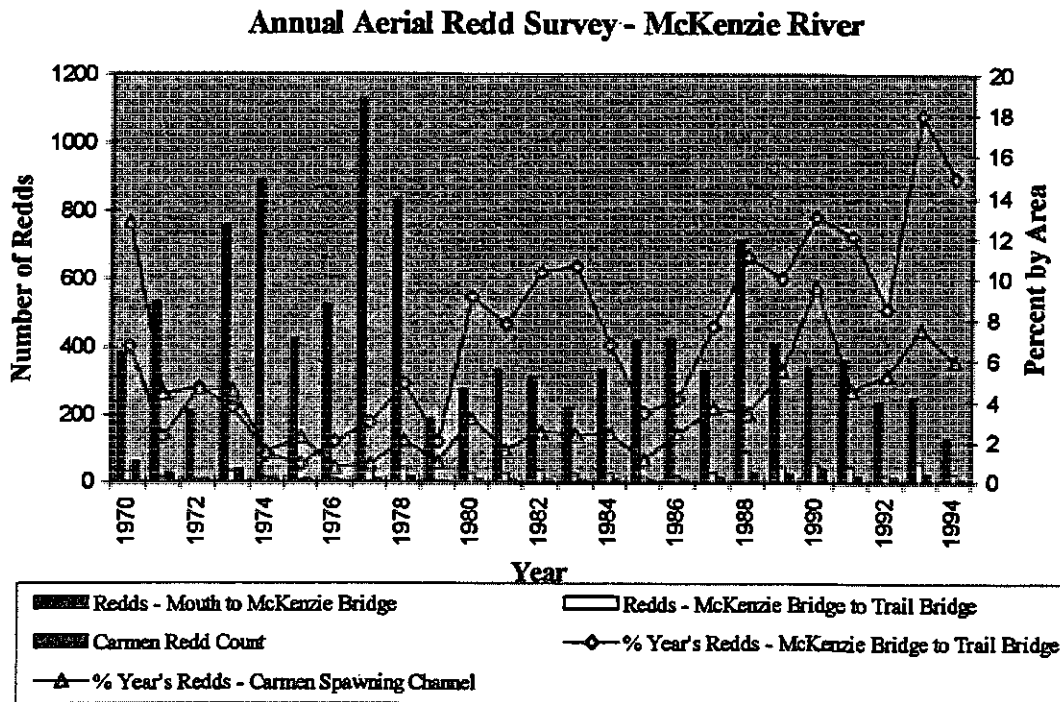
The lower portion of the basin provides important rearing habitat for juvenile salmon produced in the upper basin. Results from recent monitoring of downstream juvenile migration suggest a large portion of upper river offspring move to the lower McKenzie and Willamette to rear. Large numbers of fry have been observed moving past Leaburg Dam, leaving the upper river soon after emergence in January through April (Downey 1994), while no similar movements of smolt-sized salmon have been observed (Howell et al. 1988). Due to a long period of freshwater residency (one to two years), juvenile spring chinook are particularly vulnerable to habitat degradation. The simplification of the lower McKenzie and Willamette River channels since the late 1800's has reduced the basin's production capacity, and the loss of rearing capacity there likely limits production on the upper basin.

The upper portion of the basin remains in relatively good habitat condition compared to the rest of the basin and is now providing refugia for the Willamette spring chinook stocks. An indication of the refuge role the upper subbasin plays may be indicated in greater proportions of naturally spawning salmon using the upper river in recent years. Trends in habitat use are indicated by comparison of annual aerial redd surveys in the entire McKenzie River (Table F3). The proportion of redds in the river above McKenzie Bridge and in Carmen Spawning Channel, when compared to the number of redds in the entire river, have increased since the mid-1980's, possibly reflecting the upper basin's relative condition. This highest reach in the subbasin had remained mostly free of human impacts until 1945. For a discussion of past and present chinook habitat conditions, see the Landform block 6 Aquatic Habitat description of the main stem McKenzie River and Lost Creek in Chapter 4.

Location of Important Habitat for Willamette Spring Chinook

Habitats essential to spring chinook are the main stem McKenzie River, Lost Creek, and to a lesser degree, Lower Deer Creek (Figure 3-19). Adult holding areas consist of deep pools. Spawning habitats utilized by spring chinook are low gradient riffles and pool tail-outs rich in cobble and gravel. Rearing habitats and winter refuge consist of side channels, low velocity river margins and lower reaches of tributaries.

Figure 3-21: Annual aerial redd survey on the McKenzie River. EWEB 1970-94 unpublished data. The McKenzie River redd survey is an annual one-pass helicopter survey conducted by Eugene Water and Electric Board (EWEB) and ODFW. Carmen redd count is conducted on the ground throughout the spawning season by EWEB.



Role of the Subbasin in Recovery of Willamette Spring Chinook

To maintain or enhance the wild population of Willamette spring chinook, the upper McKenzie habitats have become increasingly important as lower basin habitats have degraded. Mitigation for dams by hatchery production has not maintained the McKenzie's historic level of production. Currently the McKenzie supports about 16% of the run, including hatchery production (1970-1994). The McKenzie River and larger tributaries within the analysis area now provide habitats (refugia) on a reach level for Willamette spring chinook, as lower reaches within the subbasin have been extensively altered by human development. Increases in upper river spring chinook production could be expected by maintaining and restoring channel complexity in the analysis area. However, greater increases in chinook production would likely come from restoration of lower river and Willamette channels, due to spring chinook life history requirements. Resource management agencies use of a top-down approach to habitat restoration, by beginning with healthier upper basin reaches, may find it necessary to simultaneously restore lower basin habitats to maximize spring chinook production. The genetic fitness of the wild spring chinook population may be placed at risk from the high proportion of hatchery

production in the subbasin. State monitoring efforts (ODFW 1995[b]) to determine the extent of hatchery influence will shape future wild fish policy and maintenance/restoration of McKenzie River wild chinook stock.

Bull Trout

Status: Category 1 candidate for Threatened/Endangered status

Production

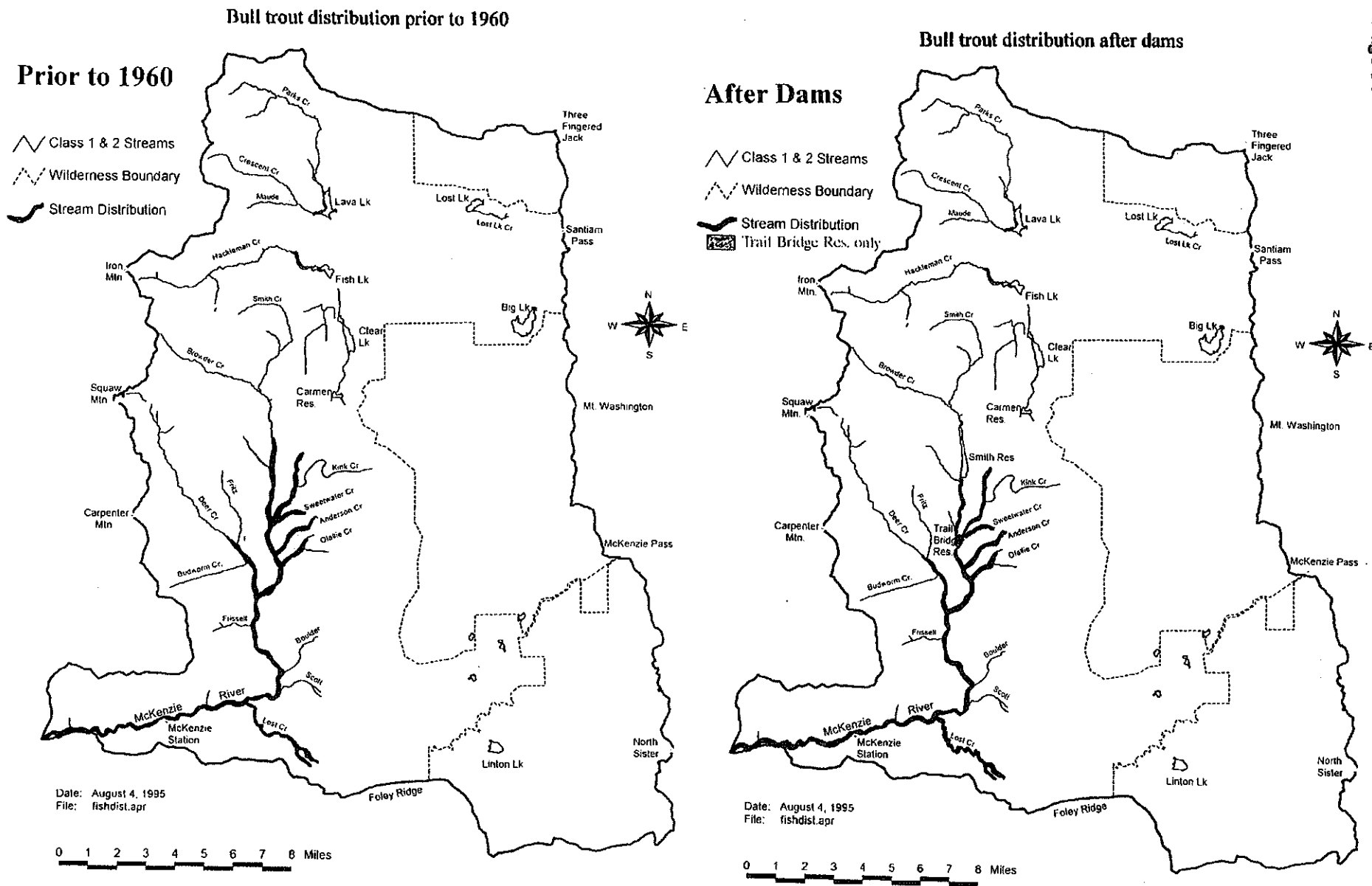
The Upper McKenzie River and South Fork McKenzie River likely possess the only remaining population(s) of bull trout within the Willamette Basin. Populations that once existed in the Santiam and Clackamas River subbasins are probably extinct (Ratliff and Howell 1992). A very small population of bull trout is suspected to remain in the Middle Fork Willamette River, but no confirmed sighting has occurred in recent years. The Upper McKenzie population is considered the only viable population remaining in the Willamette Basin (Ray Bosch, pers. comm.) by US Fish and Wildlife Service.

A river dwelling, migratory (fluvial) population of bull trout use the main stem McKenzie and tributaries, primarily above Leaburg Dam, as foraging and rearing habitat. Spawning and rearing habitat is found in spring-fed tributaries to the upper McKenzie. Streams fed by springs on the New High Cascades provide clear, cold, constant water temperatures necessary for bull trout spawning, egg incubation, and rearing. Volcanism of the past 3,000 to 6,000 years has created the spring-fed tributaries (Landform Block 5) that are currently essential to bull trout in the upper McKenzie watershed (Goetz 1994).

Bull trout historic range is similar to current distribution with the exception of fragmentation of habitat and populations by dams and other passage barriers (Figure 3-22). With the completion of Cougar, Trail Bridge, and Smith Dams (and possibly Carmen Dam) in the early 1960's, portions of the McKenzie's fluvial bull trout population were isolated above each dam. The Trail Bridge and Cougar groups survive, and both isolated populations have adapted to a lake dwelling (adfluvial) life history pattern. Spawning habitat was similarly fragmented with the construction of Highway 126 in the early 1960's and placement of impassable culverts in spawning streams. Over 2.5 miles of historic spawning and rearing habitat was made inaccessible to bull trout in Sweetwater and Olallie Creeks.

To what extent habitat disturbance in the lower basin (lower McKenzie and Willamette Rivers) has restricted bull trout migration is unknown. The migratory corridor below Leaburg Dam is unobstructed in terms of physical barriers, however degradation of habitat beyond the specialized needs of bull trout may restrict use of their historic Willamette Basin range to the McKenzie

**Figure 3-22. Bull Trout Distribution
Prior to 1960 & After Dams**



Historic and current spawning and rearing habitat of bull trout in the Upper McKenzie Watershed Analysis Area.

River. Bull trout tolerance for changes in channel condition and water quality in their migratory corridors is information essential to basin recolonization.

Little is known about bull trout numbers prior to development in the subbasin. It is assumed that this aquatic predator was more abundant, based upon the former abundance of native prey fish. No estimate is available for healthy population density of fluvial bull trout, which is difficult to attain for any migratory species. Adult bull trout are opportunistic predators, feeding on the most plentiful and available food source - largely fish. Rearing and adult bull trout can be found where prey are concentrated, such as in late winter and spring concentrations of chinook fry and smolts in the upper McKenzie. For this reason, the health of fish populations bull trout evolved and coexist with plays a significant role in bull trout recovery.

Bull trout populations have been shown to decline when chinook populations decline in shared river basins (Ratliff and Howell 1992). The coexistence of this population with spring chinook has possibly played a role in the increased number of spawning adult bull trout observed recently (Table 3-19). From 1987 to 1993, greater numbers of adult chinook returning to the upper river (Table 3-21) than in previous years (1975 through 1986) likely provided more numerous offspring upon which bull trout prey.

Changes in State game regulations have also likely enhanced recent increases observed in sexually mature populations. Beginning in 1991, Oregon fishing regulations no longer included bull trout among legal game fish. They are protected with a catch-and-release status.

Due to bull trout's fish-eating nature, stocked rainbow trout fishery in Trail Bridge pool from spring to late summer may provide easy prey and help sustain a population at high risk of extinction. Similarly, hatchery rainbow released into the McKenzie River may contribute to the diet of adult bull trout inhabiting the main stem, spring through summer.

Based upon recent redd counts in bull trout spawning tributaries, an estimate may be made of adult population size (Pratt 1985). An estimate of the main stem population range is achieved based upon two differing assumptions: 1) a sexually mature bull trout spawns every year, and 2) a sexually mature bull trout spawns every other year. There is some uncertainty about spawning frequency of fluvial bull trout (Goetz 1989), although it is likely dependent upon food supply. Recent monitoring of a McKenzie nursery stream suggests that there may be a portion of McKenzie bull trout spawning on an alternate year cycle (USFS McKenzie Ranger District 1994). Other fluvial populations (Fraley and Sheppard 1988) and the McKenzie bull trout (Jeff Ziller, pers. comm.)

Table 3-19: Total bull trout redds surveyed in the Upper McKenzie watershed spawning tributaries, 1989-1994.

YEAR	REDDS OBSERVED
1989	7
1990	9
1991	8
1992	13
1993	17
1994	33*

* includes additional habitat not previously surveyed

have been estimated to average about 3 spawning adults per redd. With a redd count of 33 in 1994 and 17 in 1993, the current number of mature bull trout in the Upper McKenzie is estimated to range from 99 to 150. To date, no evidence of bull trout spawning has been found in the McKenzie channel below Trail Bridge Dam. Population estimates will be higher if continuing surveys find main stem spawning.

To determine the viability of the McKenzie bull trout population it is important to first view the entire basin. If the McKenzie population is considered part of the historic Willamette basin larger population (metapopulation), it once drew stability from wide geographical distribution and genetic interchange of a migratory species between populations. Reduction to a single, isolated population, without benefit of immigration to replenish the gene pool, likely puts the McKenzie group at an elevated risk of extinction. There is no criteria for determining the viability of an isolated population and little available research on the minimum number necessary to avert genetic inbreeding (Rieman and McIntyre 1993). The main stem population no longer has exchange with the isolated South Fork McKenzie group, a possible separate or sub-population (USDA Forest Service 1994).

The limited current range subjects this population to additional risks. Additional risks include vulnerability of limited spawning and rearing habitat to natural and human caused disturbance. The specific habitat requirements of spawning adults and rearing juveniles below Trail Bridge Dam are currently met by three miles of habitat within two streams, all located within a one mile radius. Wildfire, or a chemical spill along a Hwy 126 crossing could devastate a significant portion of three year classes incubating or rearing in their natal stream. Spawning adults are vulnerable to poaching and incubating egg survival decreases sharply as sediment levels increase. Although recent increases in redd counts have been observed and are encouraging, long term

examination of spawning populations should be used to evaluate this small population's persistence (Fisheries Appendix). The population should therefore remain as it was classified by Ratliff and Howell in 1992 as at moderate risk of extinction.

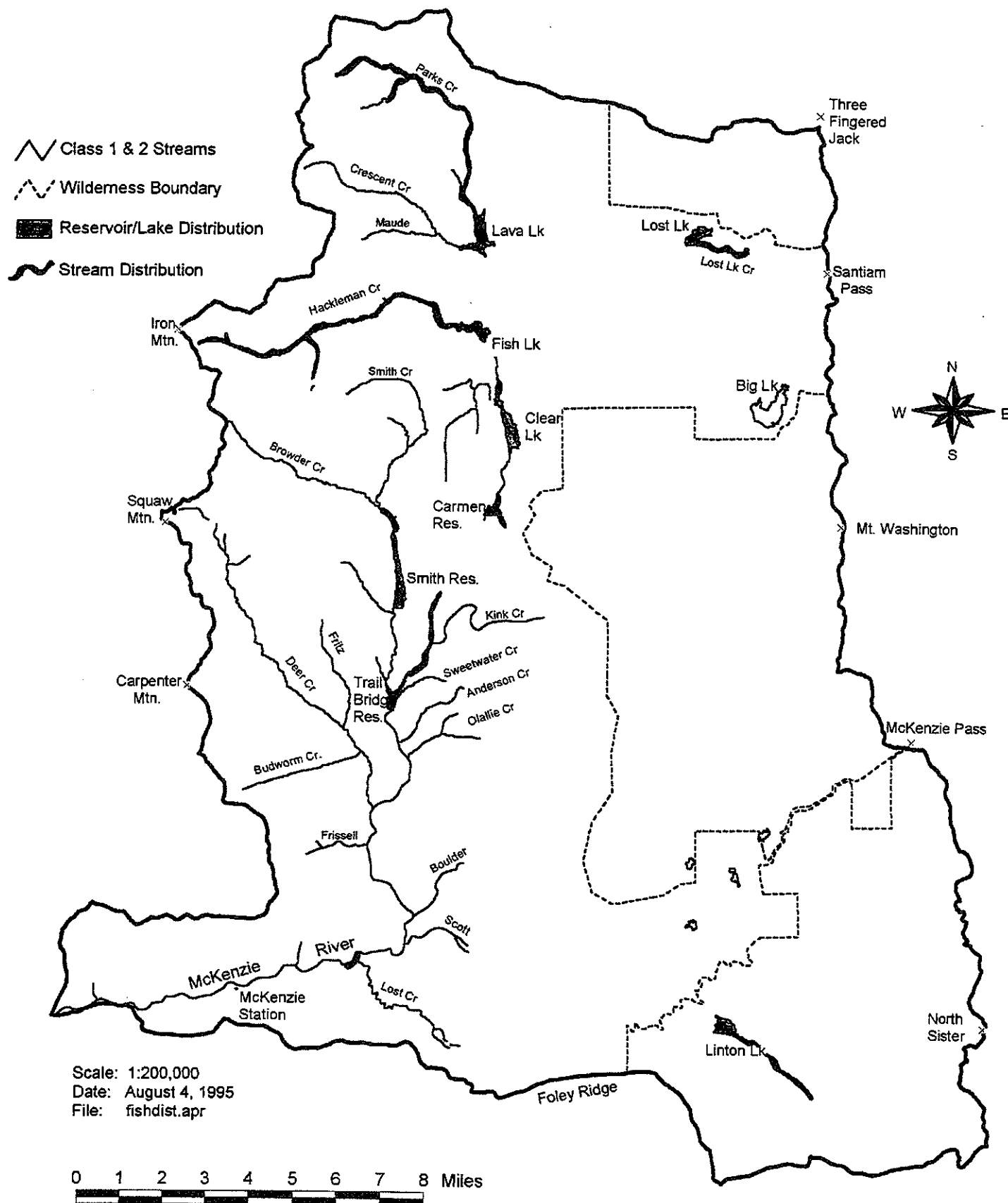
Bull trout isolated above Trail Bridge Dam are at high risk of extinction (Fisheries Appendix). Risks come from low population size (thought to range from 5 to 20 adults in 1993), passage barriers, over harvest of fish, habitat degradation, competition with brook trout, and limited available spawning habitat. Access to Sweetwater Creek spawning habitat was reestablished in 1992. Through human intervention, the main stem population is in the process of reestablishing the smaller Trail Bridge sub-population. Bull trout fry are being reseeded upstream of the dam in an effort to reestablish Sweetwater Creek spawning and rearing habitat and strengthen the number of Trail Bridge bull trout.

It is not likely that bull trout historically ranged above Tamolitch Falls. However, unverified reports of bull trout catch from Carmen Reservoir have occurred in recent years. Recent searches for bull trout in Carmen Reservoir have found none. Brook trout have been introduced to Carmen Reservoir and now reproduce naturally, ranging up the McKenzie to the base of Koosah Falls (Figure 3-23).

Location of Important Habitat for Bull Trout

Foraging and rearing habitats essential to bull trout within the analysis area below Trail Bridge Dam are the main stem McKenzie River, Lost Creek and Lower Deer Creek (Figure 3-22). Spawning and rearing habitat consists of Anderson and Olallie Creeks and historically, small, low gradient spring-fed seeps and streams, along the east bank of the upper McKenzie River. Above Trail Bridge Dam, foraging and rearing habitats consist of Trail Bridge pool, main stem McKenzie to Tamolitch Pool, and lower Smith River. Spawning and rearing habitat for the Trail Bridge sub-population consists of Sweetwater Creek and the main stem McKenzie above Trail Bridge pool. Adults and sub-adults utilize all habitats in the main stem and tributaries while foraging, their temporal distribution determined by concentrations and behavior of prey species. Adults are most often observed in deep pools utilizing available wood or undercut banks as cover. Recent monitoring of the main stem population prior to spawning saw increasing upriver concentration of adults in pools as they staged to enter spawning tributaries (ODFW 1994) or exploit drifting eggs of spawning chinook. Bull trout spawning habitats consist of low gradient pool tail-outs and riffles with abundant clean gravel and cobble. Unembedded substrates and cold water temperatures are essential for spawning and

Figure 3-23. Naturally Reproducing Brook Trout - Current Distribution



incubation success. The McKenzie spawning streams possess abundant in-stream large wood, high channel complexity and a mature conifer canopy. Main stem rearing habitats and winter refuge consist of side channels, river margins and tributaries.

Role of the Watershed in Recovery of Bull Trout

The upper McKenzie watershed retains one or two bull trout populations, including the S.F. McKenzie River. Maintenance and restoration of habitat essential to main stem bull trout is expected to provide for recovery of the local population. The response of the Trail Bridge sub-population to recent restoration will not be available until the late 1990's. Other populations in the Willamette Basin are extinct or no longer viable. Restoration of the Willamette Basin bull trout metapopulation will necessarily follow restoration of basin habitat and recovery of McKenzie populations. Following historic habitat recovery, reseeding basin tributaries with bull trout from the McKenzie River may be the only alternative available for re-colonization. Natural re-colonization, via the lower McKenzie and Willamette Rivers, will depend upon restoration of channels to conditions meeting bull trout habitat needs. Restoration of prey species and their habitat (spring chinook), with which bull trout have evolved and coexist in the basin, will be necessary for bull trout recovery.

Coastal Cutthroat Trout

Within the Upper McKenzie, native cutthroat are distributed in main stem and Class I and II tributaries. Seasonal use by cutthroat of some Class III and IV tributaries is likely. Three cutthroat life history patterns exist in the Upper McKenzie River and tributaries:

1. Fluvial populations utilize the main stem for most of their life, moving into tributaries to spawn, rear and seek refuge from high flow.
2. Resident populations spend most of their life in tributaries, utilizing this habitat as foraging, spawning and rearing habitat. Movement into larger tributaries and the main stem is possible with this life history form.
3. Isolated populations are located in higher reaches of tributaries, above barriers, spending their entire life in relatively short stream segments.

Considerable genetic variability between populations, particularly between isolated populations, is possible (Behnke 1979). Potential for genetically unique isolated populations exists in numerous upper tributaries and portions of the subbasin isolated by volcanic events. Cutthroat population trends have not been made as occasional trout inventories have been scattered throughout the subbasin. The extent and influence of hatchery stocking of non-native cutthroat is unknown, most of the activity having occurred in the early 1900's. Existing records describe planting of non-native hatchery stock in lakes (Clear Lake, Landform Block 2B). Where introduced brook trout overlap native cutthroat distribution, exists the potential for loss of cutthroat populations. Extirpation of

cutthroat trout is possible in the upper subbasin, especially in Hackleman and Parks Creeks. Loss of a possible Lost Lake and Lost Lake Cr. cutthroat population from brook trout competition may have occurred.

Rainbow Trout

A resident rainbow trout living a fluvial life history pattern is present in main stem and larger tributaries as an adult. Spawning and rearing occurs in the main stem and larger tributaries. Little is known of rainbow population trends or number. The best estimates are from creel proportions of wild fish to hatchery origin. Howell et al. (1988) found rainbow to be the most abundant fish in the Upper McKenzie River. Stocking hatchery rainbow fingerlings began in the early 1900's and ceased in the 1950's due to poor survival. Stocking of legal-sized rainbow began in 1947 in response to declines in number and size of catch (Howell op. cit.). Three stocks of rainbow have been released into the McKenzie, those originating from the spring spawning McKenzie population and fall spawning Roaring River and Cape Cod stock. Currently Cape Cod stock is utilized in the local hatchery program. The uppermost limit of hatchery stocking occur within the analysis area, beginning at Paradise Campground about 3.5 miles above McKenzie Bridge. 120-125,000 hatchery rainbow are stocked annually, evenly distributed between Paradise Campground and Hayden Bridge (River Mile 69 to 11).

In addition, various lakes and reservoirs in the upper subbasin are stocked with rainbow (Fisheries Appendix). Potential for natural reproduction exists, although no known establishment of introduced rainbow stocks have occurred. Some hatchery mixing of McKenzie and Roaring River stock is thought to have occurred inadvertently in hatcheries. The influence of hatchery origin rainbow and introduced summer steelhead upon native rainbow is not known. Monitoring of native populations will be necessary to avert potential detrimental effects of stocked rainbow, such as hybridization, disease transfer and displacement (Utter 1994). Potential impacts to native stocks may be represented in the proportion of wild rainbow observed in recent angler catches. The proportion of wild rainbow in surveyed angler catches throughout the McKenzie River dropped from 46% in 1950 to 11% in 1974 and 1983, possibly reflecting loss of wild McKenzie rainbow populations (ODFW 1983).

Summer steelhead (anadromous rainbow trout)

Summer steelhead were introduced into the McKenzie subbasin in 1968. A Skamania River stock is currently utilized as previous Siletz stock was found susceptible to a naturally occurring disease organism (Howell et al. 1988). Spawning surveys found adults are reproducing naturally in suitable larger tributaries upstream of Leaburg Dam such as upper Deer Creek and Lost Creek in late winter and early spring. State managers release all hatchery reared smolts below Leaburg Dam to avoid potential competition between native trout/spring chinook and introduced steelhead. 100-160,000 steelhead smolts

are released annually below Leaburg Dam. Counts of steelhead adults passing Leaburg Dam range from 200-2,000 since 1986 when ratios of wild to hatchery origin fish were first kept. The percentage of naturally produced steelhead passing Leaburg has ranged from 3-51% since 1986 and has dropped to 8-15% since 1990. Hatchery origin steelhead compose the remainder. Similar habitat utilization by spawning steelhead adults as native rainbow and rearing habitat use by juvenile steelhead and native rainbow/chinook salmon likely poses production limitations on native species.

Brook Trout

This popular game fish and successful exotic was first introduced into the subbasin in the early 1900's. Utilization of brook trout as a game fish has ceased in all waters where potential impacts to natives species is possible. Naturally barren high mountain lakes lacking opportunity for downstream migration are the only locations currently used for brook trout stocking. Brook trout have established naturally reproducing populations in the upper subbasin. Competition between brook trout and native cutthroat threaten isolated populations of cutthroat in Hackleman and Parks Creek drainages. The potential for hybridization between native char bull trout and brook trout exists in the subbasin. Bull trout isolated above Trail Bridge Dam are at risk of extinction, in part due to the presence of brook trout.

Mountain Whitefish

A fluvial population of whitefish is found in the main stem and larger tributaries of the Upper McKenzie River. Little is known of their abundance or population trends in the subbasin. Mountain whitefish are described as plentiful in the main stem (Howell et al. 1988) and possibly the most prevalent sport fish in the subbasin. In 1983 whitefish, seldom sought by anglers, accounted for about 1% of total sport catch in the Upper McKenzie River (ODFW 1983).

RIPARIAN HABITAT - WILDLIFE

ROD STRATEGY

The riparian protection strategy outlined in the 1994 ROD assumes that the riparian buffers will provide protection for riparian-associated species and dispersal habitat on the landscape for forest-dwelling species. The following discusses the condition of the UPMAKWA riparian network and evaluates the potential for success of the ROD riparian reserve strategy on this landscape.

There are 60 species of wildlife within the watershed that use riparian areas as primary habitat for breeding and for feeding. Table 3-20 displays these riparian-associated species and what stream classes they use as primary habitat. The majority (30%) are migrating waterfowl that primarily utilize the water column

while they are in the area. Thirteen of these species require mid or late seral forests adjacent to class 1-3 streams, lakes, and ponds.

The intermittent nature of class 4's probably precludes primary use by most species. The only species that appeared to use class 4 streams as primary habitat are the Dunn's salamander, Cascade Salamander, and water vole. It is unknown what classes the Pacific water shrew may use. Species associated with riparian habitat generally require clean, cold, running water.

Table 3-20: Species that use riparian habitat primarily for breeding and/or foraging by stream class.

SPECIES	STREAM CLASS
Water column of riparian reserve only	
American coot	1
American widgeon	1
Blue-winged teal	1
Canvasback	1
Cinnamon teal	1
Common loon	1
Eared grebe	1
Gadwall	1
Greater scaup	1
Green-winged teal	1
Horned grebe	1
Lesser scaup	1
N. Pintail	1
Pacific Loon	1
Red-throated loon	1
Redhead	1
Ruddy duck	1
Surf scoter	1
Western grebe	1
Pied billed Grebe	1
Water column and open condition on banks	
Canada goose	1
Killdeer	1
Mallard	1

**Water column and open
condition on banks**

Water vole	1-3 4?
W. Pond turtle	1

**Water Column and
banks/generalists**

Dunn's salamander	1-3 4?
Bald Eagle	1
Common egret	1
Common egret	1
Great Blue heron	1,2
Green backed heron	1,2
Osprey	1
Pied-billed grebe	1
Ring-necked duck	1
Beaver	1,2
Mink	1,2
Muskrat	1,2
River Otter	1,2
Pacific Water shrew	unknown

**Water column and
mid/late seral banks**

Cascade torrent salam.	2,3 4? (seepy areas)
Pacific giant salamander	1,2 3?
Tailed frog	2,3
American dipper	1,2
Barrow's goldeneye	1
Belted kingfisher	1,2
Bufflehead	1
Common goldeneye	1
Common merganser	1
Harlequin duck	1,2
Hooded merganser	1
Wood duck	1,2
Water shrew	1,2,3

**No water column use—
needs open plant
community on bank**

Common yellowthroat	1-3
Marsh Wren	1

**No water column use—
needs open plant
community on bank**

Yellow-breasted chat 1-3
Spotted Sandpiper 1-2

**No water column use—
generalist in adjacent
forest**

American redstart 1,2
Bank swallow 1
N. roughwinged swallow 1,2

**No water column use—
mid/late seral adjacent
forests**

Red-eyed vireo 1,2
White-footed vole 1,2

**No water column use—
deciduous riparian
vegetation required**

Downy Woodpecker 1,2
Warbling vireo 1,2,3?

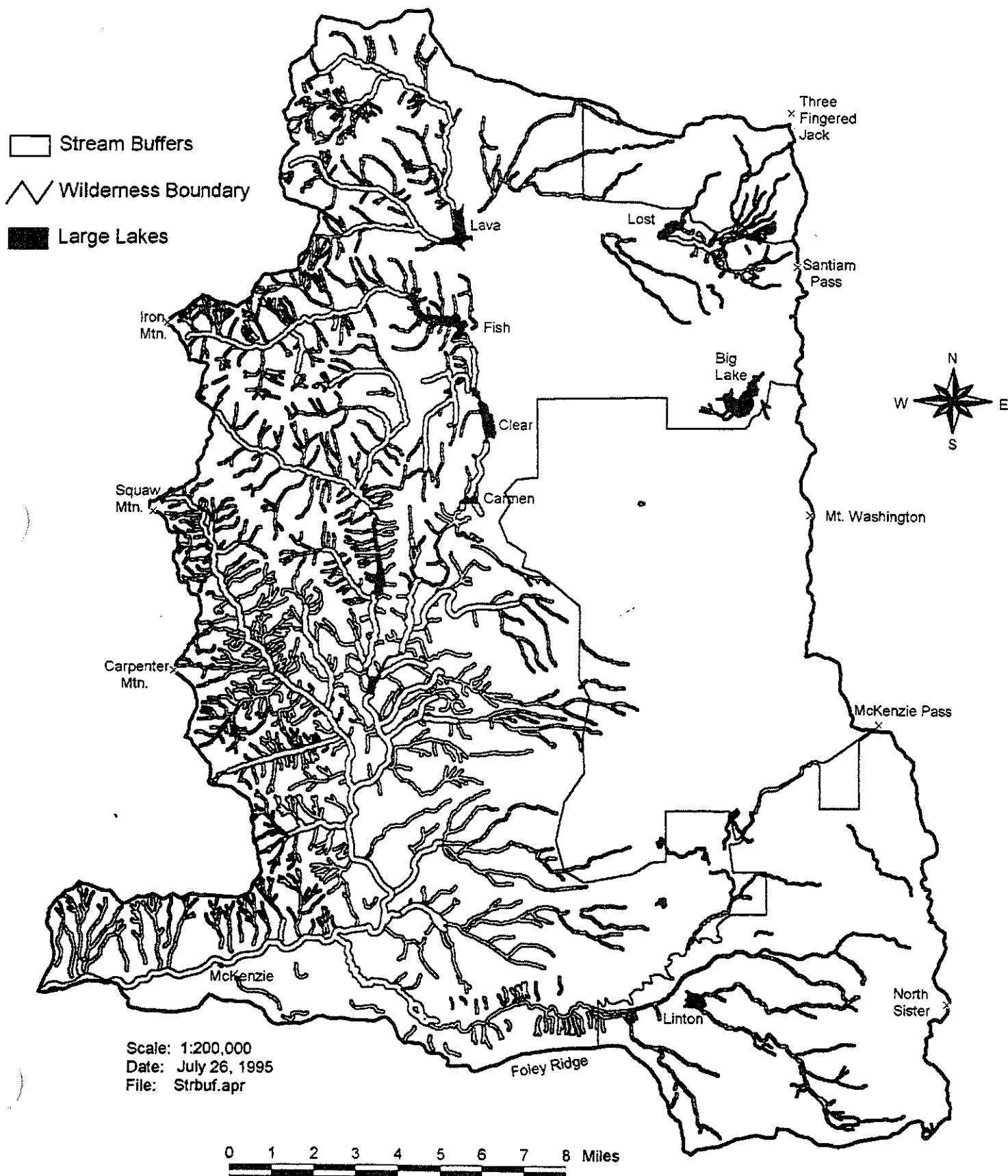
Figure 3-24 displays the riparian reserves. Table 3-21 displays the acres of habitat within default riparian reserves by stream class. The majority of all stream classes are located within a reserve with late successional habitat. Early seral habitat is primarily associated with the class II and III streams. The table above indicates that those stream classes are used by species associated with open stand plant communities. It will be important to maintain natural open communities within the riparian reserves, which are not well-represented in Fig. 3-24.

Table 3-21: Seral stage of stands within default riparian reserves in the UPMAKWA.

CONDITION OF RIPARIAN RESERVE FOREST *	ACRES CLASS I	ACRES CLASS II	ACRES CLASS III	ACRES CLASS IV
STAND INITIATION	132.3	729.4	888.9	1931.5
percent	4	18	21	14
STEM EXCLUSION	982.2	724.9	1165.6	4195.0
percent	28	28	27	30
UNDERSTORY REINITIATION	356.9	176.5	295.3	1488.9
percent	10	4	7	11
OLD GROWTH	2023.3	2390.7	1943.2	6320.8
percent	58	59	45	45
TOTAL	3494.6	4021.5	4293.0	13936.0

*See Silviculture Appendix for definitions of stand conditions

Figure 3-24. Streams with Default ROD Buffers



The REAP report (1993) modeled the range of early and late seral habitat that occurred in the McKenzie subbasin between 1600 and 1850. Table 3-22 displays this range of variability and compares it to current habitat abundance. The watershed is currently well within the historic range of variability for these habitats.

Table 3-22: Historical range of stand conditions in the McKenzie basin between 1600-1850 compared with current abundance.

----- range in abundance from 1600-1850

* current abundance



RIPARIAN RESERVE - MANAGEMENT OF WILDLIFE HABITAT

If the riparian reserve standards and guidelines are altered, additional analysis is recommended for several species (Appendix 2, Terrestrial Module for Watershed Analysis) (USDI, USDA 1994; ODFW 1992). The Wildlife Appendix displays potential affects to wildlife species with the implementation of various projects in riparian reserves. Table 3-23 displays the risk factors associated with management of these species.

Table 3-23: Conditions that could pose risks to populations of wildlife intended to benefit from riparian reserves.

SPECIES	RISK FACTORS
<u>P. Dubium</u>	road maintenance in rockslide areas, loss of riparian habitat
N.Spotted Owl	fragmentation and conversion of LS habitat
Marten	fragmentation and conversion of LS habitat, loss of LWD
Red Tree Vole	fragmentation and conversion of LS habitat
Tailed Frog	loss of streamside habitat, increase temps, sedimentation
Cascade Torrent Salamander	loss of headwater, intermittent, and seep habitat

Table 5-2 in Chapter 5 discusses the recommended riparian buffer widths for each stream class by Landform block. Generally, it was recommended that class 1-3 streams maintain the ROD default buffer widths to protect the hydrological function, plant community, fish and wildlife habitat. It was recommended that class IV streams may receive variable widths after additional site-specific analysis is conducted. Recreating patterns similar to those created from past disturbance events would be the impetus for alterations to class IV streams.

The default riparian buffers for class IV streams appear to have been prescribed by the ROD to perform 3 functions for wildlife: 1. dispersal habitat for terrestrial upland species such as the spotted owl, marten, and red tree vole; 2. dispersal habitat for species associated with the wetted portion of the riparian buffer such as tailed frog and Cascade Torrent salamander; and breeding habitat for species such as the Cascade Torrent salamander. Proposals to alter the class IV buffers should take these functions into consideration.

The dispersal for the upland terrestrial species can be accomplished through other landscape patterns not necessarily related to Class IV distribution. Table 3-24 displays the percentage of each landform block in a riparian reserve. None of the landform blocks' riparian reserve networks are of sufficient abundance and density to maintain a 50-11-40 condition without additional landscape level management of the matrix. Well-distributed patches of late successional habitat linked by patches of mid seral forest in a pattern similar to the 50-11-40 rule would adequately provide for this function. The existing abundance of late successional habitat in class IV buffers should be retained on the landscape. Instead of linear strips along the class IV's, patches could be extended out into the matrix to serve as small refugia for dispersing animals. These patches should be closer together in highly fragmented landscapes or steeply incised drainages to facilitate movement.

The breeding and dispersal habitat functions for amphibians and other species listed in Table 3-20 could be provided for by maintaining high quality cover on portions of these streams. Buffers of a width that would adequately protect the water quality and temperature of seep areas should be a high priority. Surveys for Dunn's and Cascade salamanders should be a priority in areas proposed to be managed without a riparian reserve.

Table 3-24: Percentage of riparian reserves currently and potentially meeting an 11-40 condition within each landform block.

LANDFORM BLOCK	% OF LANDSCAPE IN RIPARIAN RESERVE THAT IS CURRENTLY IN A DISPERSAL CONDITION	% OF LANDSCAPE IN RIPARIAN RESERVE THAT COULD BE IN A DISPERSAL CONDITN IN FUTURE
1	14	20
2A	20	33
2B	15	22
3	4	5
4	2	2
5	9	14
6	7	9

Many of the survey and manage species of bryophytes, lichens, fungi and vascular plants are associated with riparian zones and the transition Ecotone between the upland terrestrial vegetation communities. Field data is lacking to determine the zone of influence of individual streams. The draft Terrestrial Ecology Addendum (1995) contains a list of plant species that must be considered prior to modifying riparian reserve boundaries. These species were considered by the team when Table 5-2 was created. This is an area, however, where additional information is needed to fully support the recommendations in Table 5-2.

OVERVIEW OF WILDLIFE

Viability for many of the late successional and riparian associated species that occur within the Upper McKenzie Watershed Analysis were analyzed within the FEMAT (1993). These species were all shown to exhibit moderate to high levels of viability under the management strategy of the President's Plan. Other species, including ROD C-3, TES, and those listed in the ROD with specific S&G's, may require additional analysis at finer scales to ensure viability. Species that were outside of the scope of the FSEIS and at risk, such as some early seral species and those associated with special habitats, may also require additional analysis. The following is an overview of species that require additional analysis (Table 3-25), highlighting viability concerns that may occur with the implementation of the ROD. Species of concern for other reasons, such as economic and hunting experience, are also discussed below. Viability is generally not a concern for these species, but maintenance of populations to meet

recreational needs (i.e. determined by ODFW and WNF Forest Plan targets) is important.

Table 3-25: Species within the UPMAKWA boundary that require finer scale analysis during watershed analysis..

Threatened or Endangered	Sensitive	Table C-3 and S&M Species
Northern Spotted Owl	California Wolverine	Great gray owl
Northern Bald Eagle	California Wolverine	Red tree vole
Peregrine Falcon	Harlequin Duck	Black-backed woodpecker
	Sandhill Crane	Flammulated owl
	T.Big-eared Bat	<i>Prophyaon coeruleum</i>
	White-footed vole	<i>P.dubium</i>

Recreation Concern
Roosevelt Elk

NORTHERN SPOTTED OWL (*Strix occidentalis*)

There are 43 owl sites within the UPMAKWA. An additional 24 have activity centers that fall outside of the UPMAKWA boundary, but portions of their home ranges extend into the watershed. Eight of the sites within the boundary are currently in a "take" situation for available acres within 1.2 miles. There are 8 quarter-townships in the watershed (out of 67) that do not meet the 50-11-40 rule currently, and an additional 16 that are approaching the 50% level. There are currently few concerns for dispersal throughout the watershed and between LSR's even with these deficit quartertownships. However, a critical linkages across the Santiam Pass need to be maintained to fulfill the objectives of the Critical Habitat Unit and Area of Concern in that area. Detailed information for future incidental take calculations, assessment of the Late Successional Reserve system and Critical Habitat Unit, and 50-11-40 analysis is included in the Wildlife Appendix.

ROD S&G's ensure the continued viability of this species on the landscape. The USFWS has recommended that take be avoided if possible in the matrix while the LSR's recover habitat and begin to fully function. Incidental take will be granted by the USFWS in the matrix.

NORTHERN BALD EAGLE (*Haliaeetus leucocephalus*)

Potential nesting, foraging, and roosting habitat is recognized within the vicinity of four lakes: Big Lake, Clear Lake, Linton, and Lost Lake; and three Reservoirs: Smith, Trailbridge, and Carmen. Additional habitat may be available in smaller lakes within the wilderness.

The majority of these lakes, with the exception of Big Lake, are providing moderate to high quality bald eagle habitat. All of these areas have been surveyed over the past 4 years. Bald eagles have been observed utilizing all of these areas. An historic nest at Clear Lake appears to have been abandoned. Survey efforts have not identified a new nest site. The Clear Lake site is monitored yearly by the Oregon Cooperative Wildlife Research Unit at Oregon State University through a contract with Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and Wildlife Management Institute. The historical status of this site is described in Table 3-26. This site is counted in the Target Recovery territories. When a new nest site is discovered, a Bald Eagle Management Plan will be completed, as required under the Recovery Plan.

Table 3-26: Historical status of bald eagle occupation at the Clear Lake site, site number 269-101 (info from Anthony and Isaacs 1992).

<u>YEAR</u>	<u>STATUS</u>
1989-	site occupied, at least 1 adult and nest, no evidence of eggs or young
1990	at known nest (occupied or breeding failure).
1991-	
1992-	site occupied, at least 1 adult and nest, no evidence of eggs or young
1993-	at known nest (occupied or breeding failure). Nest used or location uncertain; need to determine or verify locations or territories.
1994	same as 1992-93
1995	" " "

ROD buffers on riparian areas will help to maintain the viability of this species. WNF LMP and the Bald Eagle Recovery Plan mandate additional protective measures that are in place on this landscape to ensure the continued viability of this species.

AMERICAN PEREGRINE FALCON (*Falco peregrinus*)

In 1981, 1990, 1991, and 1992 the Oregon Department of Fish and Wildlife completed an aerial reconnaissance of cliffs on the McKenzie RD that identified nest site potential. Ground surveys have also identified potential habitat in the area. Ground inventories in 1992-1994 did not document any occupied eyries areas in this watershed. In 1995, a new eyrie was verified. Sittings have occurred in 6 areas with cliff habitat, and efforts continue to verify use and additional eyries. Additional information on potential cliff habitat is described in the Landblock section. ROD buffers on riparian and wet meadow habitats will help to maintain the viability of this species. WNF LMP and the Peregrine Recovery Plan mandate additional protective measures that are in place on this landscape to ensure the continued viability of this species.

GREATER SANDHILL CRANE (*Grus canadensis*)

Sandhill Cranes are known to nest at Lava Lake, which lies on the northwest boundary of the UPMAKWA. They are part of the Central Valley Population (CVP), which is one of four populations in North America. It is the westernmost and second most numerous (Schlorff et al. 1985). This population is fairly stable at this time (Littlefield, pers. comm., Marshall et al. 1992), and it has expanded its range into new areas, including the Cascade Range. Cranes have been documented at Lava Lake since 1981, but nesting success has only been monitored for the past 5 years. Two chicks were observed in 1988, but it is unknown if they successfully fledged. Most pairs do not begin nesting until age 4 or 5, and most fail at fledging young the first few seasons because of inexperience (Paullin 1989). Some birds are never successful (Ivey, pers. comm.). Factors such as predation, brood strife, disease, starvation, and livestock grazing probably all contribute to poor reproductive success at Lava Lake. Predation most likely has a greater impact than effects of grazing, which has occurred in the meadow since between 1911 and 1995. Reducing grazing may not alter the reproductive success rate. It has not been seen to significantly alter the success of cranes on the Malheur National Wildlife Refuge (Paullin 1989).

The Sweethome Ranger District has developed an Environmental Analysis for managing a grazing permit in that area. The grazing permit will be void within the next year, eliminating potential impacts to this site from grazing.

ROD buffers on wet meadows within this landscape will aid in the continued viability of this population.

CALIFORNIA WOLVERINE (*Gulo gulo luteus*)

Potential habitat for wolverines does occur in the UPMAKWA area. High elevation areas in the Mt. Jefferson, Mt. Washington, and Three Sister's Wildernesses probably serve as their primary habitat for the majority of the year. In 1977 the Sweet Home Ranger District had a suspected road kill on Hwy 20, which runs through the project area. A wolverine was observed near Hoodoo Butte in the winter of 1993 and in the Cupola area in the fall of 1992. The McKenzie RD began using baited camera stations to assess the population of wolverines in the Santiam Pass area in the winter of 1993. This survey technique has yet to document their presence. ODFW in Bend is also surveying for wolverines on the Sister's RD (adjacent to the watershed) using a winter track-intercept method. They have not documented any wolverines in the area. ROD S&G's do not specifically address this species. Risks to their continued viability lie primarily in the loss of solitude at high elevations. Increased recreational activity in the wildernesses and development in the Santiam Pass (i.e. Hoodoo Ski Bowl) will need to be assessed.

TOWNSEND'S BIG-EARED BAT (*Plecotus townsendii townsendii*)

Isolated populations of this bat have been found on the WNF. Potential habitat has been mapped throughout the UPMakwa area. Lava tubes provide the highest quality habitat in the area in the Santiam Pass. Surveys have documented occupied hibernaculum. This species is extremely sensitive to human disturbance. The hibernaculum are currently being disturbed by recreationists. We believe the potential of these sites to continue to provide wintering habitat is on the decline. Surveys over the past 4 years have indicated a decline in use. ROD S&G's specifically protect this species from the direct impacts of logging through buffers on caves (C-43) and from indirect impacts through protection for riparian and wet meadow habitats. Additional threats to the continued viability of this species include human disturbance. A cave management plan for the occupied hibernaculum in the analysis area will alleviate this threat.

RED-LEGGED FROG (*Rana aurora*)

Red-legged frogs have been documented in the lower elevations of the UPMakwa area in ponds, warm springs, and in sidechannels of the McKenzie River. They appear to be relatively common. ROD S&G's aid in maintaining the viability of this species through buffers on ponds and riparian areas. Interconnectedness of the population is probably not a concern in this area. The landscape will be well connected through the riparian reserve network, and this species can also migrate through mid and late seral habitats to reach breeding sites.

HARLEQUIN DUCK (*Histrionicus histrionicus*)

Surveys have been conducted for Harlequin ducks on the McKenzie River for the past 3 years. Research for a Master's thesis is in its second year investigating nest site characteristics. Ducks and broods have been sited on the McKenzie River and several of its tributaries. A total of 13 potential sites exist in the watershed. During nesting season (April-July) adult harlequins require fast-flowing water with one or more loafing sites nearby. High quality habitat is being provided in the McKenzie River. Potential impacts to the population include human disturbance, loss of water quality, and loss of loafing sites. The McKenzie River receives heavy boater use throughout the season. The adults do not appear to be significantly disturbed by boaters, and guides have been informed to avoid disturbing them. Females with broods appear to spend their time in the adjacent tributaries or in areas of the river that are inaccessible to boaters. Harlequins nest on the ground under the shelter of vegetation, rocks, or large woody debris. Of the nests found, several were near areas of human activity. This species may be less sensitive to human disturbance than previously thought. Midstream loafing sites are very important, and the McKenzie has abundant boulders and islands to provide this type of habitat. Removal of large woody debris from the banks or within the stream channel

could impact this species if adequate habitat is not available. ROD riparian buffers will aid in maintaining the viability of this species.

WHITE-FOOTED VOLE (*Arborimus albipes*)

No surveys for this species have been conducted in the watershed. There were 3 individuals trapped on the H.J. Andrews Experimental Forest adjacent to the watershed, so we expect them to be here. White-footed voles are extremely rare. Data from trapping indicates they are associated with mature riparian stands (D. Gomez, 1990) and red alder riparian habitats. They are often found in heavy cover consisting of downed logs and/or brush. Threats to their habitat include impacts to riparian vegetation, either through logging or human disturbance, and connectivity of the population within the watershed. ROD riparian buffers will aid in maintaining the viability of this species. Mature riparian habitat within the watershed will be well-connected with the prescribed riparian reserve network and other no-harvest allocations..

BLACK-BACKED WOODPECKER AND FLAMMULATED OWL

The Black-backed is a rare but known occupant of the UPMAKWA in the higher elevation lodgepole pine/true fir forests. The Flammulated owl is suspected to occur, though it is known to occur more commonly to the east. Loss of snag habitat is the primary concern for these species. Impacts to their prey base is also a concern. Black-backed feed on wood-boring insects; flammulated owls feed on insects including lepidoptera species.

ROD guidelines should aid in maintaining the viability of these species. Guidelines include maintenance of adequate numbers of large snags and green-tree replacements for future snags. Where feasible, green-tree replacements for future snags can be left in groups to reduce blowdown. No snags over 20" dbh should be marked for cutting. Full (100%) population potential for each species must be maintained. The 100% level for black-backed woodpeckers equates to 0.12 conifer snags per acre. These snags must be at least 17" dbh or largest available and in hard decay stages. This requirement must be added to provisions for other cavity nesting species already required by the WNF LMP (1990), which requires 40% levels for the guild. This equates to 4.94 snags per acre at high elevation sites. The Wildlife Appendix describes snag requirements for primary cavity excavators in the watershed. Black-backed woodpeckers also require beetle infested trees for foraging. Some trees should be provided in appropriate habitat, and sanitation harvest of all such trees would be detrimental to the species. Riparian buffers will also aid in the maintenance of the flammulated owl population. Lepidoptera communities achieve their highest diversity in riparian area.

GREAT GRAY OWL (*Strix nebulosa*)

The GGO is a known inhabitant of the UPMAKWA. There are 8 activity centers in the watershed, including 4 historic nests. An additional 3 areas have responses and work is currently underway to determine site status. The most recent documented nest site was found in 1995 near Pebble Seed orchard. This species is most commonly found near meadow complexes on the eastside of the Cascade Crest. It may be a rare occupant of the westside. Only 15 activity centers are known on the entire WNF, the majority being in the UPMAKWA watershed. The abundance in this area may be influenced by the ability of individuals from the eastside to cross the Santiam Pass. Or, more intensive survey efforts that have occurred in this watershed may be skewing density information for the Forest. We suspect that the Santiam Pass is a dispersal corridor for this species. GGO's on the westside appear to forage in clearcut areas. Meadow complexes are widely dispersed in the landscape and do not appear to be associated with GGO known sites. Table 3-27 displays the abundance of meadow areas within varying radiuses of the known sites. Table 3-28 displays the acres of early, mid and late seral habitat within .25 miles of the sites.

Table 3-27: Meadow habitat within 0.25 miles of known great gray owl sites..

SITE NUMBER	ACRES OF NON-FOREST HABITATS
1	148.13
2	32.9
3	343.1
4	344.24
5	343.0
6	157.4
7	32.8
8	35.0

Table 3-28: Percentage of forested habitat by seral stage within 0.25 miles of known great gray owl sites.

SITE NUMBER	% EARLY SERAL	% MID SERAL	% LATE SERAL
1	0	21	77
2	15	0	83
3	28	6	66
4	16	18	65
5	63	6	31
6	77	0	23
7	42	0	57
8	37	0	49
MEAN	34	6	56

ROD S&G's were offered to specifically protect this species. Meadows within potential habitat must be buffered with 300' no harvest areas and 1/4 mile protection zones must be established around nest sites. This requirement appears to be based on ecosystems where GGO's are foraging in meadow complexes and nesting near the meadows. The GGO population in the UPMAKWA appears to forage in cutover areas. Of the 8 activity centers, meadow habitat abundance ranges from 32-344 acres within 0.25 miles of the site center. Most of these non-forested areas are small and highly scattered. No harvest zones around nest sites may protect the nest tree, but they may not adequately provide foraging habitat near the nest site if the owls are relying on early seral forested habitat created through clearcutting. Currently, an average of 34% of the habitat within a 0.25 mile radius of the GGO sites is in an early seral stage. ROD standards and guidelines may not adequately provide for continued viability of this species in this watershed because of their apparent use of clearcuts versus meadow complexes for foraging.

AMPHIBIANS

None of the amphibians listed in the ROD occur in the UPMAKWA. Riparian reserve buffers, large woody debris retention requirements, special habitat buffers, and limitations on the removal of duff layers during burning required by the ROD and WNF S&G's should adequately protect the 17 amphibian species that do occur in the watershed. An additional threat to some amphibians not covered by the WNF Forest Plan comes from introduced fish species in some high mountain lakes. Data has shown that long-toed salamanders are heavily impacted by introduced fish in high mountain lakes (Liss 1994). Undocumented impacts to other species may also be occurring. Management strategies for maintaining the native biota of the wilderness lakes should be explored.

OREGON RED TREE VOLE (*Arborimus longicaudas longicaudas*)

This species occurs in the UPMAKWA. Their remains have been found in spotted owl pellets collected by researchers with the Oregon Cooperative Wildlife Research Unit (Swindle 1995) on Blue River RD, adjacent to the watershed, and within the watershed by Al Dohmen (1990 pellet study) at the Great Springs owl site. Records from various other research projects will be checked. This species is highly associated with late successional forest patches, though recent survey efforts have also been finding nest sites in younger stands in the coast range (Biswell, personal comm.). Huff et al (1992) rated this species as the most vulnerable of the arboreal rodents to local extirpations resulting from the loss or fragmentation of old-growth forests.

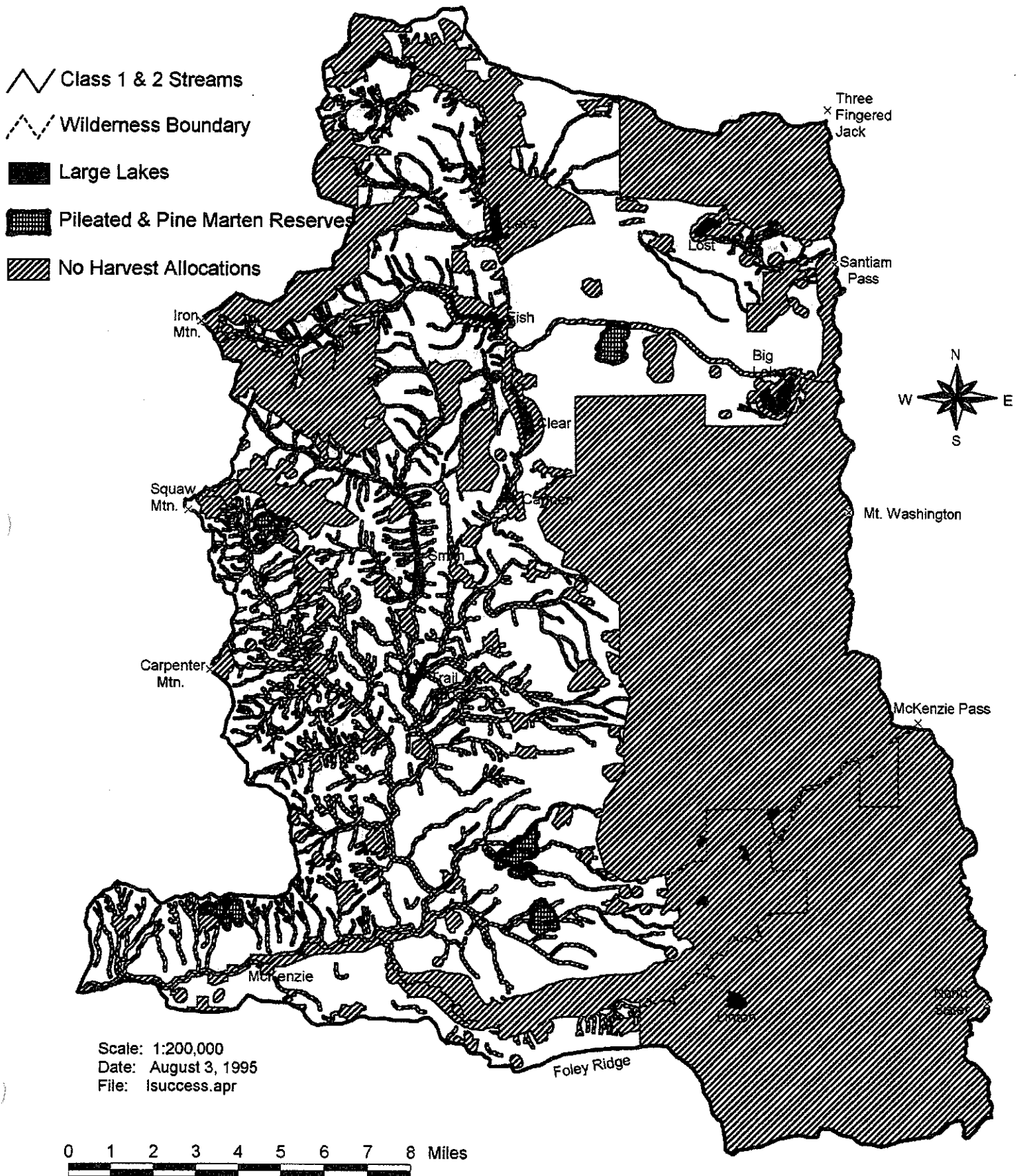
There is a likelihood they do not occupy the higher elevation vegetation series. The presence of Douglas-fir trees is a very important component of the overstory. Huff et al. (1992) described their range up to 3000' in the Central and Northern Cascade Range. However, owl pellets with voles have been found up to 4400' in the watershed. The Great Springs site is in a grand fir series, and a site on Blue River RD is in a transition area between Douglas-fir/Western hemlock and Pacific silver fir forests.

The populations are likely to be sparse in forest matrix between Late Successional Reserves in the future (Appendix J-2). The species has limited dispersal capabilities, so a fragmented matrix could limit movement between populations within Late Successional Reserves. ROD buffers for riparian areas and retention of the oldest and largest green trees in harvested areas will aid in maintaining the viability of this species by increasing the probability of successful flow through the landscape. The flow may also be facilitated by providing well distributed blocks of late successional habitat. Also, mid seral habitat should be dispersed between high quality late seral habitat over time. The LSR's are providing well-distributed, high quality patches of late successional blocks. There are several gaps, however, and recommendations for retained pileated and pine marten cores and other blocks of habitat are displayed in Figure 3-24.

The ROD also protects this species by requiring survey prior to activities and management of sites identified. It is unknown at this time what the protective measures may be for known sites. Surveys must precede the design of all ground-disturbing activities that will be implemented (contracts sold) in 1997 or later. Verification of their presence at higher elevation sites that contain Douglas-fir trees need to occur.

A habitat mapping and ranking process was described by Huff et al (1992). Time constraints and lack of data inhibited this WA team from implementing

Figure 3-24a. Potential Connectivity of Late Successional Habitat



that process. To identify high quality habitat areas, this model should be considered in the future. High quality was mapped through the guilding/Habscares process described below.

MOLLUSKS

Of the 43 mollusks listed in Table C-3 and 97 analyzed for Appendix J2, only two have a "reasonable chance" of occurring on the WNF, according to Dr. Furnish, a researcher who reviewed the list for the S. Fork Pilot Watershed Analysis process. *Prophysaon coeruleum* is a slug that occurs in relatively moist coniferous forests from low to middle elevations from south Puget Sound down into the Willamette Valley. Historic sites are now within urban areas. There are no currently known locations on the WNF. *Prophysaon dubium* is another slug that is moderately associated with riparian areas. It is also found in rockslide areas. Road building and road maintenance are potential disturbances to this species in rockslide areas. The ROD protects these species through managing known sites and conducting surveys. These surveys must be completed prior to ground disturbing activities implemented (i.e. contract sold) 1999 or later. ROD riparian reserves will provide some level of protection for these species, but rockslide areas outside of riparian zones will need to be identified and protected for *P. dubium*. Appendix J2 admits that local extirpation of these species will probably occur even with the above protective measures.

ARTHROPODS

There are four general groups of arthropods listed in the ROD Table C-3. These species occur in the southern portion of the Spotted Owl's range in southern Oregon and Northern California. They do not occur in the UPMAKWA area.

ROOSEVELT ELK

There are 25 elk management areas in this watershed, including 11 High, 10 Moderate, and 4 Low emphasis (Figure 3-25). Elk habitat is displayed in Figure 3-26. Each emphasis area has different management objectives within the WNF LMP. Wisdom model outputs for each analysis area are listed in the Wildlife Appendix. Tables 3-29a and b display emphasis areas that are currently not meeting the LMP objectives. The location of these problem areas are shown in Figure 3-25.

Table 3-29a: High Emphasis Elk areas that are not currently meeting LMP objectives. (x indicates model value below LMP objectives)

EMPHASIS AREA	HEs	HEc	HEc-w	HEf	HEr	HEi
Kink		x	x	x		x
Anderson/Olallie		x	x	x		
Norwegian/Twisty		x	x	x		
Boulder		x	x	x		
Scott		x	x	x		
Hackleman			x	x	x	x
Ikenick/Gate				x		
UW McK/Fritz/Bunchgrass		x	x	x	x	
Florence/Mill				x	x	x
N.FK Parks				x	x	
Browder				x		
Maude				x	x	

Table 3-29b: Moderate Emphasis Elk areas that are not currently meeting LMP objectives. (x indicates model values below LMP objectives)

EMPHASIS AREA	HEs	HEc	HEf	HEr	HEi
Old Squaw/W&E Brush				x	
Budworm/Frissel			x		
Frost			x		
Hoodoo		x			x
UN Santiam			x		
W.Branch	x	x			

Biologists using the Westside elk model are concerned about how well it actually reflects elk habitat. Elk numbers continue to rise in this area. This Unit has the highest bull to cow ratio on the westside even with low HE values. The ability of managers to effectively make change to model results varies depending on the index. Low HEr values can be increased to meet LMP objectives through closing of roads. The majority of areas where HEr is low are currently being reviewed as part of road management plans. Low HEf values will be more difficult to change in the future, and model outputs may not be accurately reflecting the availability of forage on the landscape. Fewer areas will be clearcut and more areas will be thinned. Burning and fertilizing are also being used less frequently. Model inputs need to be changed to reflect the management that will occur in the future. Strategies to maintain forage on the landscape could include permanent forage areas and wider thinning of plantations. Low HEc values will also be difficult to change. A flood of low quality hiding cover will effectively

Figure 3-25. Big Game Emphasis Areas with Winter Range & Problems Identified

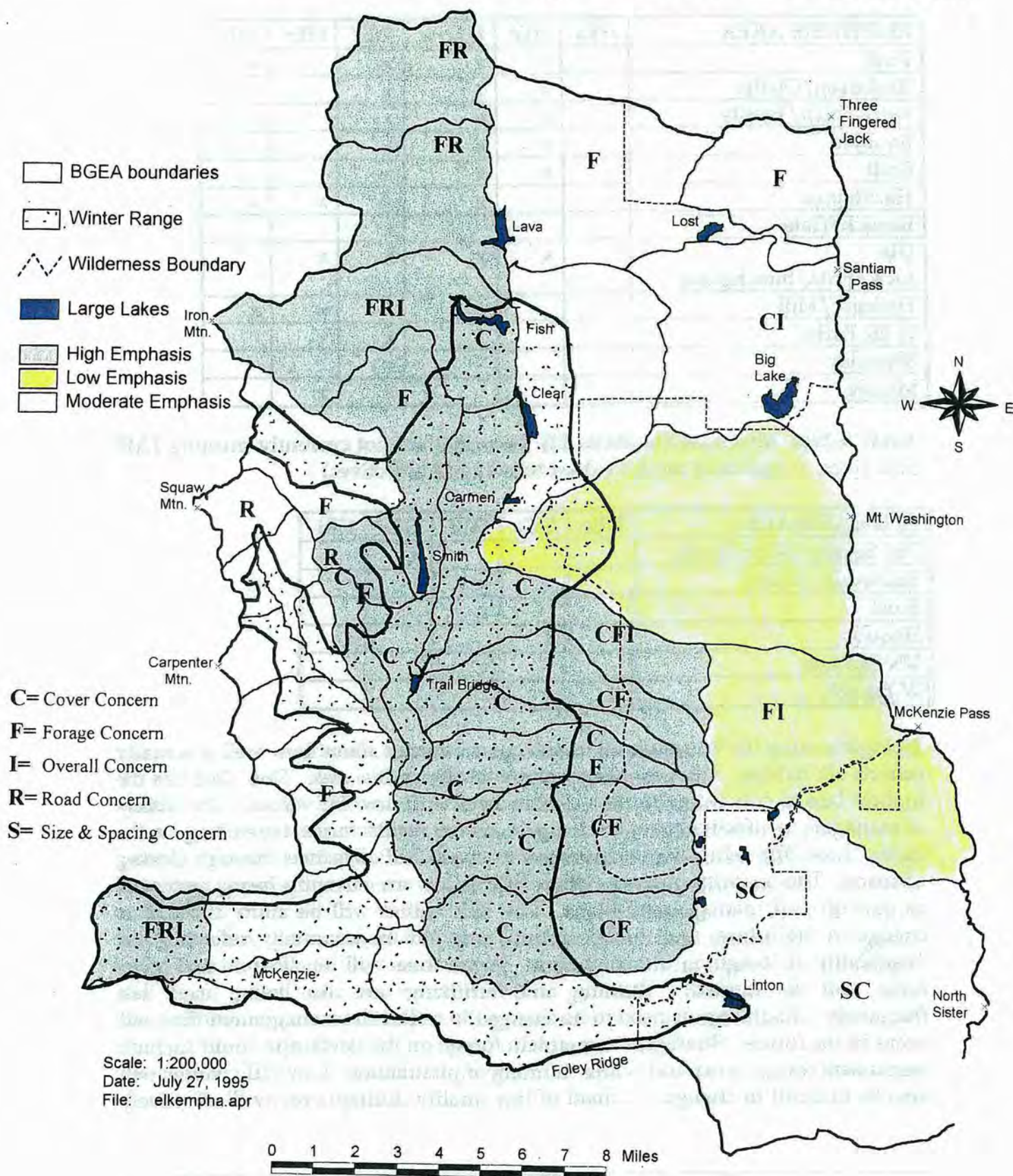
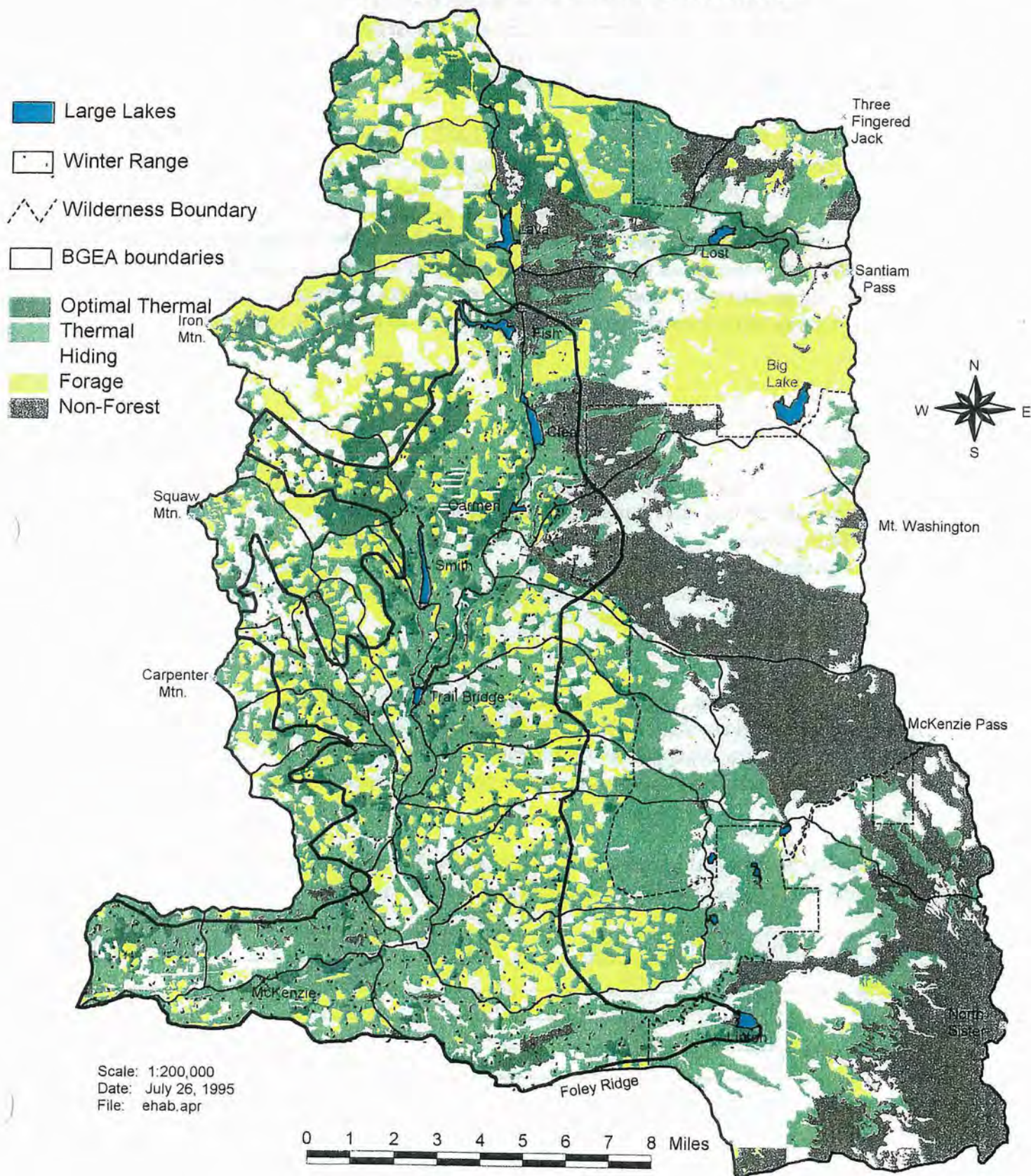


Figure 3-26. Elk Habitat with Big Game Emphasis Areas Outlined



wash out the value of the optimal cover within the next 5 years according to the model. Maintenance of blocks of late successional forest within the emphasis areas while the low quality cover succeeds into thermal cover will be important. Areas such as Hoodoo (Landform block 5) and the flat country (LFB 3) probably will never be able to attain the target HEc values because of the forest types in these areas. HEs values are generally within LMP guidelines.

As additional roads are closed to attain LMP HER objectives, concern from hunting groups on the accessibility to hunting areas continues to grow. Elk and deer hunting is a primary recreational activity in the watershed in the fall. High open road densities are known to result in increased poaching. Figure 3-27 shows that the majority of the watershed is accessible within 0.5 miles of an open road. Scattered core areas that require greater than a 1.0 mile hike from an open road do occur, but they comprise a minority of the landscape. Education to highlight areas with accessibility will be necessary to alleviate concerns from the public.

WILDLIFE GUILDS

The Willamette National Forest utilized a process developed by Mellen et al. (1994) for identifying and mapping habitat for wildlife guilds at a landscape scale. The process was applied to the WNF landscape. A description of the guilds is listed in the Wildlife Appendix . The following is an analysis of the results for terrestrial and special habitat guilds. Riparian guilds were discussed in the Riparian Habitat-Wildlife Section.

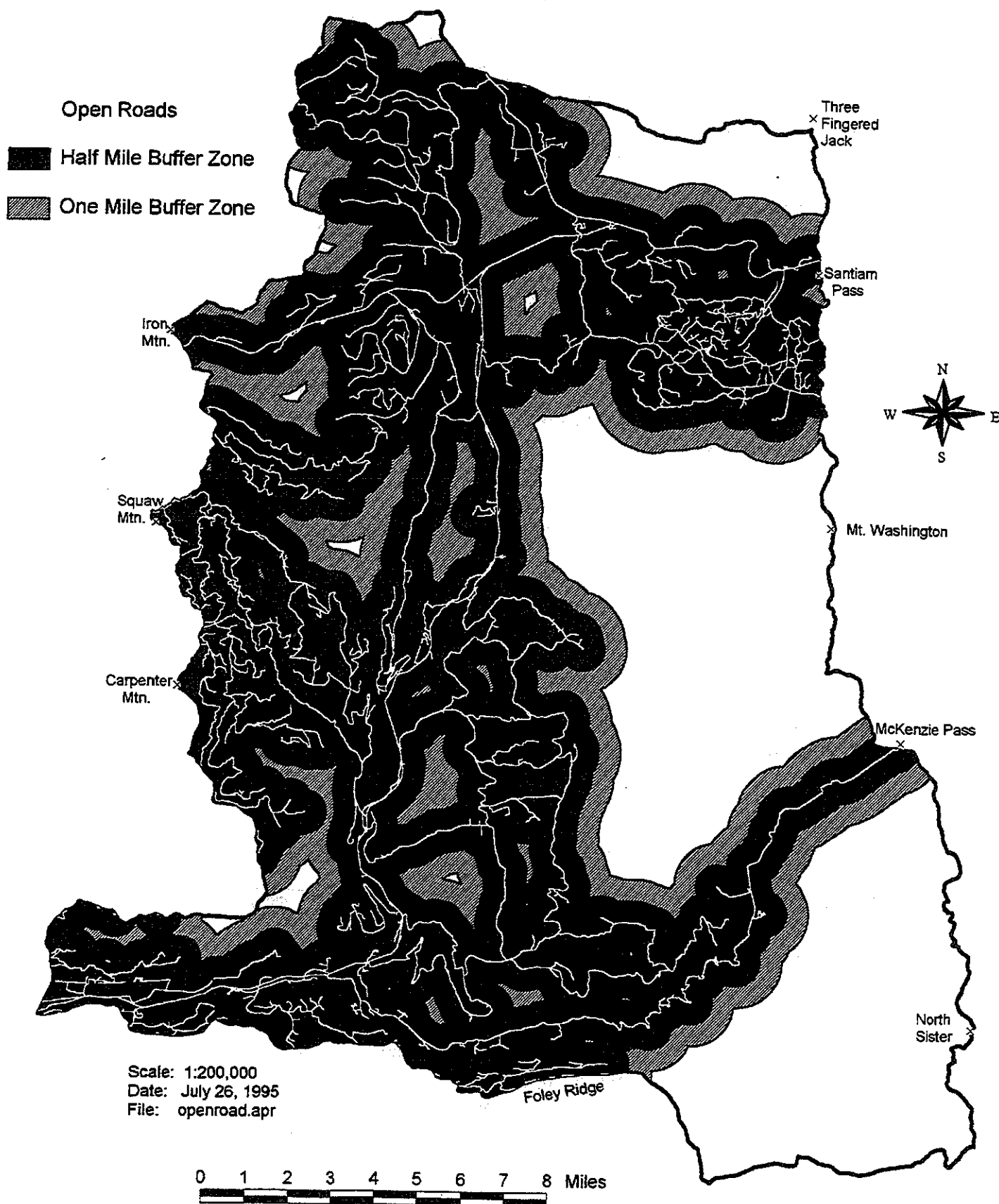
Early Seral Species

There are 43 species in the watershed (15%) that based on life history information use early seral habitat as primary breeding and/or foraging habitat. These species were lumped into 4 guilds listed in Table 3-30. The amount of quality habitat currently on the landscape for these species is also listed Table 3-30.

Table 3-30: Early seral species in the UPMAKWA landscape and the percentage of the total early seral habitat available classified by quality.

GUILD	# SPECIES	HIGH	MEDIUM	LOW	NONSUIT
TLME	3	24	2	22	53
TMME	2	31	1	26	42
TSME	14	91	0.06	1	8
TSPE	24	87	———	———	13

Figure 3-27. Areas Accessible for Hunting
Within 0.5 & 1.0 Mile of Open Roads



Currently early seral habitat comprises 34,582 or 15% of the watershed. The majority of the early seral habitat is suitable small and medium home range species and patch species based on patch size and distribution on the landscape. Most early seral species are in these guilds. Less than half of the early seral habitat is suitable for large home range species. This is a reflection of the low density of early seral patches in the wilderness area of the watershed. In matrix lands, the majority is suitable. None of the species in these guilds require large patches of early seral habitat.

It is unknown whether the amount of available habitat is adequate to maintain viability of these species. Also, the majority (roughly 80%) of this habitat type is currently lacking structural components (snags and down woody material) critical for successful reproduction of all of the species in these guilds. This fact reduces the potential species' richness and population levels within early seral forests currently on the landscape.

Early seral forest has been created almost exclusively through timber harvest in the past 40 years, with the exception of the Big Lake Burn. A mean of 720 acres per year has been produced in the UPMAKWA. This is expected to decline in the future under Option 9 to 300 acres per year. Viability analysis is needed to determine impacts to early seral species. The availability of structural components in future early seral stands is critical to maintain viability of these guilds on the landscape.

Mid Seral Species

There are no species in the watershed that use mid-seral habitat as their primary habitat for breeding and/or foraging. There are species, however, that can use early and mid (5) or mid and late (11). Because these species can use more than one habitat type, they have been classified as generalists. The availability of habitat for these species is summarized in Table 3-31.

Table 3-31: Habitat for species that can use a combination of early and mid patches or mid and late seral patches in the UPMAKWA landscape and the percentage of the habitat available classified by quality.

GUILD	# SPECIES	HIGH	MEDIUM	LOW	NONSUIT
TSGML	11	44	.01	.08	44
TSGEM	5	98	.02	.003	2.3

Currently mid and late seral habitat comprises 148,372 acres or 64.3% of the watershed, and the majority is of high quality in terms of patch size and distribution. The patches appear to be well-distributed throughout the landscape. Early and mid seral habitat comprises 97,634 acres or 42.3% of the watershed. The majority is suitable, though the discussion on missing structural

components described above for the early seral species applies here as well. Species with the plasticity to use mid and late seral habitat generally require structural elements of snags, large green trees, and large down material to maximize potential use by mid seral habitat. Approximately 80% of the existing mid seral stands have been created from historic fires, with the remainder a product of clearcutting. We estimated that structural elements are present in approximately 40-60% of the mid seral stands in the UPMAKWA. To provide for the highest potential species richness in the mid seral stands, structural elements will need to be present.

Late Seral Species

There are 12 species in the watershed (4%) that based on life history information use late seral habitat as primary habitat for breeding and/or foraging. These species were lumped into 3 guilds listed in Table 3-32. The amount of quality habitat currently on the landscape for these species is also listed Table 3-32.

Table 3-32: Late seral species in the UPMAKWA landscape and the percentage of the habitat available classified by quality.

GUILD	# SPECIES	HIGH	MEDIUM	LOW	NONSUIT
TLML	6	48	7	36	10
TMML	2	73	4	17	6
TSPL	64	97	—	—	3

Currently late seral habitat comprises 85,321.21 acres or 36.9% of the watershed. The majority is high quality in terms of patch size and distribution. This habitat type appears to be well-distributed throughout the landscape. Approximately 16% of the high quality LS habitat for these guilds is in Wilderness. An additional 17% is in other no-harvest allocations (not including LSR's or riparian reserves, and 5% is in LSR's, for a total of 38% is in no harvest allocations prior to including riparian reserves.

These species do not require large contiguous tracks of late successional habitat. They are either mosaic species (goshawk, spotted owl) or patch species (red tree vole, brown creeper). The viability of the large home range, mobile, mosaic species is moderate to high under Option 9 (FEMAT 1994). Concerns exist for the low mobility patch species, such as the red tree vole, and managing the landscape to provide high probability of flow is important to maintain their viability (see red tree vole discussion).

Contrast Species

There are 14 species in the watershed (5%) that based on life history information use edge habitat between early seral and other older forests as primary habitat

for breeding and/or foraging. These species were lumped into 3 guilds listed in Table 3-33.

Table 3-33: Contrast species in the UPMAKWA landscape and the percentage of the habitat available classified by quality.

GUILD	# SPECIES	SUITABLE	NONSUIT
TLC	7	16	84
TMC	4	16	85
TSC	3	10	90

The majority of the watershed is not providing edge habitat, but what is available is well-distributed, with the exception of the wilderness areas to the east. This distribution of this habitat is not expected to significantly change in the future, however the abundance will decline as less early seral habitat is produced under Option 9. Viability analysis for these species should occur to determine the amount of habitat required to maintain these populations.

Generalist Species

There are 115 species in the watershed (39%) that are considered generalists. They can use several different seral stages as primary habitat for breeding and/or foraging. These species were grouped in 3 guilds: TLGG (9 species), TMGG (20 species), and TSGG (86 species). These species can be found throughout the watershed. In general, there are few concerns for the viability of these species within the watershed now or in the future. Management strategies that retain structural elements within all seral stages and provide a diversity of forested habitats throughout the landscape will benefit these species. Ninety-six percent of these species use snags for breeding, and 84% use large woody debris.

Special Habitat Species

There are 27 species in the watershed (9%) that are highly associated with special habitats. Wetlands, caves, meadows, and p provide habitat for the majority of these species. The presence of these habitats is described by Landform block in Chapter 4. Special habitats are protected through S&G's in the WNF LMP and ROD. Threats to these ecosystems currently include spelunking, grazing, and off-road vehicles. Specific threats are described in the Landform block section. The majority of the special habitats within the watershed are not at risk to loss of integrity. Flow between these habitats is required over time to ensure genetic diversity. Landscapes between special habitats should be managed over time to provide for flow. This can be accomplished through canopy closure maintenance, contiguous areas with large woody debris, and protected riparian areas.

OVERVIEW OF BOTANICAL RESOURCES

Non-Forest Habitats

Non-forested habitats (special habitats) contribute to the exceptional floristic richness and biodiversity found within the Upper McKenzie watershed. Special habitats range from very wet to seasonally dry meadows, bogs, rock outcrops, lava fields to extensive alpine and subalpine plant communities. Certain plant communities associated with these special habitats are losing species diversity and or habitat characteristics. This is due to past harvest activities, encroachment of surrounding forests, livestock grazing and the introduction of non-native plant species. Forestwide standard and guideline FW-211 assures protection for these habitats and for their continual contribution to landscape biodiversity. Most rare and uncommon plant species (as defined by the Regional Foresters' Sensitive Species list) occur in non-forested habitats. Six rare plant species on the Region 6 Sensitive Plant List are located in the watershed. Ten plant species on the WNF Review or Watch Lists and eight species on the Concern list occur in the watershed. The variety of habitats that occur over the range in elevation in the watershed provide habitat for twenty-four sensitive species to occur. Special habitats and rare plants are discussed in the Landform Block Section.

Rare Plant Associations

Several rare plant associations have been identified in the Upper McKenzie watershed (Botany Appendix). The distribution and occurrence of these and other uncommon forested plant associations contribute to the biological and ecological diversity of the watershed. These communities may reflect unusual environmental conditions or be at the northern or southern extent of their range (Dimling and McCain 1993). Plant associations are considered "rare" if they are known from only five or fewer sites on a district. Plant associations are considered "uncommon" if they are known from only 6-11 sites on a district. Field surveys are needed to verify plant association rarity. Rare forested plant associations are treated as special habitats and should be maintained as recommended in the Special Habitats Management Guide (WNF 1993).

ROD C-3 Plants

The watershed contains eighteen species of fungi, lichens, and vascular plants listed in the ROD Table C-3 (USDA and USDI 1994). These "survey and manage" species of fungi, lichens, bryophytes and vascular plants are most commonly associated with late-successional forests and are valued as indicators of biodiversity, stability, and forest health. Late seral forests make up 36.9% of the forested acres within the watershed. Of that, 33% is in no harvest allocations. In general, late seral habitat including Late Successional Reserves, is fairly well distributed across the landscape. There are several gaps where connectivity

would improve by adopting the recommendation for additional pileated woodpecker/pine martin areas or other blocks of habitat (see wildlife section).

Many of these species have poor dispersal capabilities and are unable to move across large landscapes of younger stands. Unsuitable habitat in fragmented areas may prevent gene flow and expansion of species. More old forest species are found in younger forests adjacent to older forest than in isolated young stands, (Petekin and Game 1984). In addition, some species are slow to establish in rapidly growing young stands.

The vascular plant, *Allotropa virgata*, a Table C-3 species, is found in sixteen sites in three conifer series: western hemlock, Douglas-fir, and grand fir plant associations (Botany Appendix). *Allotropa virgata* is the only species in its genus. It is an achlorophyllous, mycotrophic plant that tends to be found in dry soils, with a duff layer and coarse woody debris. Although it occurs more frequently in late-successional forests it has been found in conifer stands of various seral stages. *Allotropa* obtains its nutrients from its association with mycorrhizal fungi and a broad range of photosynthetic host species. The life cycle of this complex plant allows it to remain dormant underground for unknown periods of time. It may remain dormant until specific environmental conditions exist. It is unclear the effect fire has on the life cycle of this species. It occurs in stands that have had a history of frequent fire return intervals. Thinning may be detrimental to this species because it can result in increased competition from understory vegetation, reduces coarse woody debris, and may result in mechanical disturbance to the ground (Holthausen et al. 1994). The common name for *Allotropa* is "candystick," which accurately describes its brilliant red-on-white stripes stems. Activities that are implemented in 1995 must include provisions for these known sites.

Habitat for many of the Table C-3 species require large amounts of coarse woody debris and standing dead trees. Species diversity for the majority of these species appears highest in late-successional forests due to the diversity of habitat structures, host species, and large amounts of duff and down material. Species viability will benefit from harvest practices that allow for the retention of clumped green trees of various sizes and structural diversity, large amounts of coarse woody debris and minimizing soil compaction during harvest activities. Potential habitat exist in the watershed for 242 Table C-3 species to occur (Botany Appendix). Additional issues and species are discussed in the Landform Block Section.

Noxious Weeds

Introduced noxious weeds and other invasive non-native plant species are present in the watershed. Plant species abundance and distribution varies from

isolated plants to large well established populations. Species found in the Upper McKenzie watershed are located along state highways, forest roadsides, landings and in clearcuts, along trails, campgrounds, and non-forested habitats. Forest roads and Highways 20, 22 and 126 are conduits for continual weed dispersal and expansion. Noxious weeds and non-native species are introduced by timber harvest activities, recreational vehicles, and equestrians. Routine road maintenance and construction activities contribute to the spread of weeds through continued ground disturbance, seed spread by the use of mowers, road equipment and contaminated rock and fill material. Most weed species become establish as a result of a soil disturbance activity, either natural or artificial. Once established species are able to persist and reproduce with little competition from native vegetation.

ODOT uses 40 to 50 thousand cubic yards of volcanic cinders in the Santiam Pass area each year. About 40% of that amount is distributed within the Upper McKenzie watershed of which 10 to 15% is recovered and reused. The cinders generally fall within 100 feet of the highway edge. The application of the cinders inhibits most seed germination and growth of vegetation on the highway shoulders. However, some amount of noxious weed and other non-native plant seeds lodge in the cinders, germinate and reproduce thereby expanding the species along the highway. Most native plant species are unable to compete with the aggressive growth of noxious weeds and other non-natives. The application of cinders may provide easy establishment of these species at the exclusion of native vegetation.

Six noxious weeds and twenty-six non-native species occur in the watershed (Botany Appendix). The noxious weed spotted knapweed (*Centaurea maculosa*) is the most serious threat to native plant populations within the watershed. Spotted knapweed has a broad ecological tolerance, prolific growth and seed production. It is spread primarily by vehicular traffic and has quickly become established along Highway 20 and 126. The Integrated Weed Management Plan Environmental Assessment (WNF 1993) outlines the control strategies for noxious weed species found on the Forest. Control methods used in the watershed include manual removal and mowing, release of beneficial insects that feed on the seedheads of specific noxious weed species, and the selected use of the herbicide rodeo. Currently, biological control agents are used on six noxious weed species. In 1995, populations of spotted knapweed and dalmation toadflax were treated with the herbicide rodeo in accordance with the guidelines in the Integrated Weed Management Plan Environmental Assessment (WNF 1993).

OVERVIEW OF VISUALS

The Willamette National Forest Land Management Plan (LMP) has assigned Visual Quality Objectives (VQO's) for each Management Area (MA) on the Forest. Management of scenic resources are emphasized within the viewsheds, though some allocations with visual quality objectives are located outside the viewsheds. The Upper McKenzie is the location of a confluence of three viewsheds, the McKenzie viewshed, South Santiam Highway viewshed, and the North Santiam Highway viewshed.

Table 3-34 and 34a display information on the existing condition of visual allocations within these viewsheds. Management area 11f within the North Santiam viewshed is currently exceeding the rate of harvest for this management area. Assumptions in this analysis were conservative and a closer look at this area may indicate that harvest activities are consistent with the Forest Plan. This analysis assumed that it would take all stands 20 years to recover from any harvest activities. Some stands will recover faster. All other harvest activities are currently consistent with Forest Plan standards regarding the rate of harvest and percentage of the area allowed to be in a disturbed condition within one decade.

All land allocations designated in the Forest Plan have visual quality objectives with the exception of those allocations recently adapted as a part of the amended Forest Plan. Many allocations allow no harvest and therefore require little monitoring to assure VQO's are being maintained, and so are not displayed here.

Table 3-34: The five Visual Quality Objectives represented within the Upper McKenzie Watershed.

VQO	ACRES	PERCENTAGE
P - PRESERVATION	62,157	34
R - RETENTION	27,053	15
PR - PARTIAL RETENT.	25,069	14
M - MODIFICATION	6,169	3
MM - MAX MODIFICAT	64,985	35

The acres represent only forested land, and do not include lakes and non-vegetated areas. Currently there is no inclusion of Late-Successional Reserve in this analysis, nor is there a VQO assigned yet to that allocation.

Stand ages were used to assume "Existing Disturbed Condition". There are some assumptions within that analysis that can influence results. For example the

height of a lodgepole stand at 20 years would be different than a Douglas-fir stand, but this analysis treats both the same.

Table 3-34a: Existing Visual Condition in viewsheds within the Upper McKenzie Watershed.

McKenzie Viewshed

Mgt Area	Vqo	Harvest Rate Objective	Maximum Disturbed Condition	Existing Disturbed Condition	Seedlings Saplings Ages 0-20	Poles Ages 20+ 5.0-8.9" dbh
10B	Partial Ret.	7%	14%	13.1%	1,270.01	1,210.25
11A	Mod	12%	24%	21.0%	1,058.88	1,015.44
11C	Partial Ret.	10%	20%	13.1%	1,585.91	2,481.05
11E	Retention	7%	14%	3.6%	316.27	607.92
11F	Retention	5%	10%	5.6%	326.08	504.39
14A	Max. Mod	13+%	26+%	18.8%	4,367.02	3,233.53
6D	Retention	2%	4%	0.6%	24.76	173.88

Mgt Area	Larger Trees 9"+ dbh	Non-Forest
10B	7,189.23	3,379.96
11A	2,979.08	117.76
11C	8,083.02	577.43
11E	7,784.85	572.29
11F	5,044.76	840.01
14A	15,591.800	469.15
6D	3,814.000	277.79

North Santiam Highway

Mgt Area	Vqo	Harvest Rate Objective	Maximum Disturbed Condition	Existing Disturbed Condition	Seedlings Saplings Ages 0-20	Poles Ages 20+ 5.0-8.9" dbh
10B	Partial Retention	7%	14%	16.7%	3.63%	0.00
10D	Retention	5%	10%	3.9%	5.85	0.00
11A	Mod.	12%	24%	24.1%	4,257.92	3,527.22
11C	Partial Retention	10%	20%	14.3%	1,789.57	3,173.47

Mgt Area	Vqo	Harvest Rate Objective	Maximum Disturbed Condition	Existing Disturbed Condition	Seedlings Saplings Ages 0-20	Poles Ages 20+ 5.0-8.9' dbh
11D	Partial Retention	7%	14%	9.3%	188.05	32.96
11F	Retention	5%	10%	14.8%	1,051.92	823.71
14A	Max. Modification	13+%	26+%	31.2%	2,562.79	1,668.17

Mgt Area	Larger Trees 9'+ dbh	Non Forest
10B	18.14	0.00
10D	143.30	37.77
11A	9,865.05	374.24
11C	7,525.53	558.45
	1,791.97	27.76
	5,209.76	440.12
	3,979.94	112.19

South Santiam Highway

Mgt Area	Vqo	Harvest Rate Objective	Maximum Disturbed Condition	Existing Disturbed Condition	Seedlings Saplings Ages 0-20	Poles Ages 20+ 5.0-8.9' dbh
11A	Mod	12%	24%	12.6%	2,134.67	2,511.77
11C	Partial Retention	10%	20%	14.5%	560.76	610.63
11D	Partial Retention	7%	14%	5.2%	21.54	0.00
11F	Retention	5%	10%	8.1%	588.91	905.64
14A	Max. Mod	13+%	26+%	23.9%	941.59	1,128.91

Mgt Area	Larger Trees 9'+ dbh	Non-Forest
11A	12,336.14	251.61
11C	2,706.83	18.32
11D	391.53	1.23
11F	5,783.24	191.41
14A	1,862.15	38.72

OVERVIEW OF AIR QUALITY

Fire history for this area was documented by Constance Burke in her thesis "Historic Fires in the Central Western Cascades." The study included nearly all of area covered by the Upper McKenzie watershed analysis (Burke pg. 16). Her work indicates that larger fires were more common during the latter half of the 19th century than they have been in recent decades. These large fires were primarily human caused and occurred along travel routes across the Cascades. The lightning fire pattern was difficult to identify, because thunderstorms are accompanied by varying amounts of rain.

Her text cites newspaper articles, records of investigations by the General Land Office, detailed field notes of the original cadastral surveys and other reports and mapping efforts. Statements were made indicating that "Every fall... fires occurred in many different localities so that the air was heavy with smoke." Along the Columbia River "The smoke is so thick along the river, that objects can be seen but a short distance." There are other quotes similar to these in her thesis that provide additional substantiation to the occurrence of a large fire.

A 1993 white paper prepared by the Regional Ecosystem Assessment Project team quantifies the average annual amount of PM-10 particulate released and acres burned for the historical period and the current situation. Table 3-35 approximates the findings for Western Oregon.

Table 3-35: Average annual acres burned and PM-10 emissions for historic and current time periods.

	<u>Historic</u>	<u>Current</u>
PM-10	13 million lbs	5 million lbs
Acres Burned	40000	15000

The Clean Air Act standards for allowable levels of particulates were set by the Environmental Protection Agency. They are called the National Ambient Air Quality Standards (NAAQS). The smoke from burning forest slash contains several kinds of particles that are regulated by NAAQS standards. The standard is best described by PM-10 (particles 0 - 10 microns in size).

The state standard of allowable level of TSP (total suspended particulate) is not to exceed an annual geometric mean of 60 micrograms per cubic meter of air, and not to exceed 150 micrograms in a 24-hour period. The allowable level of PM-10 is not to exceed 150 micrograms of pollutant per cubic meter of air per 24-hour period or an annual arithmetic mean of 50 micrograms per cubic meter.

These standards are for designated urban areas such as Eugene-Springfield and for wilderness areas.

The Clean Air Act directs Federal agencies to comply with state and local regulations designed to prevent and control air pollution. The State of Oregon has been delegated authority for attainment of standards set by the Clean Air Act. To do this, the state developed the Oregon Smoke Management Plan. The Forest Service has adopted this plan for national forest lands in Oregon.

The Oregon Smoke Management Plan and Oregon Visibility SIP (State Implementation Plan) have a number of requirements to meet Clean Air Act standards. The requirements include reducing the amount of smoke produced and reducing the smoke's impact on designated areas and wilderness areas. They have encouraged a variety of measures to reduce smoke emissions.

Designated smoke sensitive areas are established by the Oregon Smoke Management Plan. These are principal population centers and Class I airsheds, which include wilderness areas and other smoke sensitive airsheds. One purpose of the Smoke Management Plan is to protect air quality in these high priority areas. For the Upper McKenzie watershed, the closest designated areas are Eugene, 60 miles to the southwest and Bend, 45 miles to the southeast. The Class I airsheds are Mt. Jefferson Wilderness (north of Santiam Pass), Mt. Washington Wilderness (south of Santiam Pass), and the Three Sisters Wilderness (on the east side of the Upper McKenzie watershed analysis area).

The Oregon Department of Environmental Quality (DEQ), in cooperation with the State Forester, sets the daily limit on tonnage of woody debris that can be burned. The limit is adjusted each day, depending on weather conditions such as wind direction and inversions, and burning conditions such as fuel moisture, in order to meet standards for particulates and visibility. A forecaster issues the daily burning instructions. As an example, a typical day's instructions might restrict burning in the Cascades to units 500 tons or less, at least 10 miles apart.

Oregon's smoke management plan encourages slash burning to be done in spring when possible, with higher fuel moistures reducing the amount of smoke produced. Forest managers are encouraged to use alternatives to broadcast burning whenever possible. The Oregon Visibility SIP allows only limited smoke production from July 1 to September 15 in the Cascades, to ensure that visibility will be protected during the summer recreational season. The burning that is allowed is limited to research burns, hardwood conversion and some burning above 5000' elevation with Class I areas treated as "smoke sensitive" areas.

In addition to following the daily burning instructions, McKenzie Ranger District verifies the upper wind speed and direction locally on the day of

burning. Verification is done by releasing and tracking a balloon filled with a measured amount of helium. It is tracked with a theodolite, and observations are taken at one minute intervals. Smoke generated is monitored by fire lookouts, on-site observations, and through aerial observations when possible.

Air pollution has exceeded NAAQS standards in some communities during the winter. These communities are called non-attainment areas. The non-attainment area closest to the Upper McKenzie watershed is Eugene-Springfield. According to state meteorologists, 78% of the winter air pollution is from woodstove smoke, with prescribed burning smoke contributing less than 5% of the problem. However, DEQ has established some restrictions on pile burning during winter. These restrictions include no burn days if weather conditions could cause a smoke intrusion into affected communities. Other restrictions include monitoring burns for at least 3 days with requirements to extinguish if smoke affects the non-attainment areas; and prohibitions on new ignitions when woodstove use is prohibited because of excessive particulates. Table 3-36 displays the available data from the USFS IMPROVE Protocol Site, Three Sisters Wilderness (THSI). This is an air quality monitoring station operating on McKenzie Ranger District.

Table 3-36: Means of 4-hour* visual air quality (filtered data) expressed in $b_{scat}(km^{-1})$ and distribution of PM-10 concentrations (expressed in micrograms/cubic meter).

Means of 4-Hour Visual Quality

Period	Mean cleanest 20%	of Mean of all data	Mean of dirtiest 20%	Cumulative Frequency 50%
12/1/93- 2/28/94	0.013	0.021	0.035	0.018
3/1/94- 5/31/94	0.015	0.029	0.051	0.025
6/1/94- 8/31/94	0.017	0.038	0.074	0.031
9/1/94-11/30/94	0.017	0.029	0.050	0.025

*The results of the 24-hour data were identical to the 4-hour data

Distribution of PM10 Concentrations

Period	Arithmetic Mean	Minimum	Median	Maximum
6/15/94- 8/31/94 standard	14.60 50 per 24 hour period	4.22	14.10	23.00

CHAPTER 4

LANDFORM BLOCK ANALYSIS

INTRODUCTION

Wilson's 1981 "Landforms of the McKenzie River Basin" was the basis for most of the geomorphology interpretation of this watershed. His study divided the area into ten "Land Systems," which delineated landforms based on geological origin and process.

For the purposes of the Upper McKenzie analysis, the watershed was stratified into Landform Blocks similar to Wilson's system. The WA stratification went beyond hydrologic and geologic characterizations, however, to include vegetation patterns, fire behavior, valley segment types, and fish and wildlife habitats (Figure 4-1). The stratification allowed for more detailed discussion of the resources at a smaller scale. The following chapter discusses resources within each landform block.

LANDFORM BLOCK 1:

MCKENZIE BRIDGE GLACIAL VALLEY (Glacial Valley System of Wilson 1981)

Introduction

The western-most portion of the Upper McKenzie Watershed is confined by two east-west trending ridges. The Lookout ridge lava flows to the north, which are 6.3 to 8.8 million years old (Avramenko 1981, Preist et al. 1988) are part of the Early High Cascade ridge-capping basalts overlaying the Western Cascade slopes. Foley Ridge to the south is 2.1 to 4.0 million years old (Flaherty 1981) and is composed of younger, Late High Cascade lava flows. Foley Ridge represents inverted topography, whereby eruptions from early High Cascade volcanoes filled the ancient valley. The valley was subsequently eroded by glaciation and fluvial action, leaving the "intracanyon" lava flows perched on the base rock of the Western Cascades as ridge-capping basalts (Van Dusen 1962, Jan 1967).

This reach of the mainstem McKenzie is the point at which the river course changes from north-south to east-west. It is also where the ancestral McKenzie breached the High Cascade fault escarpment and lost elevation near Belknap Hot Springs. These hot springs lie in a north-south trending position along the North Santiam fault zone with other structurally controlled Cascade hot springs such as Foley, Cougar, McCredie, and Bagby hot springs (Figure 4-2).

Figure 4-1. Landform Blocks & Streams

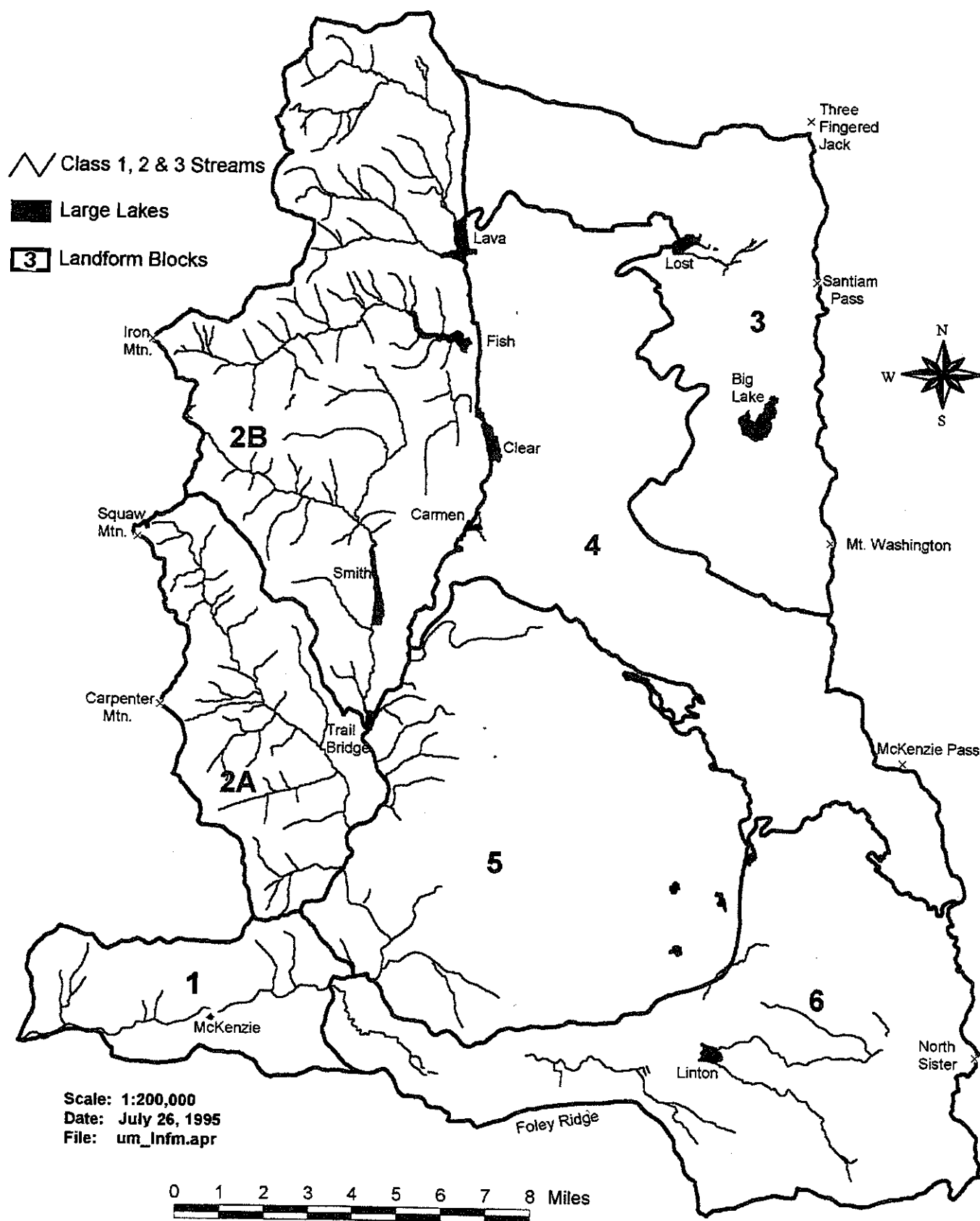


Figure 4-2: Landform Block 1 Locator Map

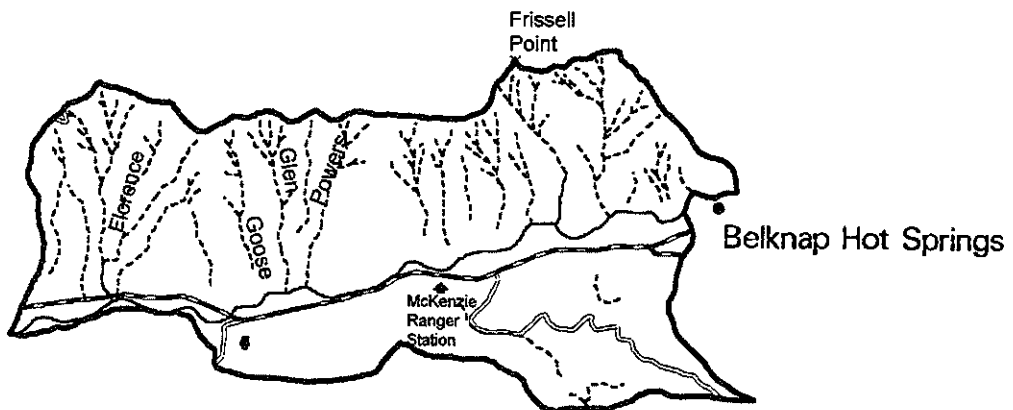
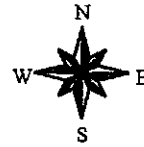
Page 3

Arterials
Collectors

Class 1 & 2 Streams

Class 3 & 4 Streams

Lakes



Scale: 1:126,720
Date: July 26, 1995
File: block1.apr

0 1 2 3 4 5 6 7 8 Miles

Disturbance History - Mass Wasting

The typical U-shaped valley of post-glacial landforms is not entirely evident in this section. Mass wasting and fluvial processes have re-filled the valley through valley side-slope stress relief failures, debris avalanches, and glacial-fluvial terrace deposits (Williamson 1987).

Landform Block 1 is susceptible to natural failures because upslope streams saturate the glacial terraces on the north side by the upslope streams. There is also high debris avalanche potential on Lookout Ridge (above the glacial terraces) and on the south side Foley Ridge because of the steep slope angles. Debris failure transport occurs over a long segment of this stream because most of the 4th order streams confluence at an angle greater than 70 degrees. Active landslides are obvious, and the area contains two of the road related slope failures in the watershed (Figure 4-3 and 4-4).

Landform block 1 contains SRI Units 3 and 235 potentially on all slopes; and Units 16, 301, 310U, 610U, and 71 on slopes greater than 70%.

Disturbance History: Fire and Vegetation Patterns

The forested vegetation of this block is mostly Douglas-fir (PSME) and western hemlock (TSHE) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these series, see the Upland Vegetation section of Chapter 3.

The typical wind pattern in this block is westerly, up slope, and up canyon. The wind is predictably erratic at the east end of the block where Lost Creek joins the McKenzie River. The landform channels the east winds, resulting in a stronger flow above 2000'. Historically fires were medium-sized, moderate-intensity, and fairly frequent. Large-sized, high-intensity, stand-replacing fires of intermediate frequency also occurred. These historical disturbances resulted in a forested landscape comprised of a mosaic of medium and large-sized patches. The majority of the forested stands are currently less than 200 years, with trees less than 150 years old common. Fires appeared to have often originated on ridgetops, moving down and across the slope.

The topography of the block greatly influences the flow of fire and the subsequent vegetation patterns. The south aspect of the block is a long rise that extends from the river valley to the ridge top (Lookout Ridge to Frissell Point). The face is dissected by both dry and wet drainages. This type of topography typically promotes large-sized fire. The north aspect of the block along Foley Ridge receives less direct sunlight, staying damper than the area north of the river. This results in lower intensity fires and smaller patches sizes.

Figure 4-3. Landform Block 1 Unstable & Potentially Unstable Areas

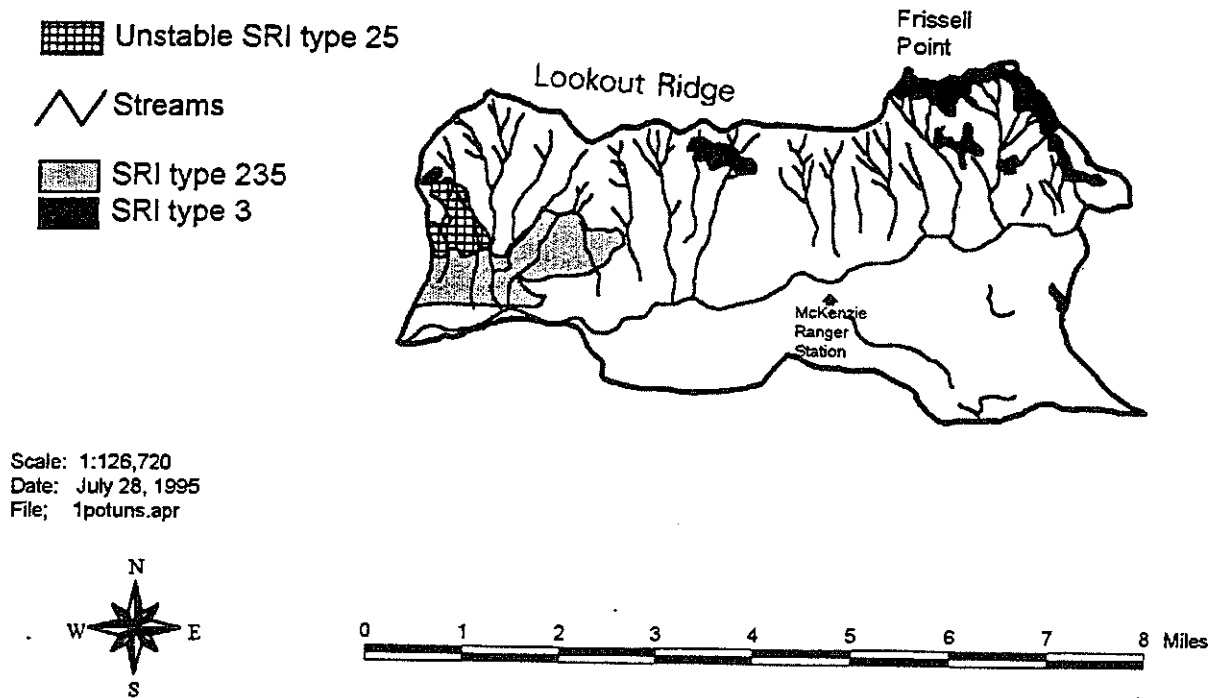
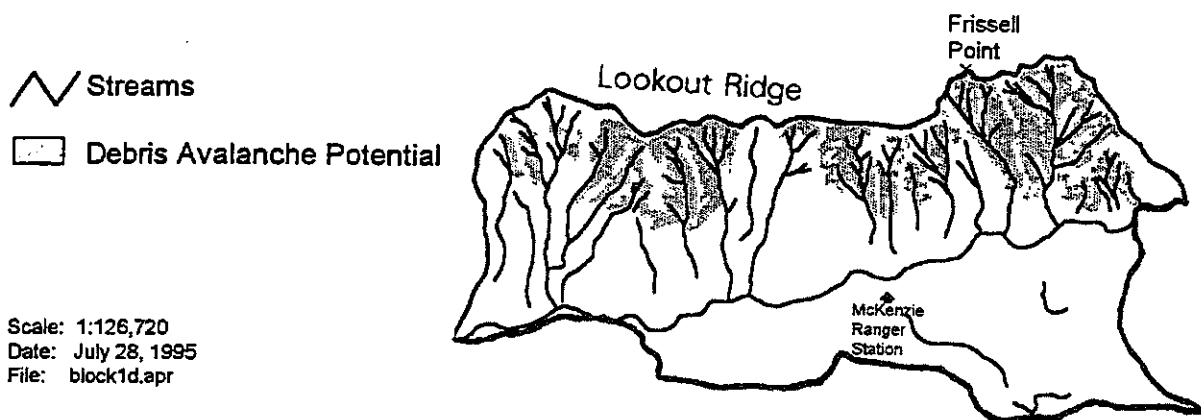


Figure 4-4. Landform Block 1 Debris Avalanche Potential



The forest patches in this block are currently a mix of predominantly even-aged stands. There may have been a fire event as often as every 40 years which helps to explain why there is such a mix of tree ages across the block. The average size of the forested patches is small, about 45 acres. This is significantly smaller than the 1900 average patch size of about 120 acres. A Shannon diversity index indicates a 12% reduction in patch-type diversity between 1900 and 1995 (from 1.63 to 1.43 1900 and 1995, respectively). This reduction is related to the loss of fire disturbance in this block. Fires historically resulted in a highly diverse mosaic of patch types on this landform.

Tree regeneration following fire events was probably slow on the warm and droughty south aspects and on the thin, rocky soils of the upper slopes.

Unique Habitats

Table 4-1 and Figure 4-5 displays the non-forested habitats located within this landform block. The prominent habitat feature of this landform block is rock outcrops and cliffs that run west from Frissel Point to Lookout Ridge. These south-facing habitats support herbs and grass species that have adapted to these harsh sites. The cliffs are providing low to moderate quality habitat for peregrine falcons. No verified sitings have been recorded.

Table 4-1: Non-forested habitats within Landform block 1.

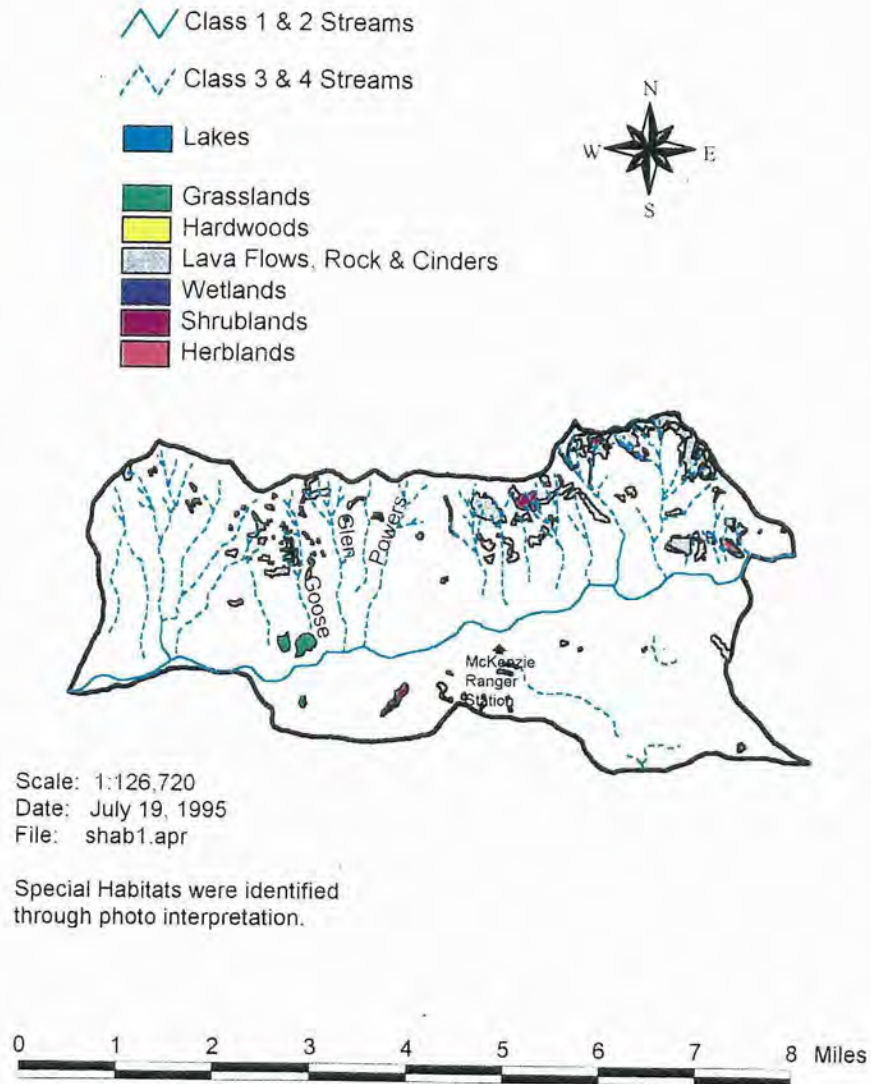
Habitat Feature	Acres
Wet meadow	3.76
Dry meadows	31.76
Herb/forb meadow	30.70
Shrub communities	55.84
Hardwood/shrub community	7.18
Rock talus	9.55
Rock outcrops	504.81
Lakes	3.82

A unique marsh/wet meadow habitat occurs on a private parcel on the valley floor. Pond Turtles, band-tailed pigeons, and wood ducks inhabit the area, as well as abundant elk.

The wetland is within a half mile of another wet meadow outside the watershed which has a known population *Ophioglossum pusillum*, a sensitive plant. The potential for *O. pusillum* to occur in this area is high. The area appears to be stable, and there are no known threats. The marsh should be a high priority to assess for a potential land exchange.

Figure 4-5. Landform Block 1 Special Habitats

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High quality, late successional riparian habitat is limited along this section of the McKenzie River. Most of the older forest in the riparian reserve has been harvested on private lands. The riparian zone and associated upland vegetation provide habitat for five sensitive plants to occur in this landform block. A pristine example of late seral riparian habitat still exists, however, at Paradise Campground. Mature big leaf maple trees provide habitat for an abundance of bryophytes and lichens. This plant community will gradually change over time due to the presence of the laminated root-rot *Phellinus weirii*. This disease kills Douglas-fir trees. As the forest canopy opens, hardwoods and western hemlock more resistant to the disease will replace the Douglas-fir.

Noxious Weeds

Extensive populations of spotted knapweed, a noxious weed, has established along Highway 126 in this block. The Department of Transportation (ODOT) is responsible for mowing the plants before they set seed. Although this practice reduces the expansion of the weed, the plants continue to grow and persist in the environment. Plants missed by the reach of the mower continue to disperse seeds.

Last fall approximately one acre adjacent to the highway was planted with two species of grass seed in an attempt to out-compete noxious weeds. Germination was poor this spring, and spotted knapweed continues to dominate the site. The non-native weedy plant oxeye daisy (*Chrysanthemum leucanthemum*), common in the Willamette Valley, has become more prevalent along Highway 126. This species occurs in patches, but should be eradicated before it becomes established. Oxeye daisy is a perennial that can quickly invade meadows and aggressively out-compete with native vegetation.

The EWEB powerline runs west through the landform block. The dominant vegetation growing in the powerline corridor is the noxious weed Scotch broom. Further expansion is limited as it does not grow well in dense shade under crown closure. However, seeds of Scotch broom can remain viable for sixty years in the soil (Miller 1994). No current eradication program exists for the removal of Scotch broom under the powerlines. A TES plant and weed survey is being completed for the corridor in FY95.

Channel Condition and Aquatic Habitat

The streams of Landform Block 1 are steep in gradient and flow south off the ridge of the Western Cascades. They generally disappear subsurface when they encounter the glacial deposits within the McKenzie River glacial valley. Debris torrents and debris avalanches are common in the steep, upper portions of the streams. In the past, intensive, large fires on the steep slopes probably introduced large amounts of sediment onto the flats of the valley glacial

deposits, with a majority of the slide material eventually making its way to the McKenzie River. Many of the streams are incised into the glacial material where debris torrents have cut through the deposits.

The landform block is located within the McKenzie Bridge subwatershed. Approximately 15% of its area has been harvested and roaded (Table 4-2 and 4-3).

Table 4-2: Percent area harvested within McKenzie Bridge Subdrainage.

SUB-WATERSHED #	SUB-WATERSHED NAME	PERCENT HARVESTED	PERCENT ROADED	TOTAL PERCENT MANAGED	ROAD DENSITY (miles/square mile)
07-1	McKenzie Bridge	13.0	2.0	15.0	3.1
07-2	Lost Cr/Wh. Branch	4.0	0.5	4.5	3.5
07-3	Boulder/Frissel	24.0	2.0	26.0	3.2
07-4	Kink/Inland Basin	5.0	0.5	5.5	0.7
07-5	Hackleman	14.0	2.0	16.0	2.4
07-6	Smith River	25.0	2.0	27.0	2.5
07-7	Deer Cr.	36.0	3.0	39.0	3.8
07-8	Park Cr.	11.0	2.0	13.0	2.3

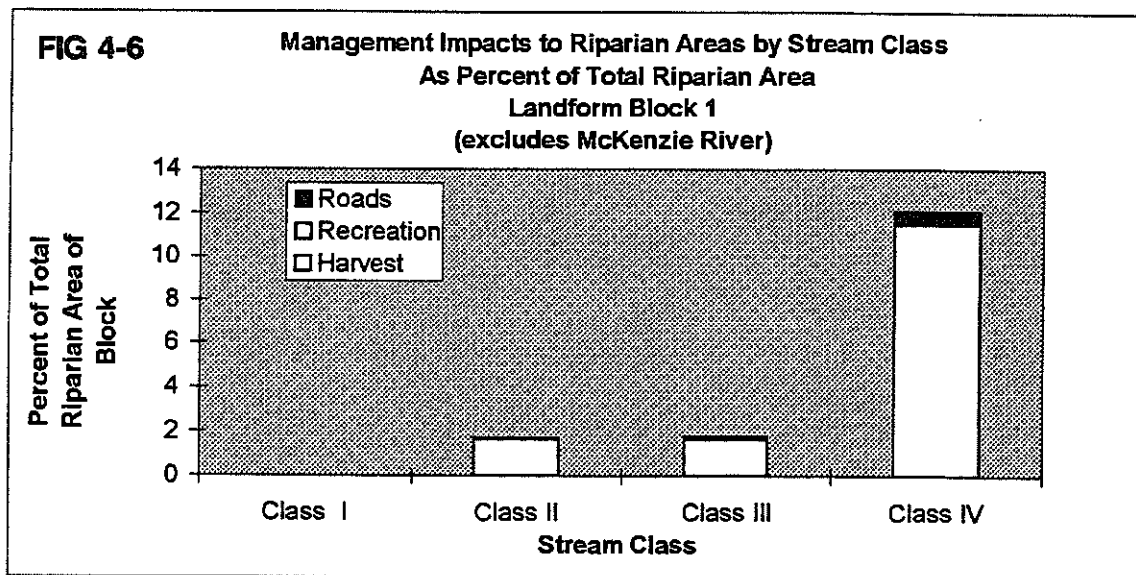
Table 4-3: Percent area harvested and roaded within each drainage.

SUB-WATERSHED NAME	DRAINAGE NAME	PERCENT HARVESTED	PERCENT ROADED	TOTAL % MANAGED	ROAD DENSITY (miles per square mile)
Boulder/Frissel	Boulder	20.0	2.0	22.0	2.4
	Frissel	15.0	1.0	16.0	1.6*
	Scott	29.0	3.0	32.0	4.4
	Sprngs Cmx	24.0	2.0	26.0	2.9
	Twisty	44.0	4.0	48.0	5.1
Kink/Inland Basin	Kink	19.0	2.0	21.0	2.3
	Sweetwater	30.0	3.0	33.0	4.5
Hackleman	Hackleman	24.0	2.0	26.0	3.0

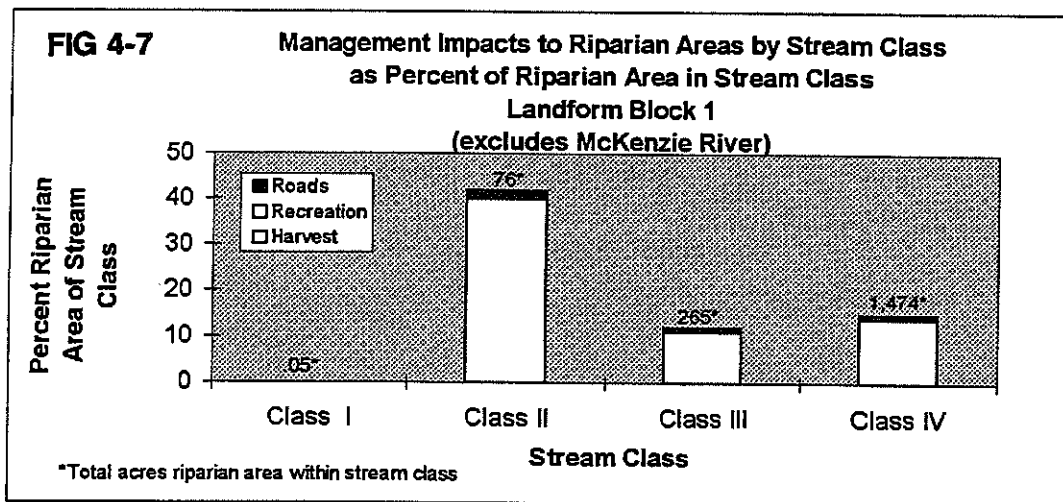
Table 4-3 continued

SUB-WATERSHED NAME	DRAINAGE NAME	PERCENT HARVESTED	PERCENT ROADED	TOTAL % MANAGED	ROAD DENSITY (miles per square mile)
Smith River	Browder	25.0	1.0	26.0	2.0
	Bunchgrass	30.0	3.0	33.0	3.7
	Smith	27.0	2.0	29.0	2.6
Deer Cr.	Budworm	13.0	2.0	15.0	2.3
	Cadenza Cm	44.0	14.0	58.0	4.7
	Carpenter	41.0	3.0	44.0	3.9
	County	35.0	2.0	37.0	3.6
	Fritz	43.0	3.0	46.0	4.3
	Sluice	42.0	3.0	45.0	4.0
	Deer Cmpx	38.0	3.0	41.0	3.8
Park Cr.	Upper Deer	40.0	3.0	43.0	4.2
	Crescent	22.0	2.0	24.0	3.5
	Danny	68.0	3.0	71.0	4.7
	Maude	0.6	0.7	1.0	1.1
	Park	26.0	2.0	28.0	2.8

Of the total riparian area within the block, 12% of the area harvested and roaded has occurred in Class IV riparian areas (Fig. 4-6).



However, of the 76 acres of riparian area associated with Class II streams, over 40% of the area has been harvested and roaded (Fig. 4-7). Harvest and roading in the Class II portion of Florence Cr. accounts for the entire 40%.



The low gradient, lower reach of Florence Cr. and an unnamed tributary across from Paradise Campground both provide perennial flow and habitat for cutthroat trout. The most recent survey of streams in this landform were conducted in 1975. Most channels draining the steep side slopes were found to flow subsurface after reaching low gradient glacial deposits. Those channels with year-round flow provided habitat for cutthroat trout and were expected to provide refuge from high McKenzie River flows. Seasonal refuge during high flows is also available in intermittent channels draining directly into the McKenzie River.

Human Disturbances And Effects - Campsites

Dispersed Campsites: All of the dispersed campsites in this block that were inventoried in the summer of 1988 fall within the McKenzie River riparian reserve. Therefore, those sites are discussed under the Mainstem McKenzie landform block.

Developed Recreation Facilities: The following developed recreation facilities are located within this block. Developed facilities include: McKenzie Bridge Campground/Picnic Area and Boat Launch; Paradise Campground/Picnic Area and Boat Launch; and McKenzie River Trailhead Boat Launch.

Administrative and Recreational Special Use Permit Areas: McKenzie Ranger Station compound and Horse Creek Work Center are located in this block. The facilities consist of an office building, warehouse, two bunkhouses, storage yard, tree cooler, and large parking lots. Horse Creek Work Center consists of five permanent residence homes, two large storage buildings, three mobile homes

and pads for two more, a large grass ball-field, parking lot, and covered storage areas.

LANDFORM BLOCK 2A:

DEER CREEK CIRQUE-RIDGE

(Western Cascade Cirque Ridge System of Wilson 1981)

Introduction

This landform block is dominated by the southeast-trending Deer Creek drainage, which originates near Squaw Mountain in the north, and near Wolf Meadow/Carpenter Mountain/Lookout Ridge in the west and south. Streams traverse only one bedrock unit, the Western Cascades, and therefore have a relatively consistent gradient and incision rate (Avramenko 1981). The landforms in this area are a product of alpine glaciation and subsequent valley filling processes such as glacial outwash and moraine deposits. The on-going fluvial processes have provided a mechanism for large mass wasting and erosion events involving side slope and toe slope deposits (Figure 4-8). The majority of mass wasting events in the watershed are located within this landform block.

Disturbance History - Mass Wasting

Landform Block 2A contains 9 of the 19 road-related failures in the watershed. Large, unstable landslows are located in the County Creek and Conroy Creek areas. Although this block is more susceptible to rotational and earthflow-type failures, it is less susceptible to debris avalanche transport over long stream reaches. An exception to this is in the Frissel-Carpenter area because of the "trellis-like" development of the fourth and third order streams and their angle of intersections being less than 70 degrees. Post-harvest debris avalanches and erosion are evident in both County and Conroy Creek drainages (Figure 4-9,10).

Landform block 2A contains SRI Units 3, 233, and 235 potentially on all slopes; and Units 13, 16, 21, 301, and 310U on slopes greater than 70%.

Disturbance History - Fire and Vegetation Patterns

The vegetation of this block is mostly western hemlock (TSHE) and Pacific silver fir (ABAM) plant series in the higher elevations. The block also contains two small pockets of Douglas-fir (PSME) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

Figure 4-8. Landform Block 2a Locator Map

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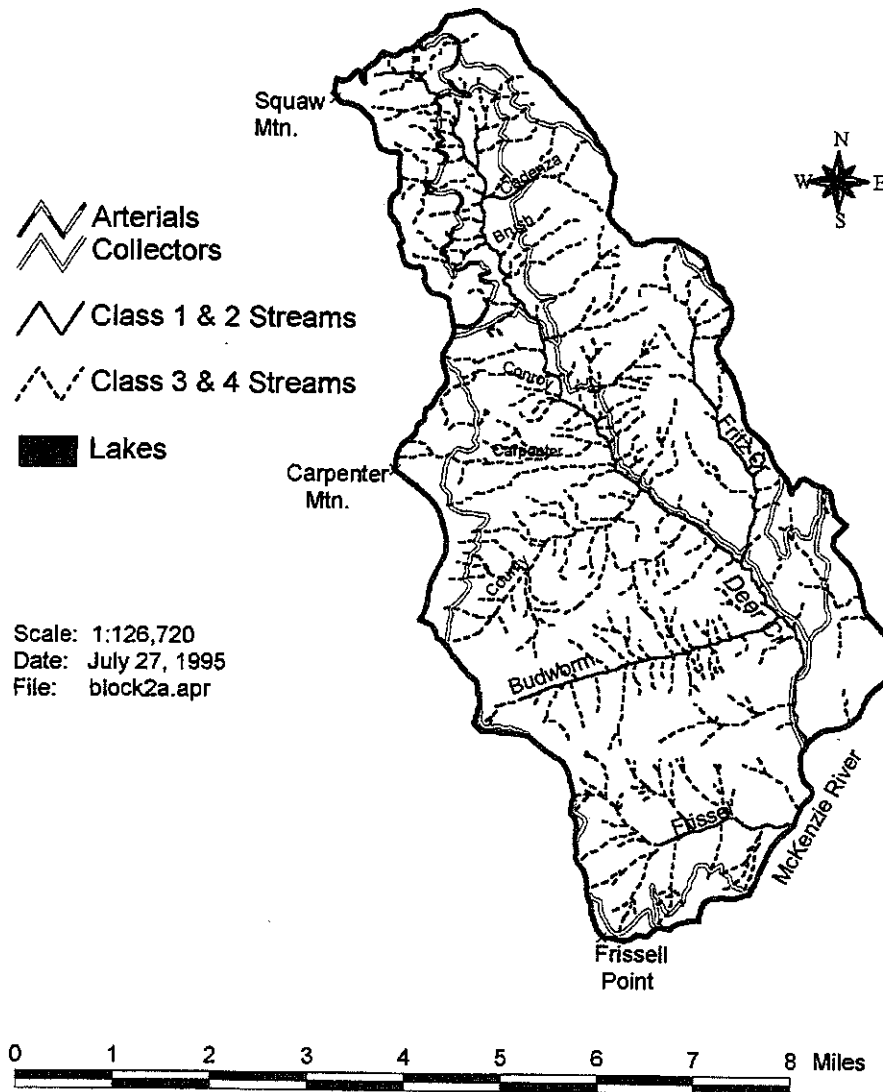


Figure 4-9. Landform Block 2a Unstable & Potentially Unstable Areas

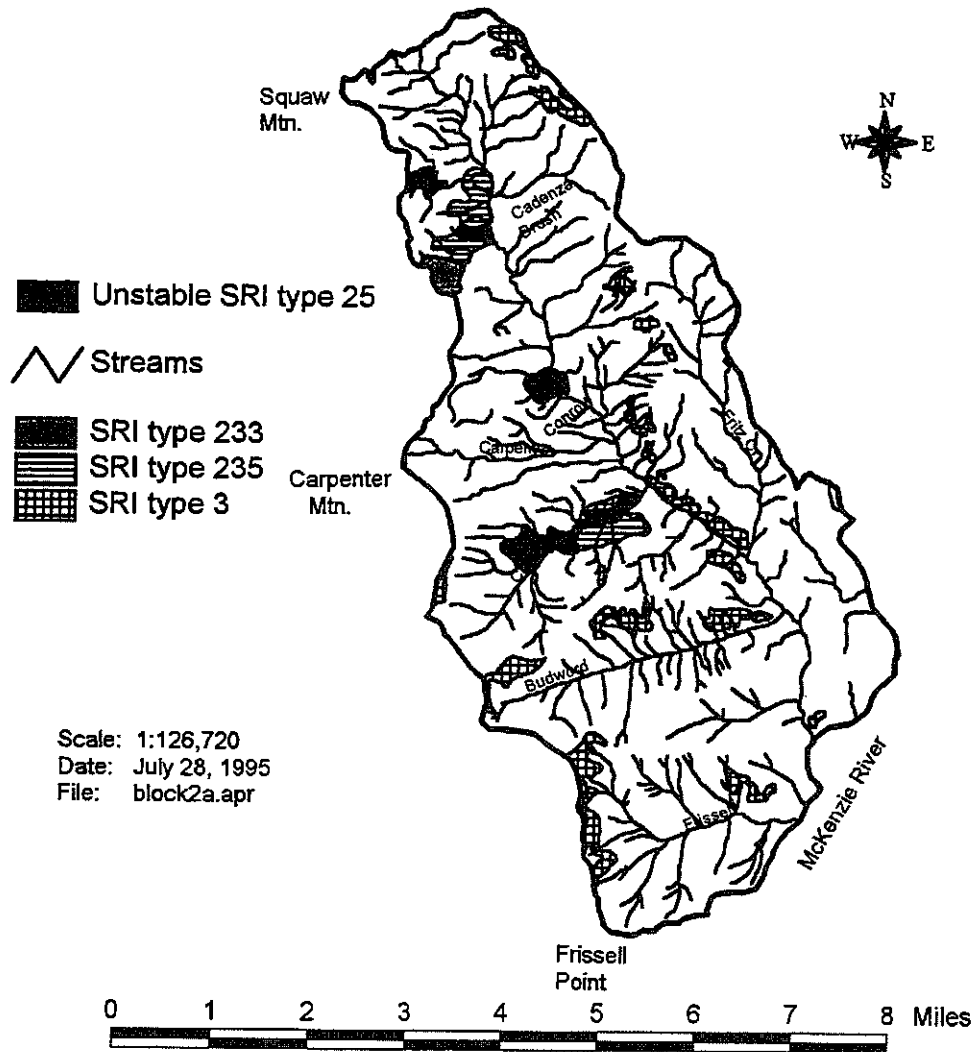
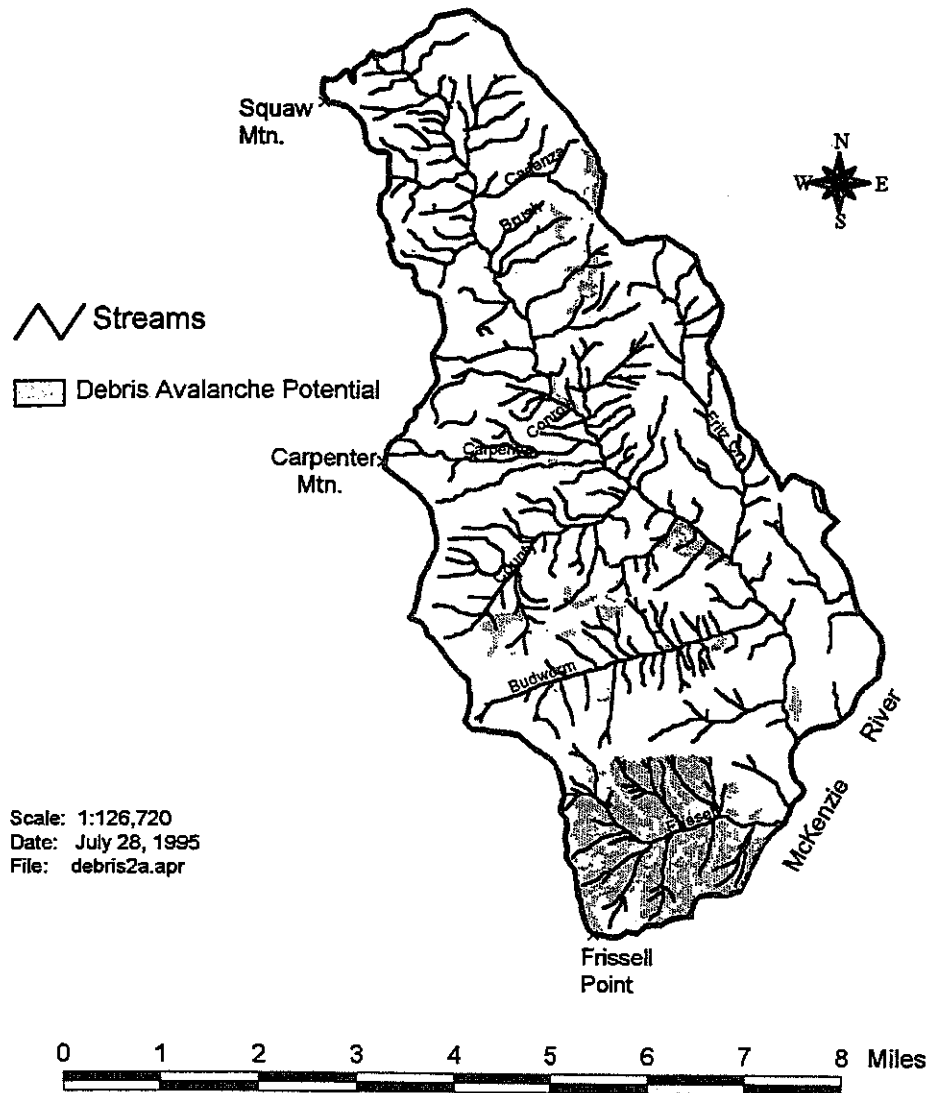


Figure 4-10. Landform Block 2a Debris Avalanche Potential



Typical daily west or southwest wind flows in this area are modified by the topography of Wolf Rock and Carpenter Mt. The wind channels up Blue River, flows through a low pass, then a portion of the wind turns southeast in response to Bunchgrass Mt. The southeast direction of this flow is down-canyon along Deer Creek. This is contrary to the normal up-slope, up-canyon winds expected. The effect is most noted in the upper portions of the Conroy, Carpenter, and County Creek areas. In other areas of the block, the wind is up-slope and up-canyon. On the ridges, the wind is west or southwest.

During periods of east wind, the wind is strongest in the upper portions of Budworm, Frissell, Carpenter, and County Creeks. Other areas, except the ridges, are less exposed to the east wind but are subject to frequent wind shifts and eddies.

Most of the area, except in the Douglas-fir stands, is composed of stands created by small-sized, intermediate to frequent return interval, stand replacement fires. The expected final fire size is a result of the steep north and south aspects associated with the east-running creeks. East winds funnel up the creek drainage and push fires into natural barriers such as rocky ridge tops and less favorable aspects.

The forest patches in this block are a mix of even-aged and multi-aged stands. The average size of the patches is currently small: about 31 acres. This is smaller than the 1900 average patch size of 82 acres. A Shannon diversity index indicated a 35% increase in diversity from 1900 to 1995. The index changed from 1.40 to 1.89 in 1900 and 1995, respectively. This increase reflects an increase in small early and mid seral patches caused by clearcutting over the past 40 years.

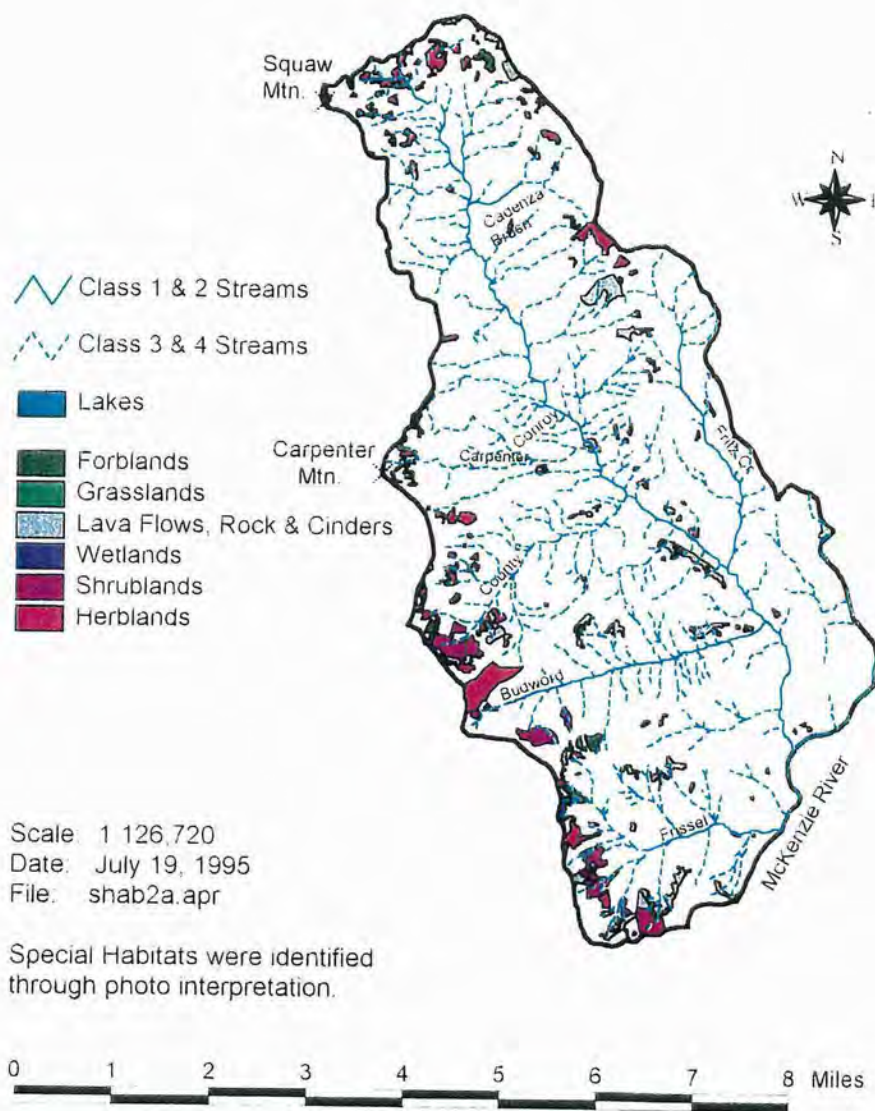
Unique Habitats

Table 4-4 and Figure 4-11 displays unique habitats within this landform block. Most of the special habitats occur along the ridgeline of Frissell Point north to Carpenter Mountain.

Table 4-4: Unique habitats within Landform Block 2A.

Habitat Feature	Acres
Wet meadow	26.62
Dry meadow	64.66
Herb/forb meadow	460.29
Shrub communities	244.77
Dry Rock Gardens	7.92
Rock outcrops	332.36
Lakes	.58

**Figure 4-11. Landform Block 2a
Special Habitats**



Moderately high elevation Sitka alder thickets and vine maple plant associations are found at the headwalls of Frissell, Budworm and County creeks. Beargrass meadows occur on the cold, dry, flat areas along the ridgeline. Old growth riparian vegetation and its associated upland vegetation is lacking along upper reaches of Deer Creek, limiting habitat for many of the ROD Table C-3 species to occur.

This landblock contains high quality cliff habitat for peregrine falcons. Sitings have been recorded. Meadow complexes in this area include Bunchgrass Mtn Special Wildlife Habitat Area (SWHA) and Upper Deer Cr. SWHA. Wetland areas include Cadenza Cr. SWHA. Maintenance of water quality, hydrological processes, and riparian/meadow vegetation are critical for these habitats to continue to function. The majority of these areas are protected from threats through Special Wildlife Habitat Area LMP designations. These habitats are not currently being threatened with the exception of Bunchgrass Mtn., which is being encroached by conifers from lack of fire disturbance.

Sensitive Plant Species

Habitat for five sensitive plant species is found within this landform block (Table 4-5). The sensitive plant species Thompson's mistmaiden (*Romanzoffia thompsonii*) is found in a seepy area on a steep road cut bank. Road cuts often produce rock faces with seeps which can develop into moist habitat for pioneer bryophyte species and other plant species. The Thompson's mistmaiden population is stable with no current threats. *Allotropa virgata* (candystick), a ROD Table C-3 survey and manage species, has been found in two separate western hemlock sites within this block. These sites should be re-surveyed to determine the current status of the species.

Table 4-5: Sensitive Plants Located in Landform Block 2A.

Species	Status	Number of pops
<i>Romanzoffia thompsonii</i> - Thompson's mist maiden	Sensitive	1
Region 6 Sensitive Plant List; Review List and the Watch List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern List for locally rare species not included in the first three lists.		

Noxious Weeds

Noxious weeds are being treated with biological control agents and manual removal in this landform block.

Channel Condition and Aquatic Habitat

Historically, the erosion rates within the geologically uplifted block of western cascade strata has been high relative to the other landform blocks of the

watershed. The deeply dissected landscape and steep side slope tributaries in this landform have historically carried heavy bedloads to Deer Cr. that were then delivered to the upper McKenzie River.

The Frissell and Budworm drainages are steeply dissected with debris flows being the major form of sediment delivery to the streams and to Deer Cr. Bank cutting was not uncommon. This landscape erodes at a faster rate than the more resistant High Cascades. In contrast, the earthflow terrain of County, Conroy, Carpenter, Cadenza, and Brush drainages generally provide large quantities of sediment to the system as stream courses cut the toe slopes. Fritz Cr. drainage is the most stable of the landform block. It drains through glaciated lava flows. Steep tributary channels of first, second, and third order streams store sediments behind debris jams of large wood. The wood was often recruited from windthrow or failed slopes, and it accumulated during high flow events. Deer Cr. drainage was historically a large source of sediment and debris to the upper McKenzie River. Elsewhere within the watershed, such as in the Smith River drainage with Western Cascades geology, similar drainage size and orientation contributed large quantities of debris and sediment to the Upper McKenzie River.

Moderate to high intensity fires occurred within a significant portion of this landform block, and these small to medium-sized fires introduced a large amount of sediment to Deer Cr. and the McKenzie River approximately every 130-190 years. Input of sediment from mass wasting processes resulted in additional sediment of all sizes, including small to large boulders and whole trees that provided LWD and structure to the channels.

Historic disturbances that have influenced this landscape include a large stand replacing fire in the early 1900's that burned about 1,000 acres on Carpenter Mountain and the headwaters of Carpenter Creek. Similar disturbances have been shown to influence erosion and failure rates, stream temperatures, and nutrient supply. The portions of the landscape that burned reduced the local recruitment supply of in-stream wood until future conifer regeneration matured to replenish the supply. No other major fire disturbance has been recorded in this landform block since the early 1900's.

Major floods also significantly shaped this landscape. Floods and debris torrents changed aquatic habitat by: altering pool:riffle ratios by filling and scouring pools; transporting and concentrating large woody debris into jams; modifying the active channel and off-channel habitats by creating new and abandoning old channels; and sorting and silting spawning gravels. Flows of record in excess of 15 year recurrence intervals occurred in water years 1946, 1953, 1956 and 1965. Reconstruction of roads and salvage of the Deer Cr. channel and flood plain followed the 1965 120-year event.

The unconfined and cobble/gravel-rich lower reach of Deer Cr. is important to chinook salmon. They use the lower 1.5 miles of Deer Cr. as spawning and rearing habitat. Bull trout subadults have been observed rearing, and adults likely forage, in lower Deer Cr. Rainbow/steelhead trout are known to migrate 5.0 miles up Deer Cr. to the base of a 60 foot falls to spawn. Cutthroat trout are found below and above the falls to Deer Cr. headwaters and within major tributaries of Deer Cr. (Fritz, Budworm, and lower Carpenter Cr.). Frissell Cr., a tributary to the McKenzie River downstream of the confluence of Deer Cr., is included in this landform block.

Deer Creek Aquatic Habitat Condition

Since the early 1960's, road building within block 2A has caused debris flow failures, and fire suppression has reduced failures associated with fires. Therefore, total sediment production within the system may not have increased, but the character of the material was different than the sediment added from non-road related failures. The size of material added to the system from the road related failures has been confined to sediment used in construction of fill slopes and lacks the various-sized material. In addition, road fills generally have stumps from large trees, but do not contribute large wood with root wads upon failure that historically provided valuable structure to the channel.

Channel conditions within the drainages of Deer Cr. reflect the intensity of management within this landform block. Tables 4-2 and 4-3 outlines the road density, total harvest, and percent harvest of the Deer Cr. subwatershed (see Figures 3-17 and 3-17a for subwatershed and drainage locations and names). With 36% of the subwatershed in a harvested or roaded condition, this subwatershed is the most heavily managed in the Upper McKenzie watershed. Table 4-3 also displays the percent harvest and roaded, and road density for selected drainages within the Deer Cr. subwatershed. Note that nearly all of the drainages within the Deer Cr. subwatershed have 35% or more of the drainages in a managed condition except for Budworm drainage.

Additionally, almost the entire west facing (east side) of the Deer Cr. watershed is located within high potential contribution to rain-on-snow, including Brush and Cadenza drainages (Figure 3-17a). The ARP value for the Deer Cr. subwatershed is one of the lowest values for the watershed at 73, with many of the ARP values in the Deer subwatershed ranging from 50-78. Although some of the drainages appear to be relatively recovered hydrologically, such as Upper Deer and Deer Complex, they are still likely experiencing increased peak flows. As discovered in a small basin study by Jones and Grant (in review 1994b), peak flow discharges increased by more than 25% for as long as 25 years after the drainage had been harvested and roaded. Channel bank cutting, high bedload transport, and wide, shallow channels indicate that removal of wood and high

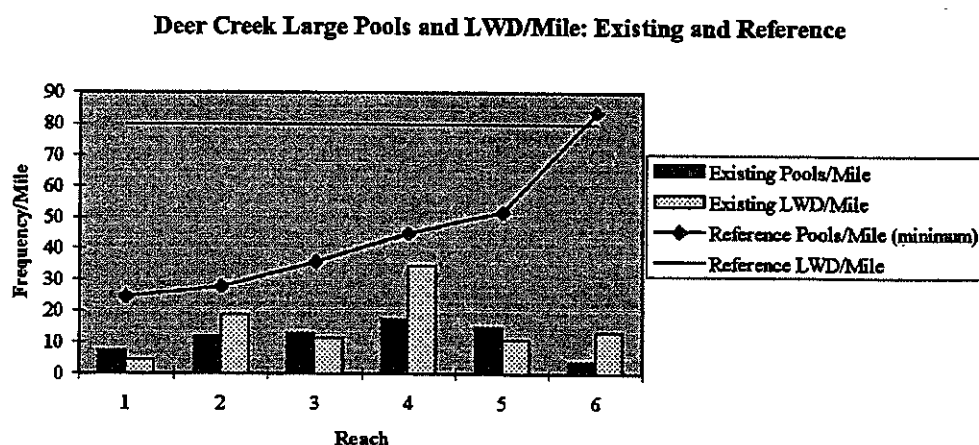
stream flows in Deer Cr., Carpenter Cr., County Cr., and Fritz Cr. have altered channel features.

Timber harvest on the earthflow complex in the Conroy Cr. drainage many years ago triggered a large landslide, leaving an escarpment over 100 ft. high. The resultant sediment and slide material never reached Deer Cr. due to the large bench below the slide area.

Stream surveys from the early 1990's reflect the instability and a wide range of channel conditions observed in this Landform Block. Some tributary channels currently contain over 300 pieces of large diameter wood per mile, present as debris jams or windthrow patches. As in Carpenter Cr., high winds from the southwest can funnel through the northeast trending tributaries and knock over stream buffers or edges of timber stands. Less managed tributaries such as Budworm Cr. have LWD counts more closely representing regional historic volumes of in-stream wood. Pool frequency drops significantly in low gradient reaches (<10%) including Deer Cr., reflecting high volume sediment transport and pool filling.

Pool frequency and volume of in-stream large wood in Deer Cr. are lower than reference conditions representative of Cascade streams (Figure 4-12). The low proportion of pool-to-riffle habitat (1:6.7) and high bankfull width-to-depth ratio (25:1) in lower Deer Cr. are also indications of channel simplification.

Figure 4-12



From USDA Forest Service Level II Deer Cr. survey, 1994. Appendix 4 describes habitat evaluation criteria.

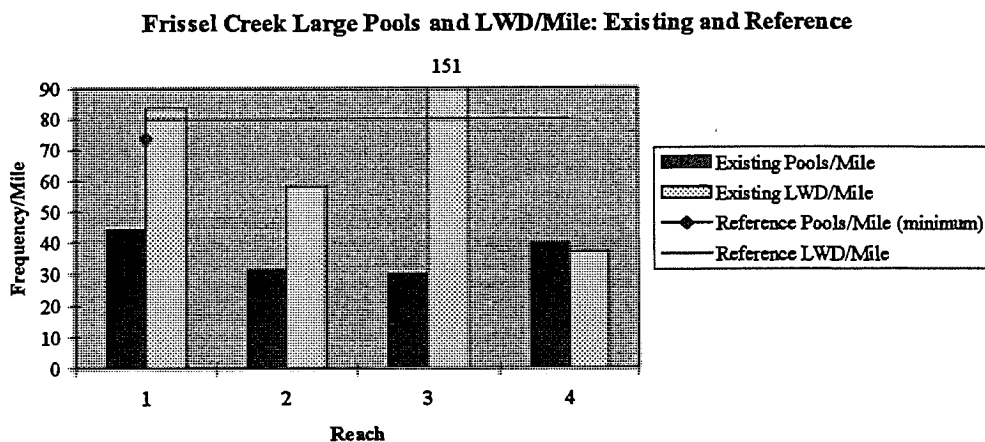
Past habitat enhancement projects in lower Deer Cr. (1988) sought to improve low pool frequency and side channel habitat, and to improve volume of in-stream wood. Boulders and large wood were placed in the lower mile, resulting in an increase in pocket-pool area and available cover. A deflector dam directs

Deer Cr. flow into 100 feet of side channel habitat. An additional 300 feet of side channel habitat was restored in the lower mile by excavating and armoring side channel inlets. Lower Deer Cr. continues to be characterized by low quantities of structure to deflect flows, abandonment of side channels, and low LWD recruitment potential, factors contributing to simplification of the channel (USDA Forest Service EA 1994).

Frissell Creek Aquatic Habitat Condition

Frissell Cr. aquatic habitat condition reflects recent disturbance. A bedload with high percentage fines and embedded cobbles reflect frequent road-related failures within the drainage. A 1985, large slope failure near the confluence with the McKenzie River contributed to higher bankfull width-to-depth ratio (10) in Reach 1 as compared to upper reaches (5-3). A 1993 road decommission of 5 miles along Frissell Ridge seeks to reduce the frequency of slope failure. Six road related failures have been recorded in the Frissell drainage. Slope failures, hardwood dominated regeneration and harvest units across the channel contribute poor LWD recruitment potential. Current LWD counts meet reference condition in Reach 1 and 3 (Figure 4-13). Reach 1 LWD is found concentrated in debris jams.

Figure 4-13



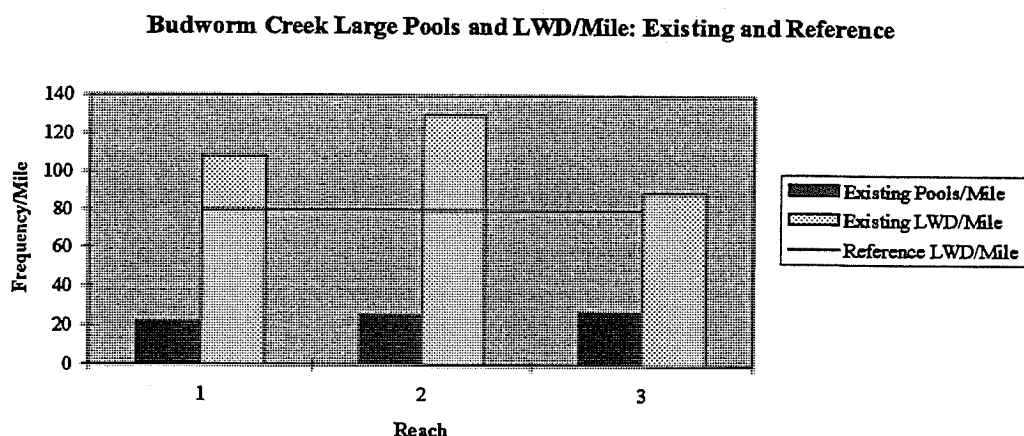
From USDA Forest Service Level II Frissell Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 2, 3, and 4. Reach 3 is a large tributary draining Frissell Creek's south-facing slope.

Recent slope failure, channel aggradation, and pool filling by fines are factors influencing lowered pool frequency in Reach 1. The 1992 biological survey of Frissell Cr. found a population of cutthroat trout along the lower 2.0 miles and fingerling chinook salmon rearing in the lower tributary. Stream temperatures recorded by surveyors did not exceed 14 deg. C for the period of July 6-20, 1992.

Budworm Creek Aquatic Habitat Condition

Budworm Cr. supports a population of cutthroat trout in its lower two miles. Rainbow/steelhead juveniles have been observed in Budworm's lower reach. Channel condition in lower Budworm Cr. represents a "least managed" condition of tributaries in this Landform block.. Although approximately 25% of the upper half of the tributary has been clear-cut during the 1980's, habitat conditions in the channel remain good. Road density is lower in the Budworm/Frissell block compared to adjacent drainages, averaging about 2.3 miles/mile². Reference levels of large wood are present, well distributed within the channel (Figure 4-14). Recruitment potential of large diameter LWD is excellent in the lower 1.5 mile.

Figure 4-14



From USDA Forest Service Level II Budworm Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for Budworm Cr. reaches as channel gradients exceed 10%.

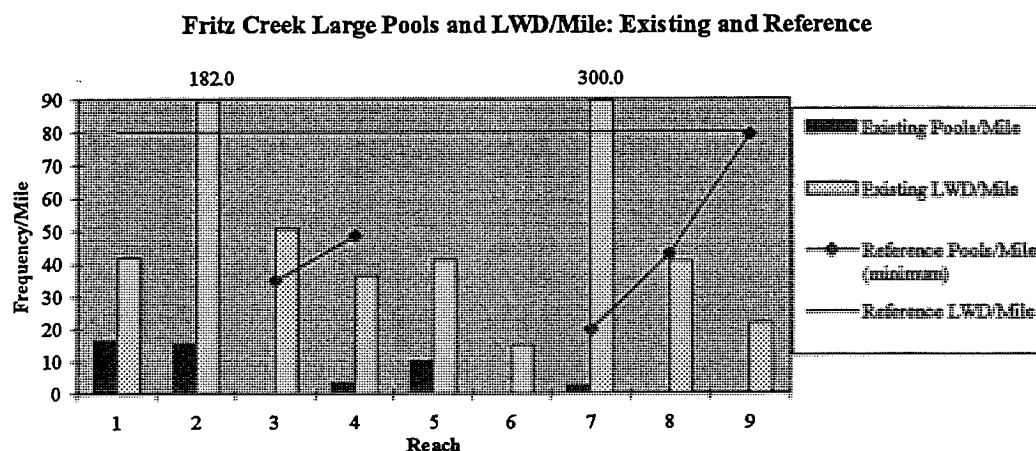
Pool frequency is good with 22 to 28 large pools/mile and pocket pools occupy 10-25% of riffle area. Management activity in the drainage is comparatively lower than adjacent Deer Cr. tributaries. Cobbles are embedded in Reach 2 and 3, however average pool depths (1.9 and 1.6 ft., respectively) and bankfull width-to-depth ratios (6 and 5, respectively) remain good. Stream temperatures meet the proposed average 7-day maximum ODEQ standard of 17.7 deg. C for perennial streams.

Fritz Creek Aquatic Habitat Condition

The moderate reach gradients found in Fritz Cr. provide habitat for a population of cutthroat trout in its lower 3.0 miles. A January 1990 windstorm leveled buffer trees in Unit 197 and account for high LWD counts in Reach 7 (Figure 4-14). Low pool frequency and shallow pool depths are consistent with frequent

bank failure and high bedload transport observed in the 1990 survey. Similar to Deer Cr., pool frequency drops significantly in low gradient reaches (<10%), reflecting high volume sediment transport and low quantities of in-stream wood.

Figure 4-15



From USDA Forest Service Level II Fritz Cr. survey, 1990. Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 1,2,5 and 6.

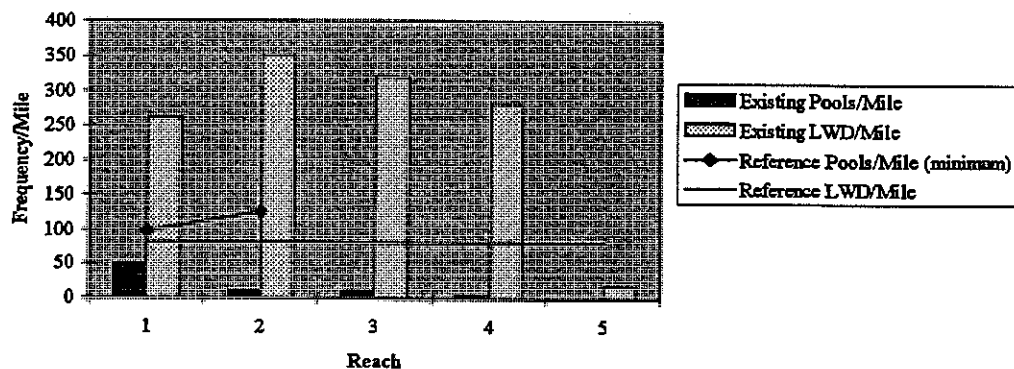
Large sediment storage areas occur behind several debris jams. The volume of in-stream large wood in Fritz Cr. is generally lower than reference conditions representative of Cascade streams. Salvage of in-stream LWD may account for low volume. A culvert passage barrier restricts upstream fish migration in Fritz Cr. above Forest Road 2654. A second culvert passage barrier exists one mile upstream, also restricting upstream fish migration beneath Forest Road 2655-503.

Carpenter Creek Aquatic Habitat Condition

Mass bedload transport characterizes the lower four reaches in Carpenter Creek. Accumulation of sediments in the channel from the drainages' highly erodable soil originated from slope and bank failures, bank cutting, and windthrown trees. The high volume of LWD observed in the first four reaches came from a combination windthrow and slope/bank failure (Figure 4-16). With high winds from the southwest funneling down the northeast trending channel, buffers or unit boundaries were subject to blowdown. High flow events have recently recruited bank trees in this deeply dissected drainage and concentrated wood into debris jams. The current channel is a stair-step of well embedded debris jams and stored sediments. Future recruitment potential of LWD is poor as a result of recent stream adjacent conifer harvest.

Figure 4-16

Carpenter Creek Large Pools and LWD/Mile: Existing and Reference

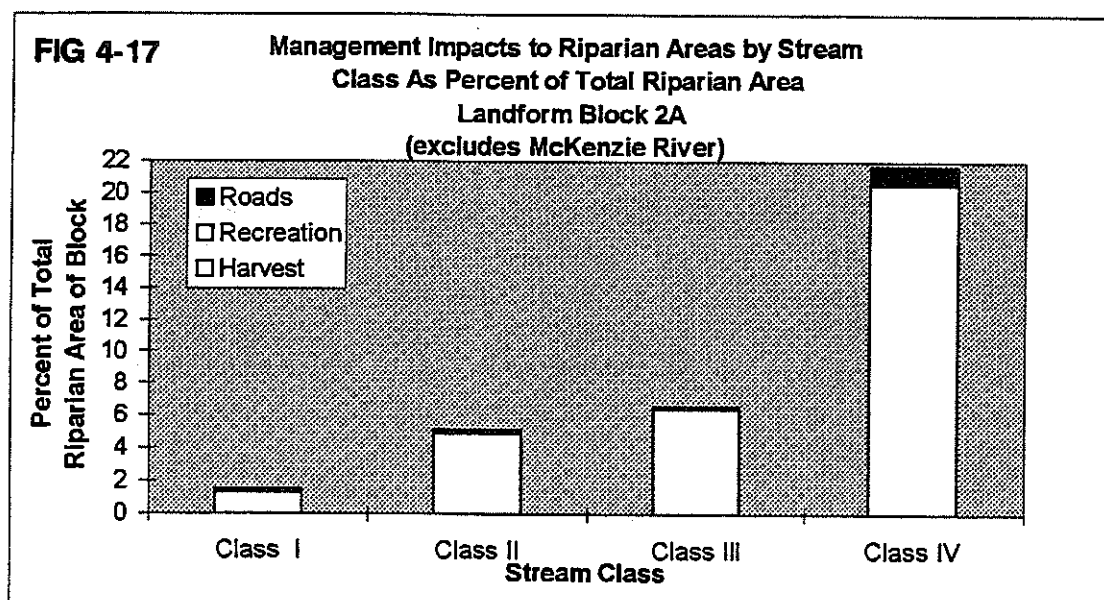


From USDA Forest Service Level II Carpenter Cr. survey, 1990. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 3, 4, and 5.

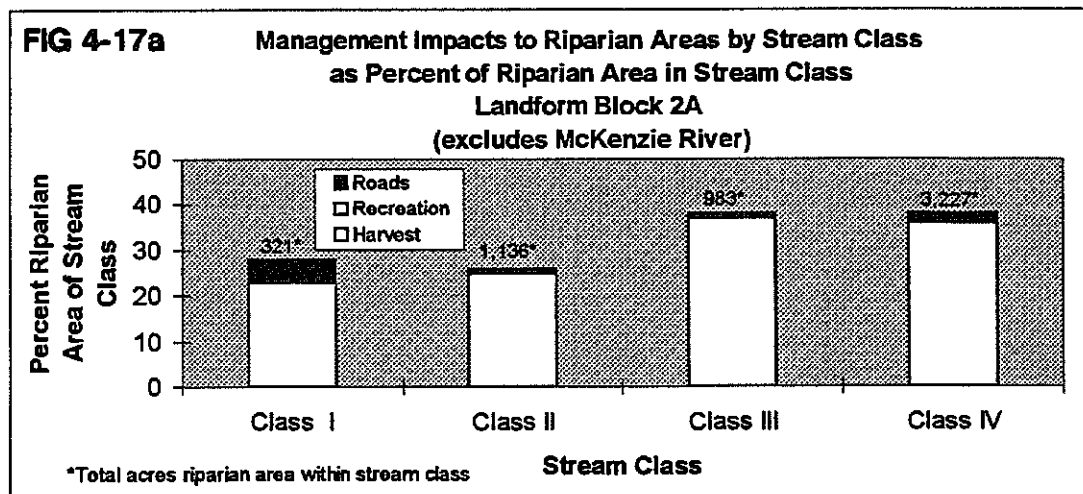
Cutthroat trout may have been present throughout Carpenter Creek's moderate channel gradient, but past disturbance (debris torrents) and current passage barrier jams may restrict their current range to the lower portion of Reach 1.

RIPARIAN VEGETATION

Of the total riparian area located within this landform block, Class IV streams are by far the most heavily altered, with nearly 22% of the riparian area harvested and roaded (See Figure 4-17).



Although it appears as though Class I, II, and III riparian areas are only slightly altered with 1-7% disturbance of the total riparian area, they are actually affected by 26-38% when looked at on a percentage of the riparian area for the given stream class (Figure 4-17a). Twenty-eight percent of the riparian area along the Class I stream of Deer Cr. has been harvested or roaded; 26% of the riparian area along the Class II stream (mainly Deer Cr., Fritz Cr., and some of Budworm) has been harvested or roaded; and 38% of the riparian area along Class III streams of the entire Block 2A have been harvested or roaded. The effects of these impacts range from increased stream temperatures due to lack of shading on the perennial streams (Class I, II, and III); reduced amount of LWD input important for channel stability and aquatic habitat; and reduced nutrient input to the stream.

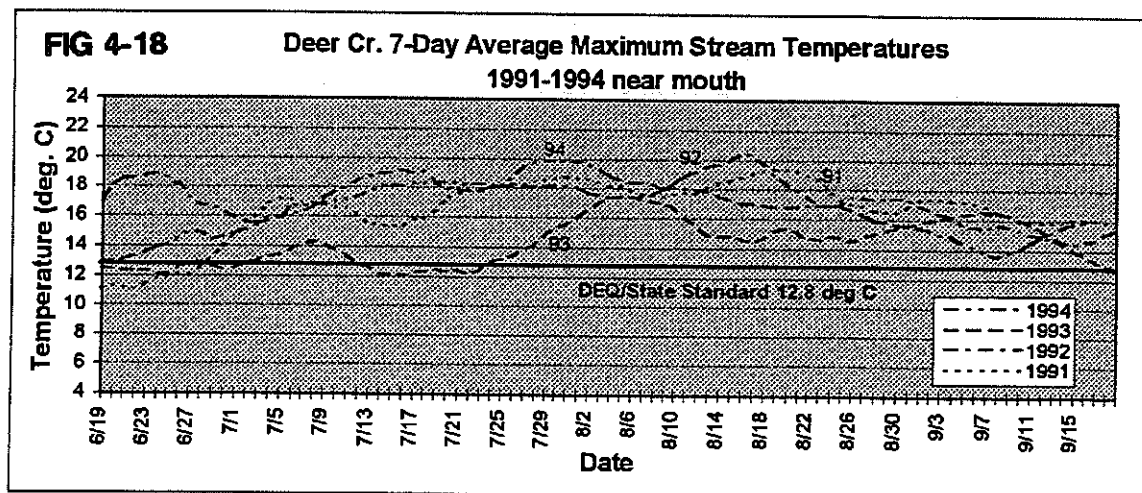


STREAM TEMPERATURE

Stream temperatures within this landform block are considered to be the most problematic of the entire watershed. Specifically, Deer Cr. has very high summer stream temperatures, and excessive temperatures is one of the possible reasons that spawning by adult chinook salmon is limited. Salmon and trout have evolved to the temperature patterns of the subbasin and deviations may adversely affect their survival. Warming of spawning and rearing tributaries can significantly diminish survival by altering migration timing and accelerating maturation, incubation and emergence timing. Spring chinook optimal spawning temperatures range from 5.6-13.9 deg. C (beyond which mortality increases) and optimal incubation temperatures range from 5.0-14.4 deg. C (Bjornn and Reiser 1991).

The apparent minimal use of lower Deer Cr. by spawning and rearing spring chinook and foraging bull trout likely reflects habitat degradation, including elevated stream temperature, beyond those species tolerance. Water quality standards established by the state and published by the Oregon Department of

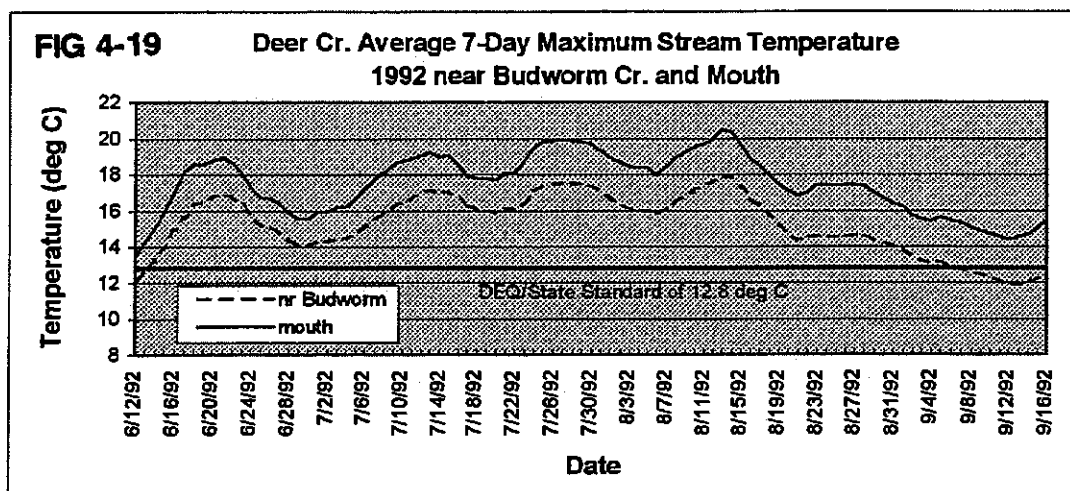
Environmental Quality have recently been reassessed for stream temperatures. New standards, which are not yet published, require that the moving average of the 7-day maximum stream temperature not exceed 55 deg. F. (12.8 deg. C) for anadromous spawning and rearing streams such as the lower 1.5 miles of Deer Cr. (DEQ 1994). Figure 4-18 display the 7-Day average maximum stream temperatures for 1991 through 1994 at the mouth of Deer Cr. Note that all years exceed state standards, and there does not appear to be a declining trend.



An analysis of stream temperatures for Deer Cr. was done for the Clipper EA in 1992 by the district hydrologist. In that report, data collected by the District Biologist in 1984 was analyzed and it was determined that the majority of heating occurred in the mainstem of the creek, while most of the tributaries contributed to cooling of the mainstem. Though no data exists prior to timber harvest within the Deer Cr. subwatershed, indications from the 1984 data are that much of the heating source is within the mainstem below Brush Cr. for approximately one mile downstream, where harvest of riparian vegetation that took place 26-32 years ago has not yet recovered to the point of providing adequate shading.

Another major source of heating is also within the mainstem near the mouth of Deer Creek. The EWEB powerline is located directly in the floodplain and crosses the creek at an obtuse angle in three separate locations. Construction of the powerline required removing the tall, coniferous riparian vegetation which has been replaced by small, deciduous trees and shrubs for approximately one mile of stream length. Additionally, the main road access into the subwatershed runs directly up the floodplain, also reducing the potential area that could be vegetated. As a result, the current riparian vegetation is inadequate to shade the stream channel from incoming solar radiation. Figure 4-19 displays the average 7-day maximum stream temperature for 1992 at the mouth of Deer Cr. and at a location upstream from the influence of the powerline corridor and road (near

the mouth of Budworm Cr.). Note that in the distance of one mile traveled, stream temperatures increase by as much as 5.4 deg F (3 deg C.) and range from 2.5 to 5.4 deg. F. (1.4 - 3.0 deg C).

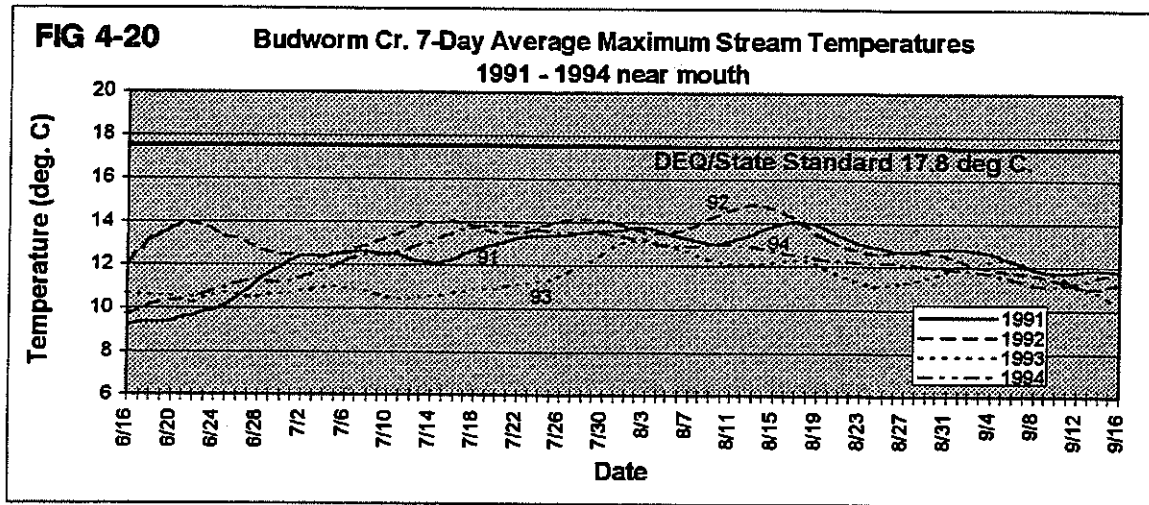


Existing high stream temperatures likely limit current spring chinook and bull trout use within this landform. Current spring chinook spawning use of Deer Cr. is extremely limited (one redd in 1993), and some chinook juveniles entering from main stem McKenzie to rear in lower Deer Cr. margins and side channels.

A tributary to Deer Cr., Budworm Cr., also has been monitored for summer stream temperatures near its mouth from 1991 through 1994. State standards for maximum stream temperatures which were reassessed and are not yet published require that the 7-Day average maximum stream temperature not exceed 64 deg. F. (17.8 deg. C). Budworm Cr. is considered to be in a fairly unaltered state from management. Where limited harvest activities have occurred, no-harvest riparian buffers were left along Budworm Cr. to ensure stream temperatures would be maintained. Note that for all four years, summer stream temperatures met state standards (Figure 20).

Comparing the stream temperatures at the mouth of Deer Cr. to those temperatures measured in Budworm Cr., one would not expect to find Deer Cr. stream temperatures to be cooler than Budworm. The best we could expect for summer stream temperatures at the mouth of Deer Cr. would be temperatures found in Budworm Cr. And yet, even the temperatures in Budworm Cr. exceeded state standards set for Deer Cr. of 55 deg. F. (12.8 deg. C). In conclusion, although stream temperatures are acknowledged to be elevated in Deer Cr., the standard set by the state and DEQ may not be achievable for Deer Cr., even given ideal conditions.

Maintenance of roads and utility corridors continue to restrict long term sources of in-stream large wood and stream shade (USDA Forest Service EA 1994).



High stream temperatures recorded in lower Deer Cr. in recent years are a result of decreased stream shade, particularly downstream of Budworm confluence; Deer Cr. channel's south flowing orientation; and probable warmed tributary contribution from the harvested upper landform.

Human Disturbances and Effects - Campsites

Dispersed Campsites, Developed Recreation Facilities and Administrative Sites: Block 2A is unique in that it has no inventoried dispersed campsites; no developed recreation sites such as campgrounds, picnic areas or boat launches; no wilderness; and no administrative sites or recreational special use permit areas. It is a roaded area with fairly heavy timber harvest in the past. However, this area does lend itself to some recreational activities. Huckleberries and blackberries are gathered here late in the summer, as are Christmas trees if snow allows winter access. Forest visitors who enjoy driving backcountry routes will often drive through this area on the way to Wolf Rock, a local landmark located adjacent to the landform block's boundary.

LANDFORM BLOCK 2B:

WESTERN-HIGH CASCADE TRANSITION ZONE

(Western Cascade Cirque Ridge, Plio Cascade and High Cascade Platform Systems of Wilson 1981)

Introduction

This landform block is characterized by west-east flowing streams (Park Creek, Hackleman Creek, Browder Creek and Bunchgrass Creek) that originate in glacially carved valleys of the Western Cascades. The exception is northeast trending Ikenick Creek, which flows into Clear Lake. The valley segments through these stream reaches are steeply incised and prone to mass wasting. This is due to the older, lower strength bedrock of the Western Cascade formation being more susceptible to erosion and slope failure. Incision rates have been higher in the geologic past in the Western Cascades due to stream gradients being twice as high as present during the Western Cascade uplift (Long 1991).

As the west-east streams cross the north-south trending contact between the older Western Cascades and younger High Cascade platform lava, the valleys broaden into meadows. More resistant and younger basalts and andesites are encountered. The streams finally confluence with north-south flowing, fault-controlled McKenzie and Smith rivers. Debris avalanche tracks are evident in the Hackleman Creek area (Figure 4-21).

Disturbance History - Mass Wasting

Landform Block 2B contains 5 of the 19 road related failures in the watershed. Debris avalanche potential exists in the upper elevations of Hackleman, Bunchgrass, Browder, Park and Crescent Creek drainages. A large Quaternary landslide has been mapped by the U.S. Geological Survey 2 miles northeast of Crescent Mountain. No recent movement could be discerned from the air photo surveys (Figure 4-22, 4-23))

Landform block 2B contains SRI Unit 3 potentially on all slopes; and Units 13, 16, 301, 610, 610U, 614, and 71 on slopes greater than 70%.

Figure 4-21. Landform Block 2b Locator Map

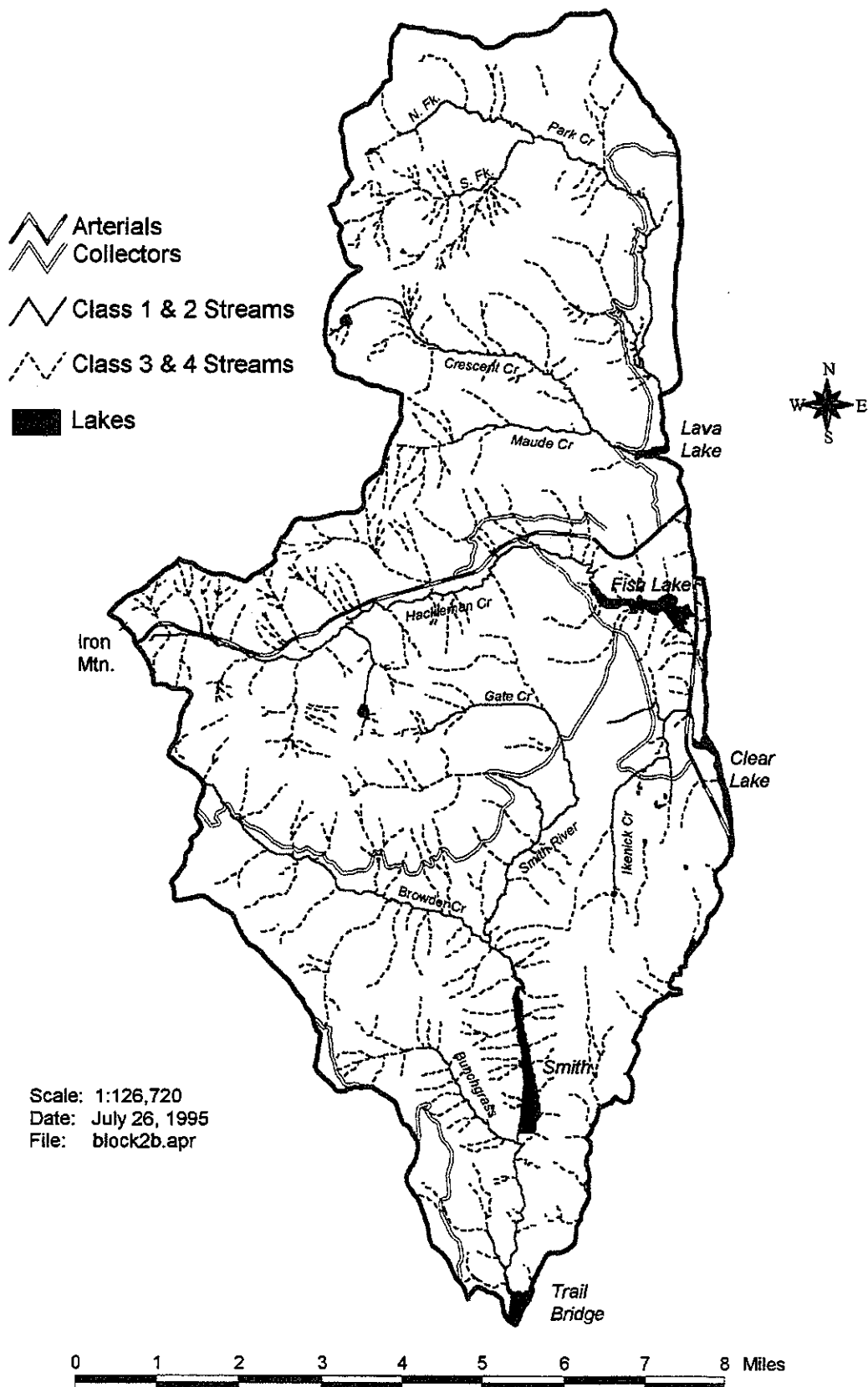


**Figure 4-22. Landform Block 2b
Potentially Unstable Areas**

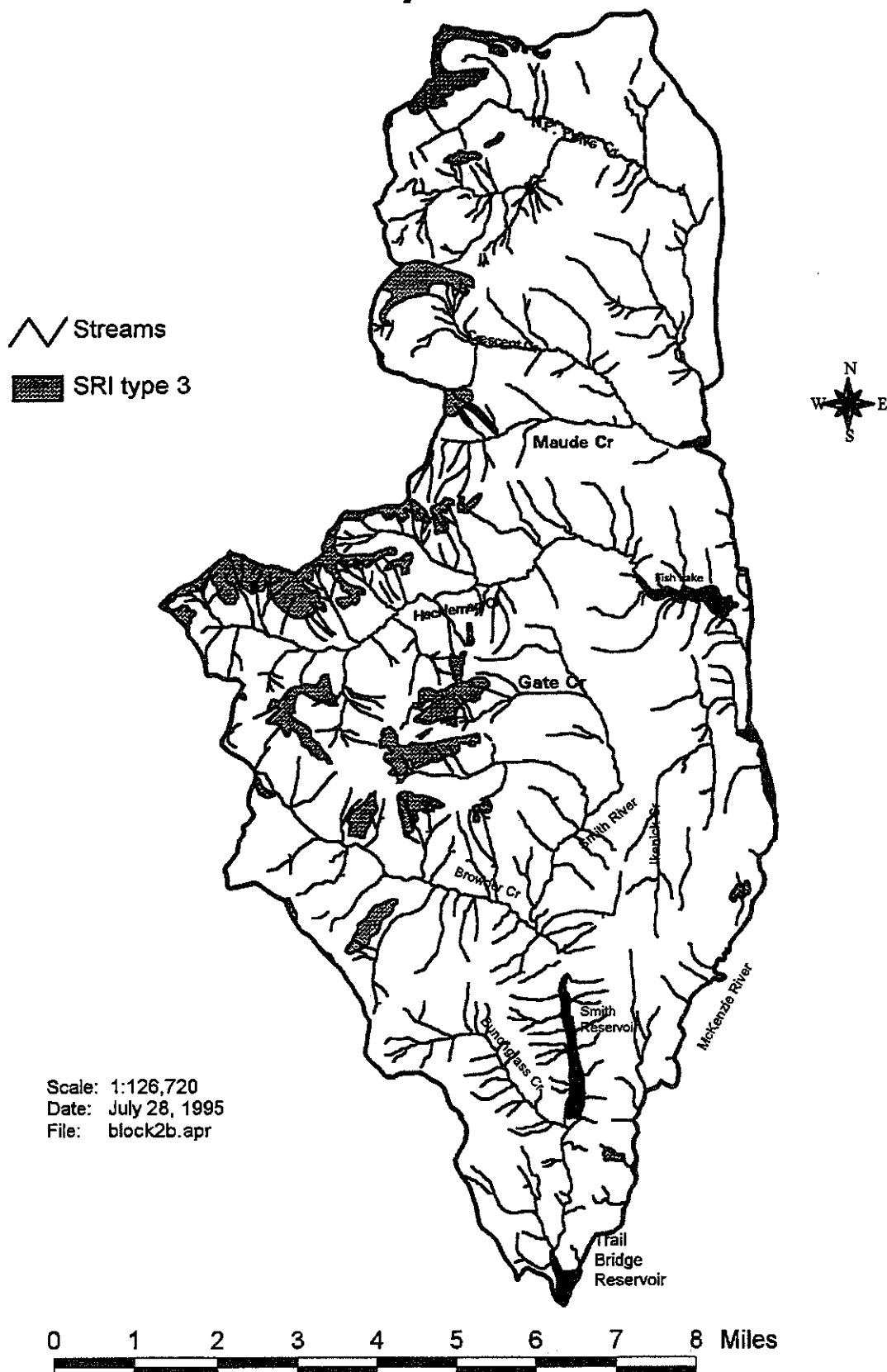
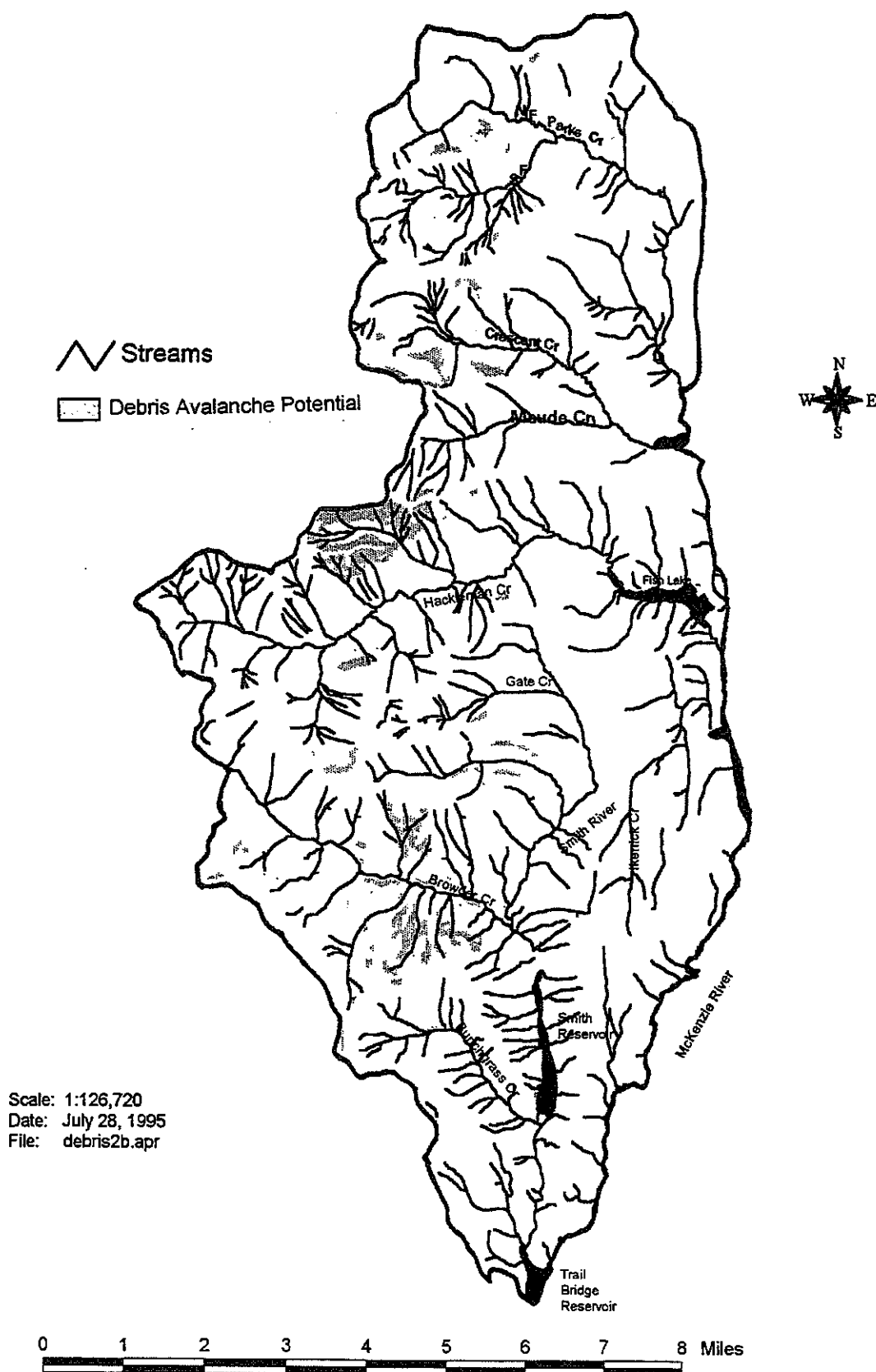


Figure 4-23. Landform Block 2b Debris Avalanche Potential



Disturbance History - Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM) and western hemlock (TSHE) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

Strong east and west winds in this area are channeled between Wildcat Mt. and Browder Ridge; Browder Ridge and Iron Mt.; and between Echo Mt. and Crescent Mt. Other areas, with the exception of the ridgetops, are subject to the normal up-slope and up-valley daytime winds.

The forested stands in this block were formed by medium-sized, intermediate-frequency, stand-replacing fires. Small-sized, relatively frequent, and low-intensity lightning fires also occurred in this block, resulting in a high level of patch diversity. Fire influences have been complicated in this area by the presence of current and traditional human travel-ways. Portions of the block that contain these corridors have experienced a significant number of human-caused fires.

Some of the mountain tops and ridge tops have had large areas that frequently burned, either by lightning or by human fire use. Certain creek bottoms in this area apparently have been favored areas for historic summer camping, as evidenced by the open stands of timber. These openings appear to have been maintained over time by the users of the area.

The forest patches in this block are a mix of even-aged and multi-aged stands. The average size of the patches is moderate: 61 acres. This is smaller than the average patch size in 1900, which was 123 acres. A Shannon diversity index for this area indicates a 6% increase in diversity between 1900 and 1995. The index increased from 1.20 in 1900 to 1.27 in 1995. This is a reflection of the increased availability of small, early seral patches on the landscape from clearcutting.

Unique Habitats

Table 4-6 and Figure 4-24 display the unique habitats present in this landform block. This area has the largest concentration and greatest diversity of non-forested plant habitats within the watershed. These habitats and associated plant communities are rich in floristic biodiversity.

Table 4-6: Unique habitats within landform block 2A.

Habitat Feature	Acres
Wet meadow	402.4
Dry meadow	17.51
Mesic meadows	3.67
Herb/Forb meadow	1529.8
Shrub communities	2.78
Shrub lava	55.73
Lava	272.93
Rock outcrops	343.66
Lakes	.58

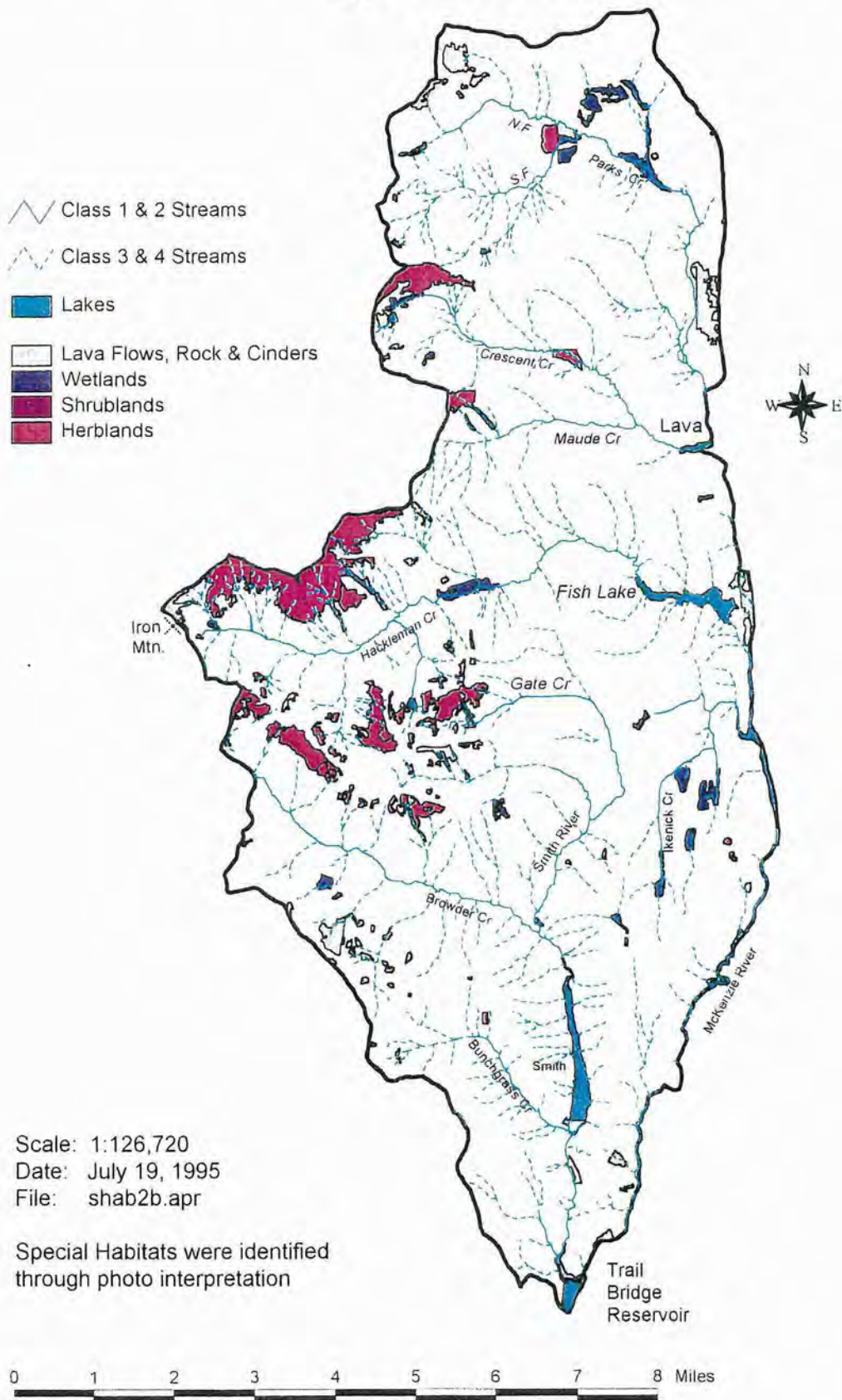
The prominent non-forested habitat type in this landform block is meadow communities, particularly along Browder Ridge. Dry meadows occupy the south-facing mountain slopes. Typically these meadows develop in shallower soils than the adjacent forested areas. These meadows have evolved with recurring periodic fires. Wildfire suppression activities have removed the role fire once had on the maintenance of the native vegetation. The periodic burning of meadow vegetation stimulates vigorous new growth, consumes dead and dying plants and reduces shrub and tree invasion. Bunchgrass Meadow is planned to be burned to reduce conifer encroachment. There are several other meadow communities that would benefit from a light surface burn.

Large wet plant communities are found at Smith Bog, Fish Lake and the wet meadows associated with the Parks Creek area to the north of the watershed. Smith Bog and Fish Lake are very resilient plant communities. Smith Bog and Parks Creek have populations of beavers. Beaver activities are known to alter plant composition and structure. Although livestock have been grazing at Fish Lake since the early 1900's, species' composition of the sedge meadow has not been severely impacted.

Smaller wetlands within and near harvest units have been impacted by past logging practices. The removal of the overstory canopy or adjacent forested areas alters the hydrology of these habitats. Changes in the hydrology of these communities alter plant species composition and succession, which may have impacts to the wildlife species that use these habitats.

Wet and dry rock gardens are scattered across the older Cascade peaks. Many of these habitats have been impacted by the removal of adjacent forested stands and the subsequent change in the microclimate. An increase in solar exposure increases the air and soil temperatures which can alter the vegetation composition of these habitats. Rock gardens adjacent to hiking trails are impacted from soil disturbances. Soil disturbance provides noxious weeds and other non-native plants the opportunity to become established. The noxious

Figure 4-24. Landform Block 2b Special Habitats



weed St. John's wort is a serious threat to the integrity of the plant communities on Iron Mountain.

Two rare forested plant associations (PSME/HODI/GRASS and ABGR/BENE) are found in this landform block. The Pacific silver fir/devil's club plant association occurs frequently in this landform block where soils are deep and drainage is impeded or near streams. These sites have high wildlife values. Remnant patches of Alaska yellow cedar (*Chamaecyparis nootkaensis*) are found in avalanche chutes, and swampy wet areas. These uncommon forest types contribute to the biodiversity of forested plant communities.

This landblock contains high quality cliff habitat for peregrine falcons. Sittings have been recorded. Fish and Lava lakes are providing high quality habitat for many wildlife species, including several threatened and sensitive species such as bald eagle and sandhill cranes. Meadow complexes in this area include Smith Prairie, Crescent Mtn., South Pyramid, Wildcat RNA, and, and Fish Lake (during summer months). Wetland areas include Smith Ridge SWHA and Lava Lake. Maintenance of water quality, hydrological processes, and riparian/meadow vegetation are critical for these habitats to continue to function. The majority of these areas are protected from threats through Special Wildlife Habitat Area or Research Natural Area LMP designations. These habitats are not currently being threatened with the exception of Fish Lake. Though grazing is occurring at Fish lake, high quality habitat is still being provided for several sensitive species.

Sensitive Plants

Potential habitat for sixteen sensitive plant species occurs within the landform block. Three sensitive plant species and numerous other species of concern have been documented (Table 4-7). The population center for the sensitive species Thompson's mistmaiden (*Romanzoffia thompsonii*) is located along the rocky, south-facing slopes of Iron Mountain, Cone Peak, and Browder Ridge. Gorman's aster (*Aster gormanii*) is a species proposed to be listed as Threatened by the U.S. Fish and Wildlife Service. Both of these species are locally endemic and found only within a narrow geographical range on the west side of the Cascades. Threats to these sensitive species are disturbances to populations growing close to hiking trails and the invasion of noxious weeds, particularly St. John's wort.

The third sensitive species documented here is the reclusive mountain grape-fern (*Botrychium montanum*). This is the only known sighting on the Willamette National Forest. There were no known collections of *B. montanum* in the Northwest prior to 1976 (Wagner 1983). Botrychiums are not 'true ferns' because their sporangia (spore sacs) are borne in clusters on a naked stalk, instead of on leaves as in true ferns. The clusters of sporangia are thought to look like

bunches of grapes. The mountain grape-fern is unique from most other sensitive plant species as it occurs in forested plant communities. It is associated with western red cedar growing on stream terraces. This species is to be considered in altering riparian reserve widths. Threats to this population are loss of shade from the removal of overstory trees and shrubs and damage from ungulate browse.

Table 4-7: Sensitive and Rare Plants Located in the Upper McKenzie Watershed.

Species	Status	Number of pops
<i>Aster gormanii</i> -Gorman's aster	S	2
<i>Botrychium montanum</i> - mountain grape-fern	S	1
<i>Romanzoffia thompsonii</i> - Thompson's mist maiden	S	>6
<i>Castilleja rupicola</i> - cliff paintbrush	R	2
<i>Douglasia laevigata</i> - Smooth douglasia	R	3
<i>Epilobrum luteum</i> - yellow willow-herb	R	2
<i>Hemicarpha occidentalis</i> - western hemicarpha	R	1
<i>Martensia bella</i> - Oregon bluebells	R	1
<i>Tholurna dissimilis</i> - lichen	R	1
<i>Sidalcea cusickii</i> - Cusick's mallow	W	1
<i>Asplenium trichomanes</i> - maidenhair spleenwort	C	1
<i>Botrychium simplex</i> - little grape-fern	C	2
<i>Heuchera chlorantha</i> - meadow alumroot	C	1
<i>Isoetes</i> spp. - quillworts	C	1
<i>Polydictyon lonchitis</i> - mountain holly-fern	C	1
<i>Viburnum edule</i> - squashberry	C	1
The Region 6 Sensitive (S) Plant List; Review (R) List and the Watch (W) List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern (C) List for locally rare species not included in the first three lists.		

In addition to *B. montanum*, several other species listed in the ROD Table C-3 are found in this landform block. A rare leafy arboreal lichen, *Tholurna dissimilis*, is found growing in the upper canopy of old growth Douglas-fir trees on Iron Mountain. This site is the only known location in Oregon. A rare endemic nitrogen fixing lichen, *Nephroma occultan*, is reported to occur in the canopy of old growth trees along Fish Lake Creek. Of the five known sites of this species

in Oregon, four occur on the Willamette National Forest. Three species of rare and false truffles are found within the Wildcat Research Natural Area (RNA) and one species (*Alpova* sp. 1690) at Hackleman Creek. The extensive timber harvest in the Hackleman Creek area may have removed much of the mature forest near the site where the fungus was discovered. These species of fungi are rare, local endemics known only from these sites. The Wildcat RNA is recommended as a Mycological Special Interest Area (Holthausen, et al. 1994). *Allotropia virgata* is found in a western hemlock stand within this landform block.

Noxious Weeds

Control methods used in this block are manual, biological control agents, and the selected use of rodeo. Spotted knapweed growing along the road should of Hwy. 126 and an isolated population of dalmation toadflax were treated with Rodeo in FY95. Manual removal and the use of biological control agents have been unsuccessful on these species. The toadflax site is the only know location on the Willamette National Forest.

CHANNEL CONDITION AND AQUATIC HABITAT

Sediment production in this landform block was historically high, similar to landform block 2A. However, the large-sized and high-intensity fires that affected this block possibly make this area the highest producer of sediment in the watershed due to the unstable nature of the terrain. This would be particularly true for Browder Creek, Smith River, Bunchgrass Creek, and Hackleman Creek, where the majority of stream length flows through the steeper, more unstable Western Cascades geology. Prior to construction of Smith Reservoir and Trailbridge Dam, the major contributors of sediment to the main McKenzie River in the watershed were likely Smith River, Browder Creek, and Bunchgrass Creek. Although Hackleman Creek produced and transported large quantities of sediment, the change in geology to the low gradient, relatively stable terrain of the high cascades provided depositional, response reaches. As the high gradient reaches of the Western Cascades transported material down Hackelman Cr., the coarser sediments such as boulders, cobbles and some gravels deposited soon after traversing from the high gradient western cascades to the low gradient high cascades. The finer materials of sands, silts, and some gravels were carried further down the channel, depositing at the lakes' edge, into the meadow system, and into Fish Lake.

Fish Lake drains during the summer via an intermittent channel to Clear Lake. Fish Lake Cr. transports very small quantities of fine sediment into Clear Lake. Drainage of the lake also occurs through two drain holes in the center of the lake, which are part of a series of lava tubes connecting to Clear Lake. Fine

sediments that might be transported into these drain holes would be quickly filtered by the porous lava enroute to Clear Lake.

The upper headwaters of Park Creek, Crescent Creek, and Maude Creek, located in the western cascades geology, historically had sediment production rates similar to Browder Creek, Smith River, Bunchgrass Creek, and Hackleman Creek. Large amounts of sediment were produced as debris avalanches and slides resulted from the high intensity fires were quickly transported downstream to the lower gradient, non-transport response reaches within the high cascades geology. Like Hackleman Cr., deposition within the lower gradient, high cascades geology has formed meadow systems through which Park, Crescent, and Maude meander. These low gradient channels were characterized by high pool frequencies. However, unlike Hackleman Cr., a large proportion of their stream lengths is located within the lower gradient, meadow systems. Also like Hackleman Cr., these streams flow into a lake with no outlet that had been dammed by lava flows (Lava Lake). It also drains subsurface through lava tubes to feed Clear Lake and the McKenzie River.

Ikenick Cr. is the only major stream within the landform block that flows entirely within the low gradient, stable terrain of the High Cascades. Historically, sediment production within the Ikenick drainage has been low even though very large, high intensity fires occur within this drainage. All of the streams within this block that flow within the High Cascades had very large, high intensity fires. Fine sediments such as sands, silts and clays may have been transported from these meadow systems down into Lava Lake, Fish Lake, or in the case of Ikenick Cr., into Clear Lake following an intense, large burn.

Historic disturbances that have influenced this landscape include a large, stand-replacing fire prior to 1901 that burned a large area between Squaw and Bunchgrass Mountain to the south to Cone Peak to the north. This large burn would have influenced the unstable slopes of Smith and upper Hackleman Cr. drainages. Fire disturbance has been shown to influence the erosion rates, stream temperatures and nutrient supply. The portions of the landscape that burned reduced the local recruitment supply of in-stream wood until conifer regeneration matured and replenished the supply. No other major fire disturbance has been recorded in this landform since the early 1900's. A 64 acre fire burned near the headwaters of Browder Cr. in 1919.

Major floods also significantly shaped this landscape. Floods and debris torrents changed aquatic habitat by altering pool:riffle ratios (filling and scouring pools); transporting and concentrating large woody debris into jams; modifying the active channel and off-channel habitats by creating new and abandoning old channels; and sorting and silting spawning gravels. Evidence of debris torrents is present in bedrock scoured channels in the Smith River drainage. Flows of

record in excess of 15 year recurrence intervals occurred in water years 1946, 1953, 1956 and 1965.

The source of the McKenzie River's perennial surface flow is Clear Lake. The lava flow that formed Clear Lake isolated a population of cutthroat trout above, while creating natural barriers to upstream migration. Clear Lake is fed mainly by subsurface flow. The largest flows are from springs on the lake's north and east shores. Fish Lake Cr. and Ikenick Cr. supply Clear Lake with surface flow on the north shore. This low production lake never stratifies and has Secchi disk depth in excess of 100 feet. The recent volcanism that created Clear Lake also dammed the Hackleman, Parks, and Lost Lake drainages, restricting flow from these drainages to subsurface routes to reach Clear Lake below. The isolation of those drainages about 4,000 years ago isolated resident cutthroat trout in their headwater tributaries. Seasonal lakes (Fish, Lava, and Lost Lakes) are present during periods of high flow in winter and spring when basins provide enough flow to exceed seepage through lava. Spring runoff leaving Hackleman Cr./Fish Lake is great enough to flow seasonally over Fish Lake Cr. bed into Clear Lake and provides a corridor for upstream migrating cutthroat trout from Clear Lake. The lake beds of Fish and Lava Lake become meadow during summer and fall as subsurface percolation exceeds basin supply. These lake's long period of isolation is thought to provide the opportunity for genetically unique cutthroat trout population(s).

The high quantities of cold, spring-fed surface water in this high elevation landform provide habitat for unique aquatic macroinvertebrates. Within Landform 2b are found specialized caddisfly whose range is limited to habitat similar to upper Hackleman Creek. Tombstone Prairie Farulan Caddisfly is known from three locations throughout Oregon, including the high elevations of Hackleman Creek's Tombstone Prairie (Schmidt 1968). Occurrences of this species have been in high gradient streams adjacent to old-growth coniferous forest or open road cut areas. Stream channels contained large amounts of woody debris and aquatic mosses. Another aquatic macroinvertebrate, the Tombstone Prairie Oligophlebodes Caddisfly has only been found in Hackleman Creek (Anderson 1976). Both Tombstone Prairie caddisfly are considered Region 6 sensitive species.

Because of fire suppression efforts in the last 50 years, the main cause of mass wasting and sediment production has shifted to road-related failures. As in Landform Block 2A, the quantity of sediment transported from hillslope and into the channels within this Landform may have actually decreased since historic times. However, the character of the sediment probably has changed. Whereas mass wasting from fires or floods would incorporate large trees and various sized sediment, road related failures would generally entrain materials cobble sized and smaller along with some tree stumps. Also, source areas that

historically provided sediment to the McKenzie River have had the supply interrupted by construction of Smith Reservoir.

The streams within this landblock have likely experienced increased peak flows as a result of harvest and roads, though not to the extent of streams in Landform Block 2A. Table 4-3 displays the percent area harvest with roads for subwatersheds Park, Hackleman, and Smith in which Block 2B lies (See Figure 3-17 and 3-17a for subwatershed and drainage boundaries and locations). The area managed for the Park and Hackleman subwatersheds is relatively low, however, the area managed in Smith subwatershed is fairly high and exceeded only by the Deer subwatershed. Indeed, the ARP values for Smith and Hackleman are 82 and 96, respectively, with no value for Park as the entire subwatershed is located in the permanent snow zone and not in the transient snow zone. These high values for hydrologic recovery are due mainly to the small area considered to be within the transient snow zone, because the harvest within the subwatersheds is located within the permanent snow zone, not the transient snow zone. The low percent area managed for the Park and Hackleman subwatersheds is due to the boundaries of these subwatershed encompassing large areas of wilderness and/or new lava flows. When focused down on a smaller scale, it is obvious that drainages within the Park and Hackleman subwatersheds have been extensively managed, with increased peak flows a likely result in Hackleman Cr., Browder Cr., Bunchgrass Cr., Smith River, Danny Cr., and Park Cr. (Table 4-3).

This conclusion is based on data analyzed in a large basin study by Jones and Grant (see Chapt. 3 Overview of Stream/Aquatic Processes for this discussion), and a small basin study by Jones and Grant (see Chapt. 4, Block 2A Streams and Channel Conditions and Aquatic Habitat peak flow discussion). The increases in peak flows result almost entirely from rain events, while rain-on-snow events probably do not contribute to higher flows within this landform block. Figure 3-17b, Potential Contribution to Rain-On-Snow Events, depicts the area east of Smith Reservoir and Smith River below the reservoir as the only high contributing area in the block.

Crescent and Parks Creek and Lava Lake Aquatic Habitat Condition

Crescent and Parks Cr. flow into Lava Lake basin, which flows subsurface to the McKenzie River. Lava Lake bed has been used for domestic grazing since the early 1900's. After the lake bed dried in summer, horses were brought in from 1911-1930, sheep from 1930-1942, horses again from 1945-1966, and cattle from 1967 to present. The animals remained on the lakebed until September (USDA EA 1993[a]). Stream banks within the lake bed meadow are characterized as severely eroded and unstable with little vegetation due to overgrazing. Eighty plus head of elk are observed grazing in the lake bed each spring. The elk leave as livestock are brought onto the allotment. Water quality concerns include

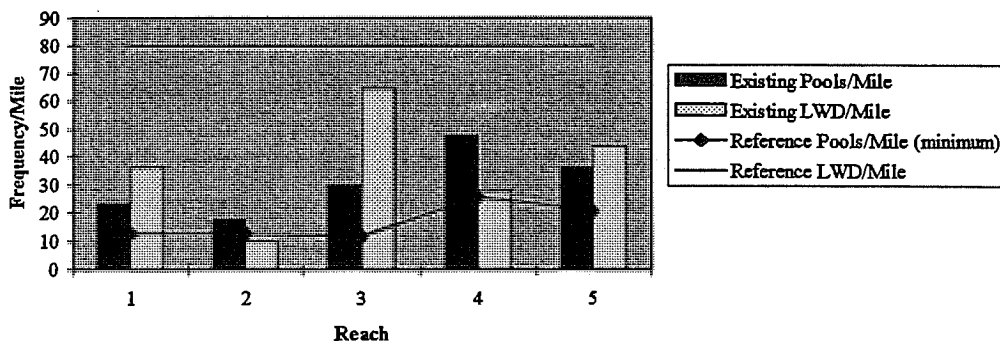
sedimentation and enrichment of surface flow. Fencing to exclude cattle use of portions of Parks Cr. in 1992 resulted in stabilized stream banks and willow survival. In 1993, Sweet Home Ranger District recommended cessation of grazing to improve water quality, riparian and aquatic condition, recreation opportunities, and wildlife habitat. The grazing permit is scheduled to end after the 1995 season.

Fish sampling in 1981 by ODFW biologists found cutthroat distribution throughout Parks Cr., Crescent Cr., and their tributaries. Brook trout established in upper Parks Cr. Brook trout appear to have displaced cutthroat along 3 miles of low gradient pool habitat above and below the confluence of N.F. and S.F. Parks Creek. Cutthroat trout in 1981 were found distributed above brook trout in higher gradient reaches of upper N.F. and S.F. Parks Creek. Both species were found in Brook Trout Cr., a tributary to Parks Creek. It is not known when brook trout were introduced into the Lava Lake system. Brook trout are similarly displacing native cutthroat in Hackleman Cr./Fish Lake system. Monitoring during the past decade by ODFW in Hackleman Cr. saw an increase in proportion of brook trout to cutthroat population. The Parks/Crescent Cr. composition in 1981 was 95.6% cutthroat and 4.4% brook trout.

Low gradients provide for high pool frequency in the Parks Cr. (Figure 4-25) and Crescent Cr. channels. Beaver dams are common. Habitat conditions within regional reference conditions exist for pool habitat, although LWD/mile is present below reference conditions. Certain reaches are deficient of wood due to a natural low density of conifers adjacent to meadows. Elsewhere, recent harvest of conifers in a checkerboard of private ownership provides a poor recruitment source of future in-stream wood as in Reach 2. A 25 acre fire burned an area adjacent to N.F. Parks Cr. in 1973.

Figure 4-25

Parks Creek Large Pools and LWD/Mile: Existing and Reference



From USDA Forest Service Level II Parks Cr. survey, 1993. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

Only cutthroat (no brook trout) were found in the Crescent/Maude Cr., Twelve/Danny Cr. tributaries of Parks Cr in 1981. A potential passage barrier to upstream fish migration in Twelve Cr. may exist beneath FS Rd 2067.

Hackleman Creek and Fish Lake Aquatic Habitat Condition

No current stream survey has been conducted on Hackleman Creek. A 1964 Oregon Game Commission/Forest Service survey found good habitat conditions in Hackleman Creek. Frequent debris jams contributed to a high pool:riffle ratio of 47:53, however much of the wood was subsequently salvaged in efforts to improve fish passage and reduce bank erosion. Approximately 5 miles of Hackleman Cr. and seasonally available Fish Lake and Fish Lake Cr. are currently used by native cutthroat.

A transport corridor for LWD has been interrupted by Hwy 126 over Fish Lake Creek. Large wood historically moved into Clear Lake from the Hackleman Cr. drainage via Fish Lake Cr. is no longer able to continue beyond a highway culvert. Debris from this uppermost part of the McKenzie subbasin historically found its way to the main stem river below.

Fish Lake is an intermittent lake, filling with snowmelt runoff from Hackleman Cr. in the spring, then drying to a sedge meadow in the summer and fall. The lake drains internally through what is believed to be a subsurface lava tube in the center of the lake, and also by surface flow through Fish Lake Cr. into Clear Lake. The lakebed of Fish Lake, when drained to a meadow condition, is approximately 120 acres in size and contains 3.7 miles of winding and interconnected stream channels of Hackleman Cr. and approximately five

permanent ponds. The sedge meadow and streams provide unique habitat to numerous species of wildlife and fish, including the Hackleman cutthroat trout, indigenous to Hackleman Cr.

Historically, the meadow has been grazed by livestock during the summer months, and manipulation of willows (chemical and mechanical removal) and stream channels (rerouting and channelizing) has occurred to increase forage production. As a result of these past management practices, most of the stream miles within the meadow are in poor condition. The streams are downcut into the meadow, are extremely wide and shallow, have very low sinuosity (straight channels that do not meander), and have no overhanging banks. All of these conditions provide poor fish habitat. Both willow and sedge are important to wildlife by providing cover, forage, and structural diversity. Some of the wildlife that use the lakebed include bald eagles, waterfowl, great blue herons, beaver, and osprey.

Stream-side vegetation is important because it builds stream banks by catching sediments; it decreases the erosive force of the creek by dissipating stream energy; and it reinforces banks through its root network. Stream bank stability is reduced within the grazed area due to grazing of vegetation and trampling resulting in stream channel widening, downcutting, and reduced sinuosity. This causes the channel to become very simple in structure with little channel complexity. Vegetation overhang provides cover and food for fish and anchoring sites and food for aquatic macroinvertebrates. Vegetation overhang also protects stream banks from erosion. Stream side willows can shade the stream, act as better bank reinforcement than sedges, and add small wood and nutrients to the stream.

Because of the inherent lack of large wood to this part of Hackleman Creek, undercut banks play an important role as cover for fish. Reduced bank stability due to a lack of stream bank vegetation and grazing early in the year (trampled wet banks) has had an impact upon the amount of bank undercut. Without cover, fish become easy prey for the numerous aerial predators which utilize the lake.

Livestock trampling, stream bank erosion, channel downcutting, and a change in channel shape to a wide, shallow condition, has caused an increase in the amount of stream substrate fine sediment content. As sand and silt content increases in the stream substrate, spawning habitat and cover for fish, and cover and anchor sites for macroinvertebrates decrease.

Approximately eight years ago, 71 acres of the western-most portion of the meadow (59% of the entire meadow) was excluded from grazing. The excluded area contained 1.71 miles, or 63%, of all perennial stream courses in the meadow, and three of the five permanent ponds. Recovery of channel conditions in the

excluded area has been slow, but the gullied stream is showing signs of rebuilding stable streambanks, increasing sinuosity, and providing lush, overhanging vegetation within its newly formed floodplain. . Channel shape has recovered enough to allow transport of fine sediment from the bottom of the channels, exposing the cobbles and gravels. Building of the floodplain up from the gullied situation will take many decades.

Two years ago, a management plan was adopted within the Fish Lake meadow to provide for recovery of all perennial streams and lakes. Implementation of the plan began in 1993, with full implementation of a management alternative occurring in 1994. The plan required exclusion of livestock from an additional 23 acres of critical habitat which contained the remaining 1.0 mile of perennial streams, and 0.4 miles (40%) of intermittent streams. An additional 6 acres of non-critical area (containing no perennial streams) was added to the acreage to be grazed located on the eastern boundary of the meadow. With current practices, 33 acres, or 27%, of the entire meadow is grazed during the summer months, and contains 0.6 miles (60%) of all intermittent streams.

Visual estimates of meadow and stream condition since the change in management practices in 1993 indicate an upward trend in channel condition. Monitoring data collected the summer of 1994 will continue throughout the coming years to track condition of the stream channels and riparian vegetation.

Hackleman cutthroat are thought to be a unique population due to their geographic and temporal isolation and have been identified by ODFW as a Category 2, Stock of Concern. Hackleman Cr. has been closed to angling since 1922. Brook trout, established in Hackleman Cr. and Fish Lake, are believed to have migrated downstream after introduction into Heart Lake in 1949. Brook trout were first noted in Hackleman Cr. in 1989. Continuing monitoring by ODFW biologists reveal an increasing proportion of brook trout to cutthroat trout in annual trapping of Hackleman Creek. The potential for extirpation of Hackleman cutthroat from this drainage by competition from brook trout or exposure to disease appears to be a real danger. In 1994, an annual effort to trap Hackleman cutthroat as hatchery brood stock yielded no schools of cutthroat as are usually encountered. Trapping effort in spring 1995 have found Hackleman cutthroat.

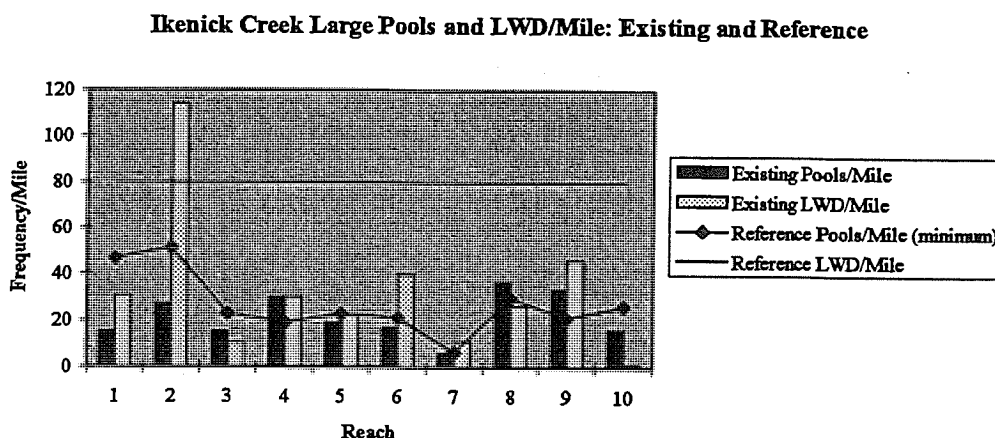
Ikenick Creek Existing Aquatic Habitat Condition

Ikenick Cr. drains Smith Prairie into Clear Lake. The construction of Carmen-Smith-Trail Bridge complex in the early 1960's may have significantly altered groundwater storage and flow regime on Smith Prairie.

Brook trout residing in lower Ikenick Cr. originated from introduction into Clear Lake and now appear to be limited to Ikenick Creek's lower 0.2 mile. The low gradient habitat found above on Smith Prairie would likely provide ideal brook

trout habitat if not for a passage barrier culvert beneath Hwy 126 and steeper gradients of Reach 2. This barrier to upstream migration appears beneficial because it prohibits brook trout from expanding their range into upper Ikenick Creek. Native cutthroat trout are found throughout Ikenick Cr., with brook trout only found in Reach 1 up to Hwy 126 culvert. Low volumes of in-stream wood characterizes most Ikenick Cr. reaches (Figure 4-26). The stream channel and tributaries are adjacent to roads and have been salvaged in the past. Several reaches are deficient of wood due to a natural low density of conifers adjacent to meadows. Reach 2's higher volume of in-stream wood was provided by windthrown buffer of stream adjacent conifers and bank failure.

Figure 4-26



From USDA Forest Service Level II Ikenick Cr. survey, 1993. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

The channel condition is generally characterized as possessing low stream canopy density due to recently managed stands or meadows. Stream banks are often unstable, and bank cutting/failure is common. Low quantities of large diameter in-stream wood are not available to provide cover and a source of pool scour. Several reaches with stream adjacent conifers have poor recruitment potential due to young seral classes. The lack of stream canopy in Ikenick Cr. may warm water temperatures beyond the historic range. A survey of the stream in late June 1993 found temperatures to 18 deg. C.

Pool habitat is near regional reference levels, sometimes exceeding reference minimums. High pool frequency and deep pool depth are common in Ikenick Cr. low gradients. Beaver dams are common. A 15-30 foot wide zone of vine maple and alder hardwoods is characteristic of most reaches.

Clear Lake Aquatic Habitat Condition

A variety of game species have been stocked in Clear Lake since the early 1900's, including non-native cutthroat stocks. It is unknown if native cutthroat remain genetically distinct. Brook trout were introduced in the early 1960's, and they now reproduce naturally. Continued natural reproduction of brook trout is expected to limit survival of juvenile cutthroat trout in Clear Lake (ODFW 1990). Periodic sampling of the lake reveals brook trout comprise about 75% of the lake's fish population. Rainbow trout are the only species currently stocked and do not appear to reproduce naturally in Clear Lake or its tributaries.

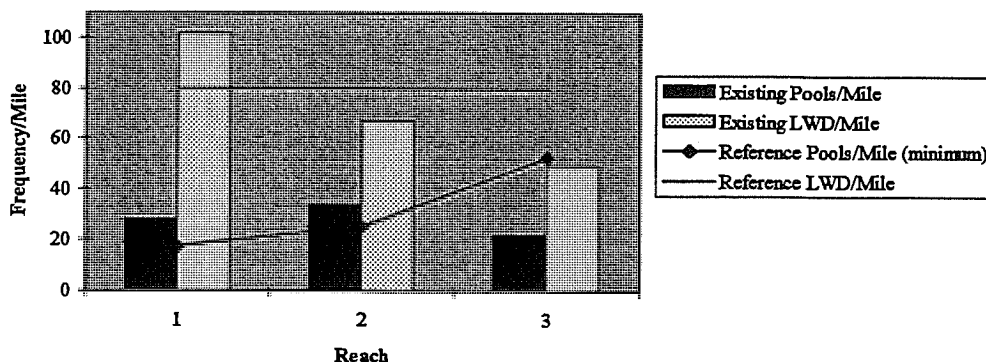
Smith River, Bunchgrass and Browder Creeks Aquatic Habitat Condition

Recent surveys have been conducted on Bunchgrass and Browder Cr. Older surveys (1975 and 1977) are available for Smith River, Gate, Bunchgrass, and Browder Creeks. Twenty years ago, Smith River was characterized as having a wide channel with few pools. Pool depths were shallow and bedrock exposure in the channel was common, suggesting debris torrents had scoured away portions of bedload. Numerous log jams of natural origin (windthrow and bank failure) with stored sediments were common in Smith River upper reaches. The Western Cascade geology is evident with steep side slopes and highly erodable soils. Bunchgrass Cr. typifies larger tributaries with common bank failure, frequent stored sediments behind debris accumulations, and many alluvial bars. Smith River and its tributaries have had their substrate and debris transport intercepted by Smith and Trail Bridge dams. LWD collected behind each dam is removed from the channel to avoid damage to utility equipment.

A recent survey in Browder Cr. reflects Smith drainage's current general condition. In-stream wood is present in fair numbers, but the recruitment potential is poor due to recent harvest activity (Figure 4-27). Pool frequency is best where in-stream wood continues to influence the channel. The upper reach of Browder Cr. (Reach 3) contains fewer pieces LWD, which is lower than reference pool frequency, and poor recruitment potential of large diameter wood.

Figure 4-27

Browder Creek Large Pools and LWD/Mile: Existing and Reference



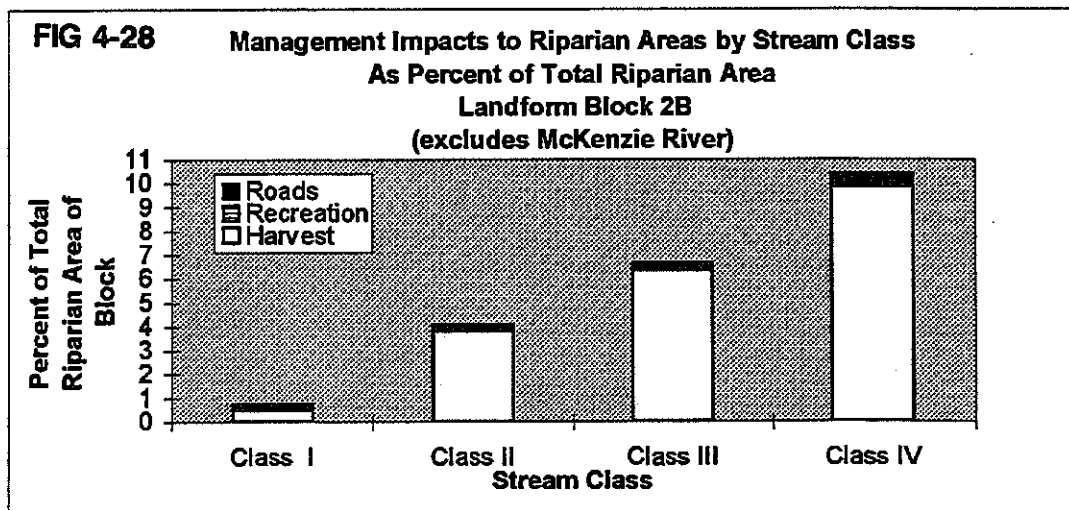
From USDA Forest Service Level II Browder Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

Similar to Browder Cr., high quantities of LWD are present in lower Bunchgrass Cr., and pool frequencies meet reference conditions.

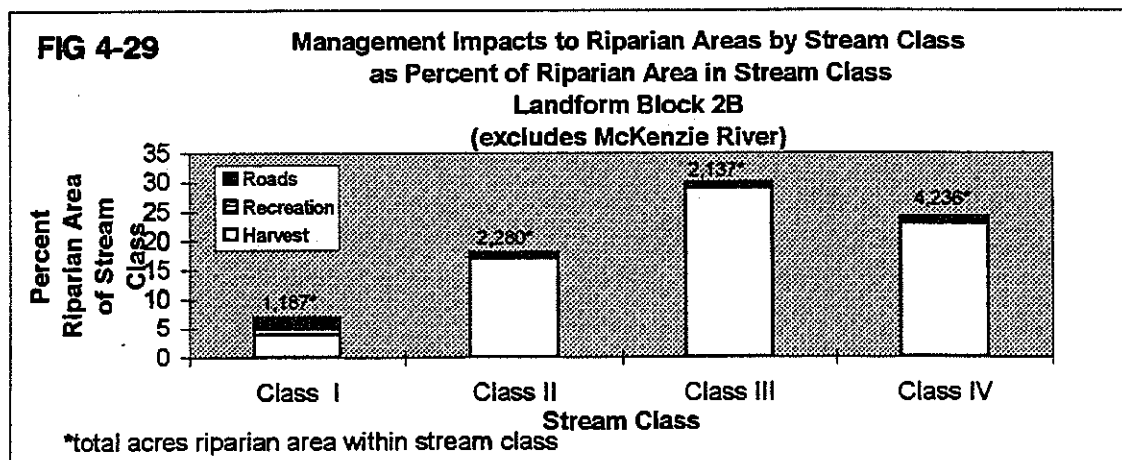
Cutthroat trout are currently the most prevalent fish species. They are found throughout Smith River and its tributaries. Previous surveys found a few rainbow trout in lower Smith River and lower Browder Creek. Rainbow trout are stocked in Smith reservoir throughout summer. A naturally reproducing population of brook trout are found in Smith Reservoir, likely utilizing lower Smith River as spawning habitat. Bull trout were reportedly caught for several years following impoundment of Smith reservoir, apparently trapped upstream of Smith dam as they utilized Smith drainage as foraging habitat. No suitable bull trout spawning and rearing habitat has been found above Smith dam to support an isolated population in Smith reservoir. Two potential barriers to cutthroat upstream migration are present in Smith drainage: a barrier culvert on upper Gate Cr. beneath FS Rd 1598 and a barrier culvert on upper Browder Cr. beneath FS Rd 1598.

Riparian Vegetation

Landform Block 2B has approximately 22% of the total riparian reserves for the block in a harvested or roaded condition (Fig. 4-28).



Class IV streams are the most altered, with approximately 10% of the total riparian vegetation impacted. However, of the total acres in Class II and III riparian reserves, 18% and 30%, respectively, have been roaded or harvested (Fig. 4-29).



Of the Class II riparian areas, Smith River, Browder Cr., and Crescent Cr. are the most heavily impacted. The total miles of Class II stream riparian reserves in an altered condition is approximately 9 miles. The 30% of Class III riparian reserves impacted are mainly located in Hackleman Cr., Crescent Cr., and Park Cr. (including Danny Cr.). This figure is particularly troublesome as it represents nearly 30 miles of Class III stream riparian reserves that have been manipulated. Four percent of the Class I riparian reserves have been harvested,

while approximately 1% is in a recreation site (Lake's End Campground and part of Trailbridge Campground), and 2% is roaded.

Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that this landform block has 49 dispersed camp sites located on McKenzie Ranger District. In 1990, Sweet Home Ranger District conducted a dispersed campsite inventory that collected information on somewhat different data. For those 33 dispersed sites, information on the total campsite area was not gathered; barren core measurement were not collected for eight of the thirty-three; and distance to water was not specifically measured for any. Inference can be made as to whether these are riparian sites, as a data entry for water on/off site was gathered. The analysis for these 33 sites will be discussed separately below. The 82 dispersed sites in this block represent 25% of the total 333 sites in the watershed.

Riparian: McKenzie—Thirty-one sites (or 38%) are in a riparian reserve, with 25 of these sites concentrated in the Fish Lake dispersed area. There are 2 riparian sites on Hackleman Creek Road and 4 on the road to Smith Reservoir. Vehicles can access all but 2 of the riparian camp sites. The 31 riparian dispersed sites have a total of 55,825 sq ft, or 1.28 acres of total campsite area. The barren core of these sites equals 24,550 sq ft or 0.56 acres. That averages to 44% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very large core areas.

Riparian: Sweet Home—Six of the inventoried sites are riparian. Three are on the 2067 Rd, and two are on the 2672 Rd. That equates to 7% of the 82 sites. Four of the six sites did not collect barren core data. All of these sites are accessible by vehicle.

Non-Riparian: McKenzie—Eighteen of the dispersed campsites are not close enough to water to be considered within a riparian reserve. These 18 sites have a total area of 40,145 sq ft, or 0.92 acres. Of this area, 21,195 sq ft or 0.49 acres is considered barren core. That averages 53% of core within these sites. All of these dispersed camps are accessible by vehicle.

Non-Riparian: Sweet Home—Twenty-seven of the sites are not in a riparian buffer. The barren core data collected included two huge measurements (500x500 and 500x1000) that skew data to the point that, compounded by missing barren core measurements for three sites, an "average barren core"

would be meaningless. Separating out those five sites, the remaining twenty-two sites have a barren core of 2770 sq ft, or 0.64 acres. All of these dispersed sites are accessible by vehicle.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service provided tables, fire rings, vault or flush toilets, and parking spurs. They may have water systems and garbage service. The Recreation Resource Information System (RRIS) lists the condition of facilities. Boat launch facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river.

The following developed recreation facilities are located within landform Block 2B:

Campgrounds: Trailbridge Campground—There are 28 designated camp units in this campground. Trailbridge "Flats" refers to the rocky, open area near the shore of the reservoir, outside of the forested developed campsites. Undesignated camping is allowed in this area, with 49% of the total campground area within the riparian reserve of the Trailbridge Reservoir. Lake's End Campground—There are 17 camp units in this campground, located at the end of Smith Reservoir. Eighty-three percent of the campground is within the riparian reserve. Fish Lake Campground—There are 10 camp units in this campground, and 93% of the campground is within the riparian reserve of Fish Lake. Lost Prairie Campground—There are 10 camp units in the campground with 100% falling within the riparian reserve.

Boat Launches: Trailbridge, Carmen, and Smith Reservoirs all have boat launches with simple ramps. Vault toilets are located at Carmen and Smith, with seasonal placement of portable toilets at Trailbridge. All of these boat launches are located within the riparian reserves.

Picnic/Day Use: Clear Lake Day Use Area consists of 8 picnic sites and a historic covered picnic shelter. It covers 40 acres of which 43% falls in riparian reserve.

Sno-Parks: Ikenick, Lost Prairie, Big Springs, Lava Lake, and Tombstone Pass sno-parks are in this landform block. The only facilities connected with these areas are signs, plowed parking, and winter-accessible composting toilets at Lava Lake and Big Springs. Ikenick, Big Springs, Lava Lake sno-parks cover over 7 acres and none are in riparian reserves. Lost Prairie and Tombstone Pass sno-parks are entirely in riparian reserves.

Administrative or Recreation Special Use Permit Areas: Fish Lake Remount Station is located in this block. It consists of three historic cabins, a large barn and corral, a pioneer grave interpretive site, and a modern-day bunkhouse duplex with the historic Santiam Wagon Road running through the complex. Clear Lake Resort consists of small rental cabins, vault toilets, a restaurant/store with floating boat dock, a gravel parking lot and a boat ramp. This permit area covers 11.87 acres of which 99% falls within the riparian reserve of Clear Lake.

LANDFORM BLOCK 3

HIGH CASCADE PLATFORM

(Hoodoo, High Cascade Plateau systems of Wilson 1981)

Introduction

This Landform Block is characterized by broad, flat, glacially scoured rock plains (Davie 1981) interrupted by volcanic cinder cones (Hoodoo Butte), residual volcanic plug domes (Hayrick Butte and Hogg Rock), shield volcanoes (Maxwell Butte), glacial lakes (Big Lake), glaciated ridges (Potato Hill), and High Cascade composite volcanoes (Mt. Washington). Relief in the area is between 0 and 20% except near or on the side-slope of cinder cones. The soils in this area are largely a result of wind-blown and glacial-lake silt deposits; volcanic ash and cinder fall from the Sand Mountain cinder cones; and large deposits of free draining and granular of glacial moraine in the Santiam Pass area (Figure 4-30).

Disturbance History - Mass Wasting

Landform Block 3 is located on the High Cascade platform with low relief. Any unstable potential in this area is confined to the rock cuts on the main arterial highways (See Mainstem McKenzie landform block discussion) and on the flanks of cinder cones (Figure 4-31).

Landform block 3 contains SRI Unit 3 potentially on all slopes.

Disturbance History: Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM), Grand fir (ABGR) and mountain hemlock (TSME) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

**Figure 4-30. Landform Block 3
Locator Map**

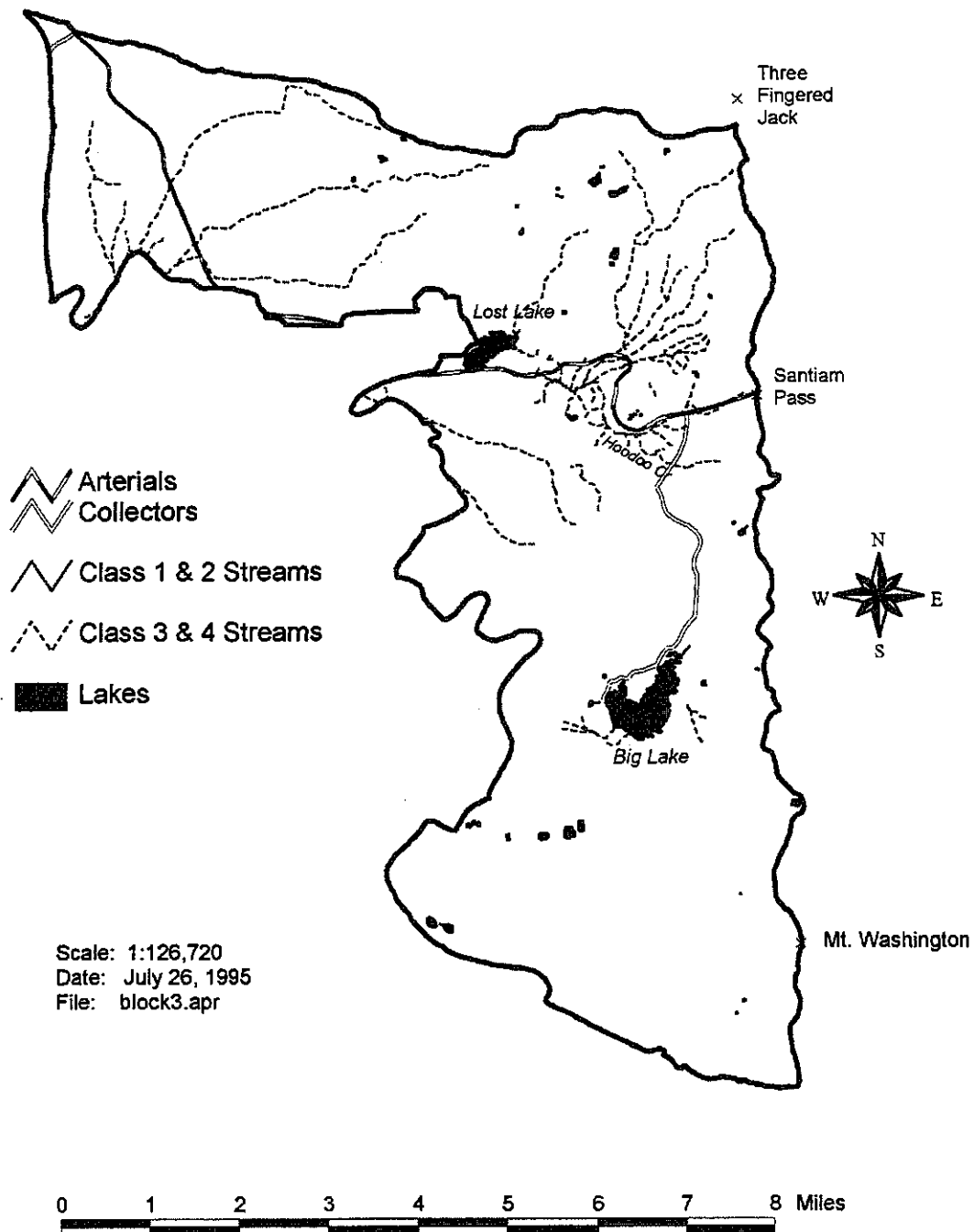
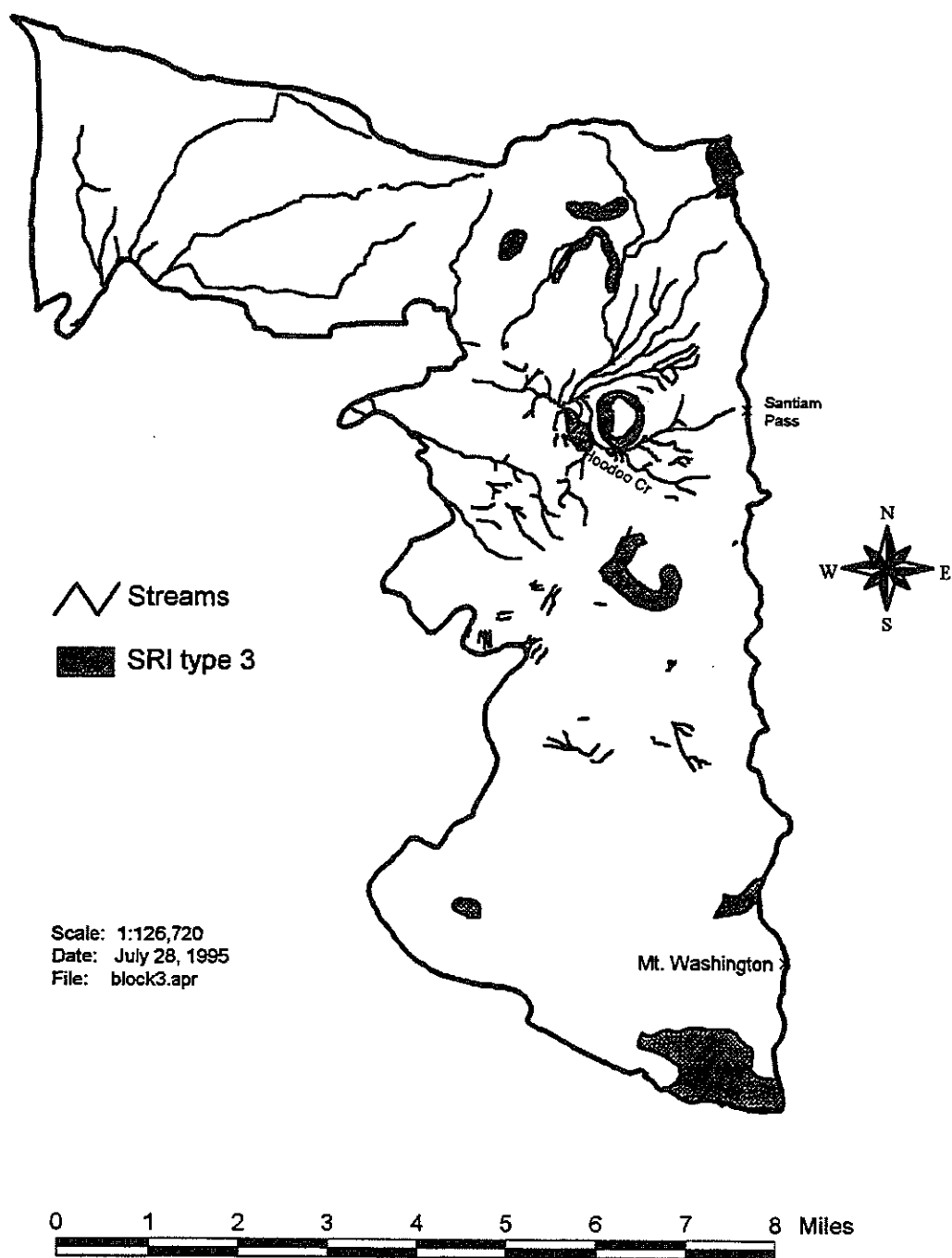


Figure 4-31. Landform Block 3 Potentially Unstable Areas



Wind flow in and around this area predominately occurs from two directions: southwest and east. The majority of the time, wind blows from these directions with little to no effect. Depending on the time of year and atmospheric condition, both wind directions can occur on a daily basis. This is caused by the difference in the intensity of heating on the east side and west side of the Cascade crest. When the heating is stronger on the east side, an easterly wind passes a few miles over the crest.

Most of the stands have been created by small-sized, low to medium-intensity, relatively frequent fires. Large-sized, high-intensity fires of intermediate frequency also occurred on the more southerly, lower aspects in this block.

The two most recent outbreaks of western spruce budworm (*Choristoneura occidentalis*) within block 3 coincided with regional outbreaks along the east slope of the Cascades and in the Blue Mountains of northeastern Oregon. Defoliation in the Santiam Pass area was recorded from 1949 to 1953 and from 1986 to 1993. In the absence of fire, the number of shade tolerant, budworm-host trees increased in many of these stands. The effects of the budworm defoliation on these stands may have been more severe than would have been under an uncontrolled fire regime.

The effects of budworm outbreaks within the Santiam Pass area depend largely on the availability of suitable forest habitat. The amount of suitable habitat is influenced by the exclusion of fire which results in the development of multi-storied stands of fire susceptible true fir.

The forest patches in this block are mostly even-aged stands. The average size of the patches is small: about 70 acres. This is smaller than the average patch size in 1900, which was about 118 acres. A Shannon diversity index indicates that a 14% increase in diversity has occurred from 1900 to 1996. The index changed from 1.50 in 1900 to 1.71 in 1995. This increase reflects an increase in small, early seral patches in this landform block from clearcutting.

Unique Habitats

Table 4-8 and Figure 4-32 displays the unique habitats that occur in this landform block. The Cascade range functions as barrier for plant movement from east to west. Some movement does occur at Santiam Pass and few eastside plant species have adapted to this area. This ecotonal affect adds to the biodiversity of the area.

A variety of atypical non-forested habitats and associated plant communities occur in this landform block. Many of these special habitats were created from past volcanic activity, including lava flows, talus, sand blowouts, cone rims, and

rock gardens. Off-road vehicles and the introduction and establishment of noxious weeds and other non-native plant species are the major threats to these habitats. Lava and talus are stable with no known threats. Talus habitat occurs around Hayrick, Hoodoo, and Hogg Rock and at the headwaters of Lost Lake.

Due to the porous nature of the soils, the hydrologic regime determines the types of meadows that are scattered throughout this area. Meadows range from very wet sedge or shrub communities to very dry grass meadows. Hydrologic disturbances can alter plant species composition and structure. Many of these meadows have evolved with fire. Suppression activities have disrupted the ecological role fire once had in maintaining the plant growth and vigor of these communities. Several grass meadows have been identified as seed collection sites for restoration projects.

Table 4-8: Unique habitats within Landform block 3.

Habitat Feature	Acres
Wet meadow	124.17
Sedge Meadow	47.72
Herb/forb meadows	808.52
Vine Maple talus	19.56
Shrub communities	270.48
Dry Rock garden	28.41
Sand blowouts	25.05
Cone rims	1.00
Talus	385.29
Lava	89.05
Rock	675.66
Lakes	3.77

Lost Lake, Big Lake, Mosquito Lake, Patjens Lakes, and Washington Ponds are providing low to high quality wildlife habitat within this block. High levels of motorized boat traffic on Big Lake reduce its quality for wildlife many species. Mosquito and Lost lake are suffering from off road vehicle traffic on their banks. Hogg Rock, Hayrick Butte, and Hoodoo Butte are providing low quality cliff habitat. Because of the low potential for these outcrops to have caves or ledges, they are not considered high quality habitat for most species. Enhancement efforts would probably be best spent elsewhere because of the high levels of human use in this area.

Sensitive Plants

Potential habitat for seven sensitive plant species is found within this landform block (Table 4-9). Two C-3 species are known to occur in this block: *Thaxterogaster pingue*, a rare false truffle found in a conifer stand at Lost Lake, and *Allotropa virgata*, which occurs in two grand fir stands.

Figure 4-32. Landform Block 3 Special Habitats

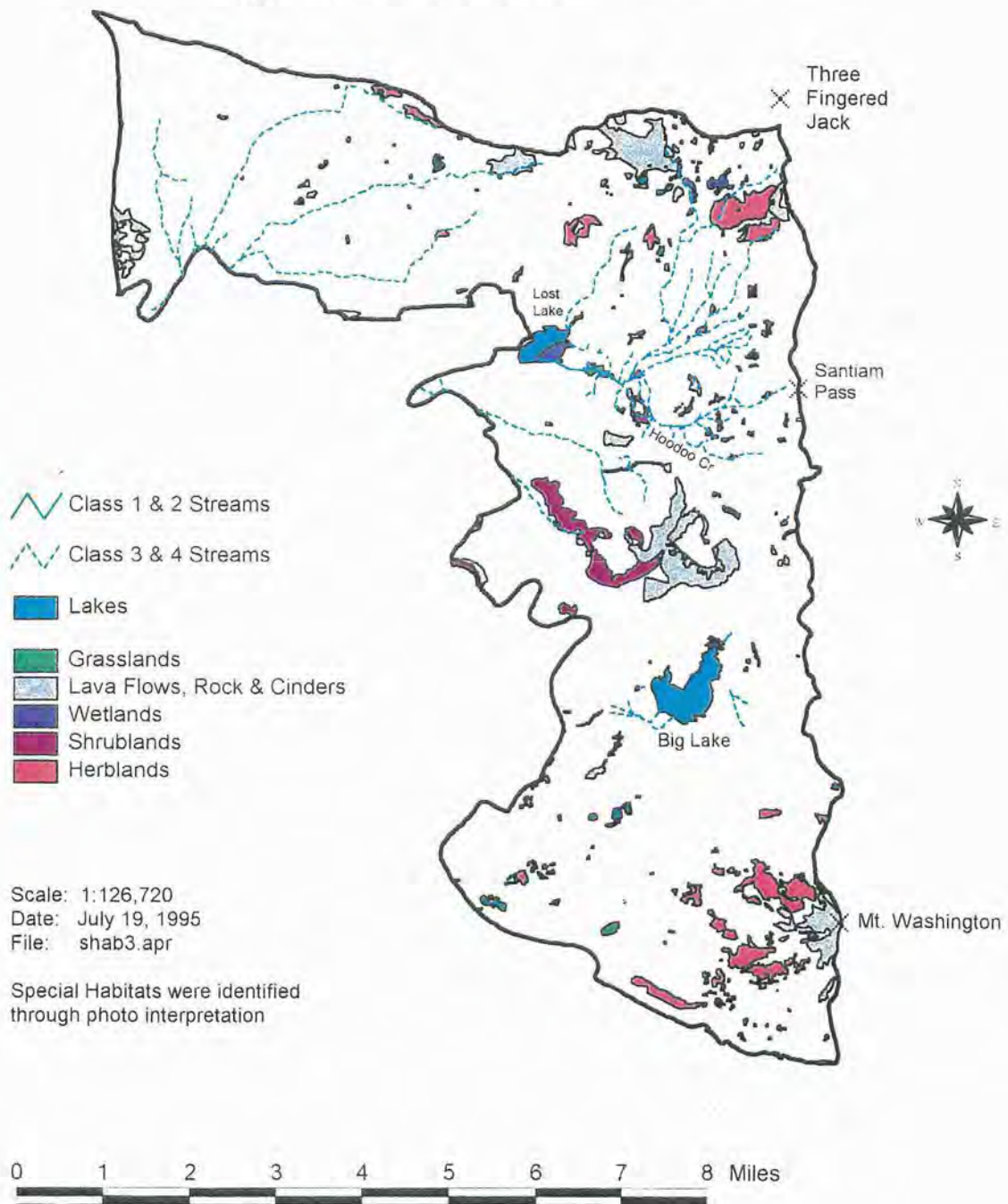


Table 4-9: Sensitive and Rare Plants Located in Landform Block 3.

Species	Status	Number of pops
<i>Botrychium simplex</i> - little grape-fern	Concern	1
<i>Botrychium virginianum</i> - rattlesnake fern	Concern	2
<i>Viburnum edule</i> - squashberry	Concern	1
The Region 6 Sensitive (S) Plant List; Review (R) List and the Watch (W) List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern (C) List for locally rare species not included in the first three list.		

CHANNEL CONDITION AND AQUATIC HABITAT

Block 3 is located within portions of the Park and Kink/Inland Basin subwatersheds, and it is within the permanent snow zone. Lost Cr., a class II, is the only major stream within this block. This subwatershed has very little of its drainage area harvested and roaded (Table 4-3). Like Landform Block 5, the porous glacial deposits and high storage capacity of the lava aquifers result in a large network of Class IV streams and channels that are not subject to high peak flows.

Landform Block 3 contains low quantities of water and riparian habitat. Although intensive, large to medium fires burned here historically, sediment production was minimal due to the general stability of the area and the flat terrain. In wilderness, Craig and Berley Lakes (Mt. Jefferson Wilderness) occupy 12 acres and Patjen Lakes (Mt. Washington Wilderness) occupy 9 acres (Fisheries Appendix). Big Lake and Lost Lake, the largest lakes within Landform 3 occupy 238 and 50 acres, respectively. All lakes are believed to have been barren of fish with the exception of Lost Lake. Anecdotal accounts describe a cutthroat population residing in Lost Lake. If cutthroat once inhabited Lost Lake, they would have behaved much like Fish Lake and Lava Lake populations and migrated up tributaries as the lake bed dried in summer. Lost Lake Cr. would have provided cutthroat with spawning and rearing habitat. Early 1900's accounts also describe Lost Lake as drying entirely, which would have forced aquatic inhabitants to seek refuge in Lost Lake Creek or two short spring-fed tributaries. Unique habitat exists for specialized macroinvertebrates with cold (4° C), spring-fed tributaries feeding Lost Lake, similar to Hackleman Creek. No surface outlet drains Lost or Big Lake.

Disturbance of record in this landform include the 9,000 acre Big Lake burn in 1967, the largest fire recorded in the analysis area since the early 1900's. A large earthflow of unknown date originated from the flanks of Hogg Rock and

contains large quantities of fine sediment (glacial sand?). Lost Lake Cr. now incises the earthflow, and its lower gradient reaches are dominated by sand.

Lost Lake, Lost Lake Creek and Big Lake Aquatic Habitat Condition

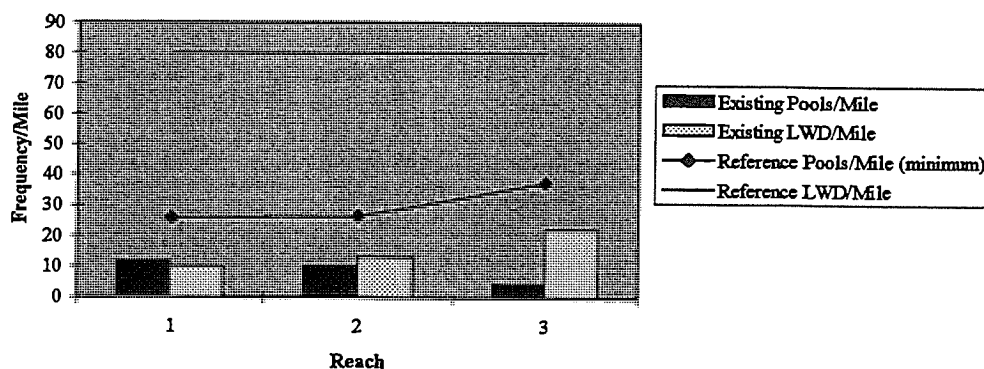
Lost Lake dries during drought years, most recently drying in the early summer of 1992. Lost Lake Cr. provides important refuge for aquatic organisms when the lake bed goes dry. Brook trout have established a naturally reproducing population in Lost Lake and Lost Lake Cr. sometime before records began to be kept in 1950. Currently rainbow trout and Atlantic salmon are stocked in Lost Lake for a popular fly fishing fishery. An idea of how tenuous Lost Lakes' water storage ability is came from recent efforts to provide holding pools for potentially stranded fish. Excavation of tens of cubic feet in the lake bed resulted in more rapid subsurface loss through the lava bed and seasonal drying. Filling in the excavated pools slowed the flow.. The water storage, geology, and subsurface outflow of Lost Lake appear quite similar to Lava and Fish Lake (Landform 2b) and vary only in rate of water percolation. Lava and Fish Lake, with significantly larger catchment basins, are supplied with far greater volumes of water than Lost Lake, but difference in their subsurface flow routes allows them to drain every season.

Heavy recreational use and vehicle access to the lake bed have impacted Lost Lake shoreline and aquatic habitat quality. Soil compaction, vegetation removal and unstable banks have resulted from the heavy use. Aquatic plants adapted to inundation and drying are removed or not allowed to establish in concentrated-use areas. Downed woody material in or near water have been removed.

As described earlier, Lost Lake Cr. has a primary fine sediment supply from an earthflow near its headwaters. Much of the fine material has transported from above and deposited in lower gradient Reach 2, Lost Lake Cr. meadows, adjacent to Hwy 126. The low volume of LWD observed in the 1993 survey is likely a result of broad hardwood riparian zones (Reach 1), or meadows (Reach 2) (Figure 4-33) or the proximity of Hwy 126 to the channel. Smaller diameter wood is present in good quantities in the channel. Smaller diameter true fir and Douglas-fir are characteristic of this high elevation (3,900 ft. or more) and the reference levels of in-stream LWD need adjustment for diameter. Previous management activity does not appear to have reduced the supply of large wood available to the channel. Recent insect infestation and disease have entered the high elevation stands of Douglas-fir, true fir and mountain hemlock. Anticipated rates of LWD input are expected to accelerate, then lull following loss of riparian tree density.

Figure 4-33

Lost Lake Creek Large Pools and LWD/Mile: Existing and Reference



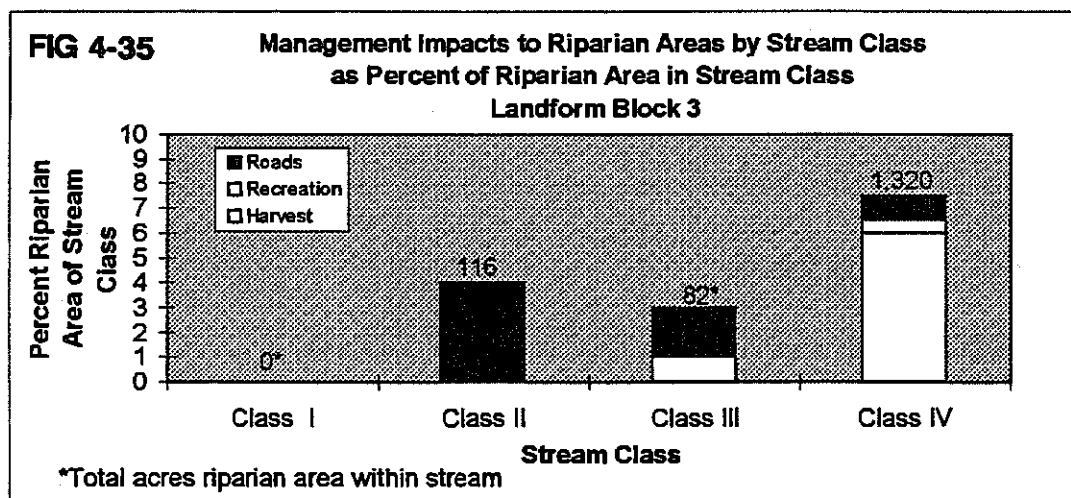
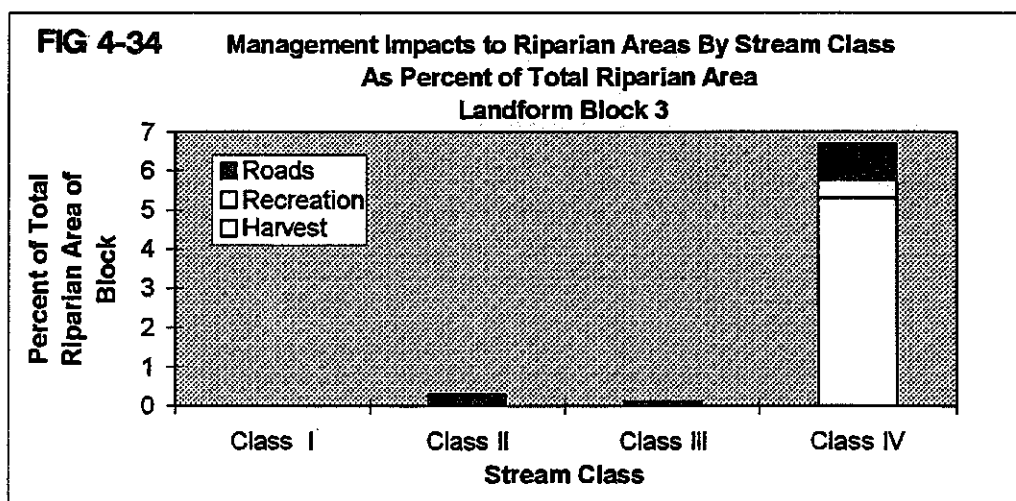
From USDA Forest Service Level II Lost Lake Cr. survey, 1993. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

The highly sinuous channel creates pools by lateral scour or by scouring around in-stream wood. However, low quantities of pools are present in Lost Lake Cr. compared to reference levels, possibly due to large quantities of sand filling pools and lowering pool frequency. Aquatic macroinvertebrate sampling in 1993 collected numerous caddisfly species with various tolerances to sedimentation. Species diversity (18 different species identified) had high to moderate tolerance to sedimentation, with none present with low tolerance to sedimentation (USDA 1993[c]), reflecting the quantity of fine sediment observed in bedloads. Sedimentation appears to be the result of natural disturbance. Human alteration of physical habitat has occurred where the channel nears Hwy 126 and large quantities of red scoria, used by ODOT to sand winter roads, has washed into and accumulated in the channel. Surveyors in 1993 saw concentrations of juvenile brook trout near beds of scoria, suggesting brook trout have found it suitable spawning substrate.

Big Lake, formed by glacial scouring, was barren of fish life until introduction of a variety of salmonids beginning in the 1920's. Big Lake has two Class IV inlets and no outlet. Current stocking occurs annually with various numbers of four species: brook trout, rainbow, cutthroat and kokanee (Fisheries Appendix). Big Lake retains its low level of production despite continued heavy recreation use. Impacts to the lake margin are soil compaction, vegetation and downed woody debris removal, and bank erosion. A portion of youth camp property and Forest Service campground is rip-rapped to protect eroding banks.

Data indicates that of the total riparian reserves within the block, Class IV streams are the most impacted with almost 7% of their areas harvested, roaded,

and containing recreation or administrative sites (Fig. 4-34). And although less than 0.5% of the Class II riparian area (Lost Cr.) is roaded on the basis of the total riparian area within the block, it is interesting to note that based on the percentage of the riparian reserve along Class II streams, 4% of the riparian reserve along the Class II portion of Lost Lk. Cr. is within a roaded condition (Fig. 4-35).



It may not seem as though 4% is much of an impact, however, roads are linear features and tend to impact more stream length given the same percent area impact than other kinds of disturbances. This concept is portrayed well for Lost Cr., where although only 4% of the riparian reserve is impacted, the length of the impact runs for 60% of the entire length of the Class II portion of the creek. This may have created wider, more negative impacts than a disturbance that runs for a lesser distance along the length of the channel. Shading and LWD input may be reduced where length of stream impacted is great.

Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that this landform block has 69 dispersed recreation sites. That is 21% of the total 333 dispersed sites in this watershed.

Riparian: Forty-four sites (or 64% of those in this block) are in a riparian reserve, with 38 of these sites concentrated in the Lost Lake dispersed area. The remaining 6 riparian sites are located at Big Lake on the Santiam Wagon Road. Vehicles can access all of the riparian camp sites. The 44 riparian dispersed sites have 213,242 sq ft, or 4.98 acres of campsite area. The barren core of these sites equals 147,560 sq ft or 3.39 acres. That averages to 69% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very large core areas.

Non-Riparian: Twenty-five of the dispersed campsites in this landform block are not close enough to water to be considered within a riparian reserve. Fifteen of these sites are located at Cayuse Horse Camp. The remaining 10 are along the Santiam Wagon Road. These 25 sites have a total area of 62,580 sq ft, or 1.44 acres. Of this area, 8,325 sq ft or .19 acres, is considered barren core. That averages 13% of core. All of these dispersed camps are accessible by vehicle.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets, and parking spurs. Some may have water systems and garbage service. This narrative will identify campgrounds that do not have gray water disposal sumps. Boat launch facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river. The following developed recreation facilities are located within landform block 3:

Campgrounds: Big Lake Campground--There are 49 designated camp units in this campground. 86% of the campground falls within the riparian reserve of Big Lake. Big Lake West Campground--There are 11 camp units in this campground. All of the campground falls within the riparian reserve of Big Lake.

Picnic/Day Use Area: Big Lake Campground has 3 picnic sites near the boat ramp: all are within riparian reserve.

Boat Ramps: Big Lake Campground has a paved boat ramp and parking for approximately 15 vehicles. All of this boat ramp is located within the riparian reserve.

Sno-Parks: Ray Benson Sno-Park and Santiam Sno-play are in this landform block. The facilities connected with these areas are plowed parking, a winter accessible vaults toilet at both. Sixty-three percent of Ray Benson and 72% of Santiam sno-park fall into a riparian reserve.

Administrative or Recreation Special Use Permit Areas: Hoodoo Ski Area is in landform block 3. It covers 879 acres; has a lodge, lifts, X-country ski trails, and large plowed parking areas. Class IV streams are located in the northern part of the permit area, with winter cross country ski trails crossing in several locations. A new Hoodoo Master Plan is currently being developed, with riparian influences being analyzed in that document. Thirteen Special Use Permit Recreation Residences covering 14 acres are located near Hoodoo. Fifteen percent of the area is in riparian reserve. Big Lake Youth Camp, covering 24 acres, is operated on the east shore of Big Lake. Eighty percent of it falls within the riparian reserve of Big Lake. The facilities consist of many small cabins, dining hall, storage buildings, a floating dock with boat moorage, a stable and corral, and a year round residence. A historic structure, Santiam Lodge is located within this block. It is an unused structure, with its status and future undetermined.

Human Disturbance and Effects: Rooding

The "Airstrip Burn" occurred in 1967 and is still a recognizable feature defined by old fire lines. Many current trails and roads (some of which were originally fire lines) are not surfaced. There are approximately 39 miles of existing Forest Service system roads within the area of the burn, of which 34 miles are unsurfaced and considered primitive in nature. Vehicles may easily stray off these roads. Vegetation along roadsides does not usually restrain vehicle traffic from driving off road. Some travel-ways were created by recreationists, never intended or designed for long term use by the Forest Service. The area does not have designated Off Road Vehicle (ORV) routes for the road system. As designated forest roads, many ORV users do not realize that they must be both a licensed driver and their vehicles must also be "street legal" to operate.

There are approximately 4 miles of trail being used for ORV, motorcycle, and limited mountain bike use. Some of these trails have become brushed in, but they are still listed as Forest Service system roads. The 34 miles of primitive road varies from two wheel drive vehicles to four wheel drive, and they are being used by all types of vehicles. ORV's, motorcycles, mountain bikes, and horses. A portion of the above is also used by cross-country skiers and snow-mobilers in the winter season. The Pacific Crest Trail has multiple ORV crossings, which conflicts with trail management goals.

There are various segments of the primitive roads and trails which have minor to heavy ditch and wheel rut-type erosion. Minor erosion is defined as mostly wheel rutting within the road prism, ruts no more than 3" deep, and no off-site damage caused by sedimentation. There are approximately 5.3 miles of this minor erosion.

Moderate erosion is defined as wheel rutting within the road prism that is forming a water channel. This type of erosion can involve ditch erosion, which carries sedimentation for short distances. In most cases it is not causing off site damage (beyond the road prism). There is 2.6 miles of moderate erosion present. There are 1.3 miles of heavy erosion. Heavy erosion is defined as damage occurring from wheel rutting and ditch erosion. Deep wheel rutting may be causing vehicles to avoid the ruts, which causes damage outside of the road prism. It may also be causing boulders to protrude. Ditch erosion may be carrying sediment off-site in some cases, and it also can cause vehicles to go completely around the area extending the damage.

During the months of May through August 1994, seasonal fire patrol Jim Denney collected data on use, type of Off Road Vehicles (OHVs) encountered, and locations of encounters while on his normal patrol. On days following the encounters, Jim would use his own motorcycle to initiate public contact with OHV users. A chart following this narrative provides a summary by month on numbers of users and type of vehicles in various locations. The types of Off Highway Vehicles encountered in the Big Lake area were Motorcross Competition on Motorcycles, Three Wheelers, Quad Cycles, Dual Sport/Street Legal, Trials/Competition Motorcycles. Also encountered were two dune buggies used by hunters, several trail bikes, and small cc Honda 90s. The report's text is as follows:

User conflicts in or about Big Lake Campground: mainly complaints about noise from OHVs. No complaints from horse users. Some remarks regarding dust. Resource damage is occurring in areas where user trails have been developed, especially between Road 2690 and Road 810 as well as the area directly south of Cayuse Horse Camp and the horse camp itself. Damage is taking the form of deeply rutted trails in soft soil as well as damage to vegetation. Significant public comment was received expressing concern about vehicle use in the Sand Pits below Sand Mountain. Also concern was expressed by some users about encounters between OHV's and other vehicles on the road up Sand Mountain to the lookout parking lot. Comments were received from OHV users during the Endurance Horse Ride staged from Cayuse Horse Camp concerning horse event "taking over" the area. User trails into Mosquito Lake area is well established and the lake (pond) bed shows considerable impacts from OHVs. There are continued signs that OHVs are crossing the wilderness boundary to the south of Sand Mountain as well as entering the same area

from access point off the Santiam Wagon Road to the north of Sand Mountain. A problem still exists with OHVs getting on the Pacific Crest Trail to the east of the PCT trail head at Big Lake. The Patjens Lake Trail was also illegally accessed several times by motorcycles. Some complaints were received from people camping next to the PCT trailhead at Big Lake concerning dust and noise from OHVs. OHVs users expressed concern on several occasions about lack of maps, signage, information about the area. Confusion about the different land use classifications between the Deschutes and the Willamette National Forests in the Santiam Pass area.

From informal questions posed to people encountered, it appears that roughly 40% of the OHV users were from Eugene/Springfield, 40% from Salem/Albany/Highway 20 corridor, 10% Bend, and the remainder from Portland, Southern Washington, or the Oregon Coast.

Days OHV's users were encountered included May: Sunday 15th, Sunday 22nd, Monday 23rd, Sunday 29th; June: Saturday 4th, Wednesday 8th, Sunday 12th, Friday 17th, Mon 20th, Sat 25; July: Saturday 2nd, Sunday 3rd, Friday 8th, Saturday 9th. Fire restrictions started by mid-July, with road closures in effect by August 12.

LANDFORM BLOCK 4

RECENT HIGH CASCADES LAVA

(Belknap-Sand Mountain system of Wilson 1981)

This unit consists of the most recent lava flows and pyroclastic ash deposits in the watershed that were erupted from north-south trending cinder cones of the Lost Lake/Sand Mountain Chain and Belknap Crater less than 12,000 years ago (Holocene). This young geomorphic unit was deposited after the last glacial retreat, and it covers the central third of the High Cascades Plateau between 4,000 and 6,000 feet elevation with relatively low relief and few erosional features. (Taylor 1979, Avramenko 1981)

The lava flows covered the pre-existing topography of the Older High Cascades and surficial glacial deposits. Due to the high vertical and horizontal hydraulic conductivity of these recent lava flows, they provide a pathway for water migration through the basalts and underlying glacial deposits which discharges as springs and underground flow in the McKenzie valley. These flows also produced geomorphic features such as lava-dammed lakes (Clear Lake, Lava Lake) interrupted drainage features, and islands or "kipukas" of older landforms as the lava flowed around them. In areas that were associated with final eruptions of ash, or those areas older than 6,000 years that have deposits of Mazama ash, the permeability of the lava may have been reduced enough to prevent complete percolation of the winter snow pack in closed contour depressions, leaving year-round wet meadows (Figure 4-36).

Disturbance History - Mass Wasting

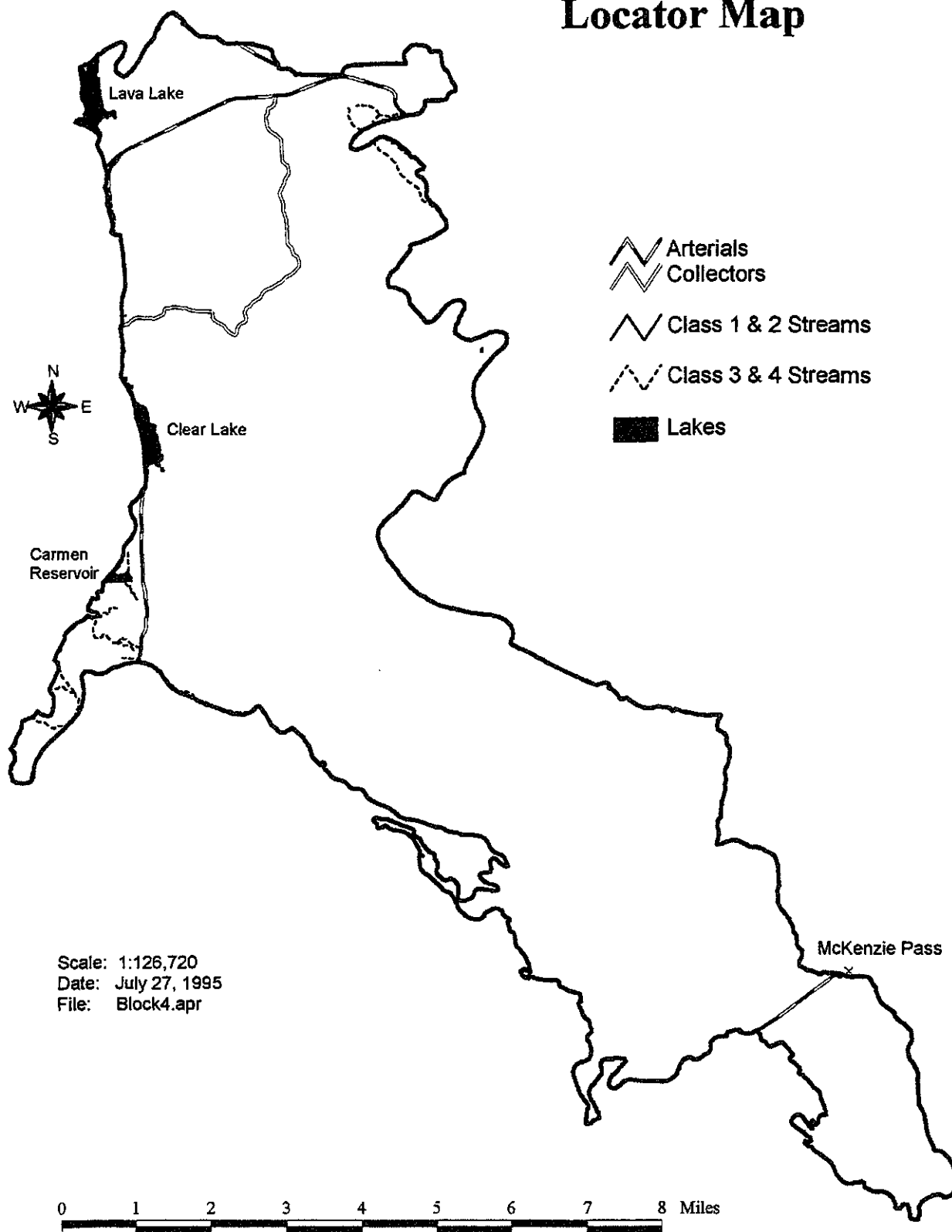
The only potential for mass wasting in this Landblock is on sideslopes of cindercones, and on the major volcanoes and active glaciers.

Disturbance History - Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM), Grand fir (ABGR) and mountain hemlock (TSME) plant series. The mountain hemlock portions contain pockets of subalpine fir (ABLA) series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

This area is composed of lava fields, pumice cones, and sand from relatively recent geological events. Vegetation is sparse because the soil in this block is not

Figure 4-36. Landform Block 4 Locator Map



as old as the others. The block is high in elevation, rather flat, and exposed to both typical westerly and easterly winds.

Fire is relatively frequent and normally of low intensity due to the lack of available fuel to burn. Even though the fuel is sparse, the area does experience stand-replacing fires and partial stand-replacing fires as evidenced by the 700 acre Lava Flow fire of 1967 and the more recent 13 acre Clear fire. Strong east winds drove both these fires.

Block 4 has changed the least of all the blocks in the Upper McKenzie watershed over the past 100 years. The average patch size had declined from 40 acres to 36, and the diversity index has not changed from the value in 1900. Fire has continued to influence on the vegetation patterns in this block.

Unique Habitats

Table 4-10 and Figure 4-37 display the acres of unique habitats within this area. Lava is the dominate landscape feature. Talus occurs where andesite and basalt boulders have weathered and soil has accumulated to support vegetation. A variety of cryptogram species grow on the lava.

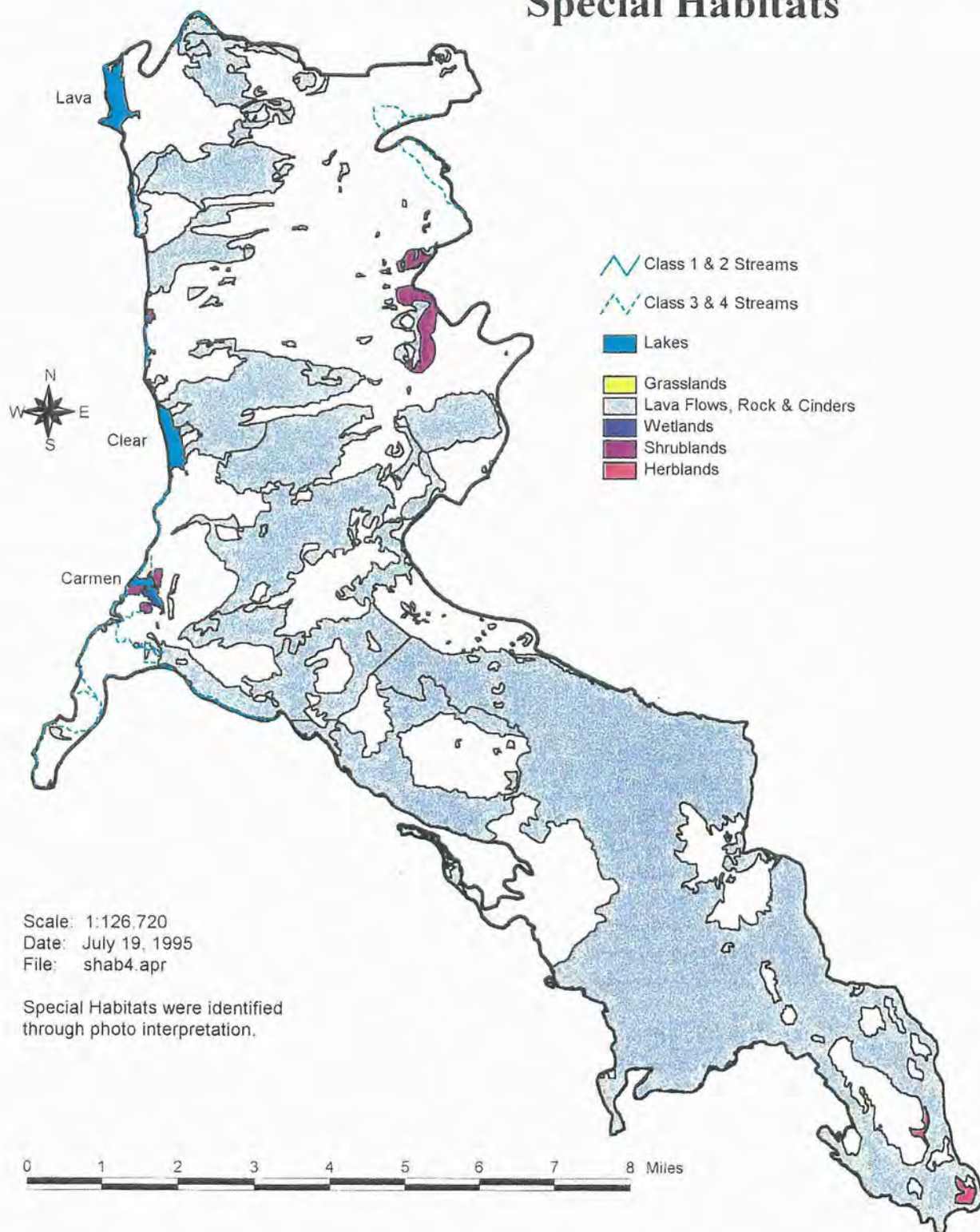
Table 4-10: Unique Habitats within Landform block 4.

Habitat Feature	Acres
Wet meadow	27.55
Mesic meadows	8.37
Dry meadows	4.50
Herb/forb meadows	92.38
Shrub communities	269.61
Dry rock gardens	13.36
Sand blowouts	1528.96
Cone rims	163.15
Shrub lava	1249.72
Lava	21,412.99
Lakes	237.25
Reservoirs	20.86

Livestock grazing at Lava Lake has severely degraded the native vegetation. In some areas it is so complete that noxious weeds and other non-native species dominant. The current allotment expires at the end of 1995. Based upon the Environmental Assessment for Lava Lake future grazing will be prohibited.

Beaver Marsh and the surrounding plant community provide potential habitat for several sensitive plant and Table C-3 species. These wetlands are protected by a Special Wildlife Habitat LMP designation. This area is an excellent candidate for an interpretive site. A rare nitrogen-fixing lichen,

**Figure 4-37. Landform Block 4
Special Habitats**



Pseudocryphellaria rainierensis, occurs at Koosah Falls. This species is to be protected and managed under survey strategy 1. This lichen is known only from five sites in Oregon, of which four are located on the Willamette National Forest. All of these sites are old growth forest approximately 400 years of age (Neitlich et al. 1993, Neitlich 1993). *Allotropa virgata* is documented in three grand fir stands in the block. Sahalie and Koosah Falls and the forested area surrounding Clear Lake may provide habitat for additional Table C-3 species.

Huckleberry Lake, Clear Lake, and Carmen Reservoir are providing moderate to high quality wildlife habitat within this block. Human use at Clear Lake and Carmen may be reducing their potential for some species. Abundant lava fields across the Santiam Pass area are providing high quality, stable habitat. There are no known threats. Tamolitch and Sahallie falls are providing high quality habitats, and they are currently protected from threats. Sawyer's Ice Cave is providing habitat for bats and other animals. Its quality is deteriorating because of human use and vandalism.

Sensitive Plants

Habitat for seven sensitive plant species is found in this landform block.

Noxious Weeds

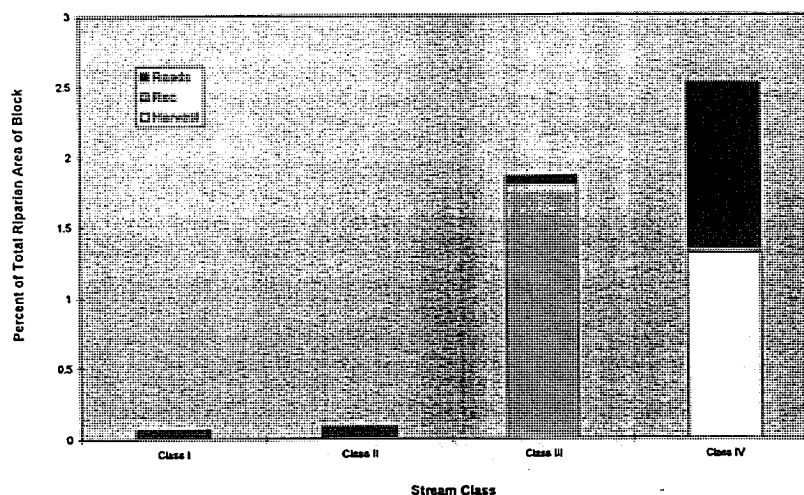
The introduction and establishment of noxious weeds and other non-native plant species is the major threat to this area. Extensive populations of the noxious weed spotted knapweed have easily become established in the cinder material along the road shoulders of Highway 126 and 20. In FY95, isolated populations of spotted knapweed along the road shoulder will be treated with the herbicide Rodeo. Removal of these weeds by either manual or biological control agents has been unsuccessful.

CHANNEL CONDITION AND AQUATIC HABITAT:

Perennial streams are virtually non-existent in this block, and Class IV and ephemeral streams are scarce. Drainage networks within the new lava flows have not yet formed, and precipitation within this block drains directly into subsurface aquifers. Because of the mostly lava terrain, vegetation is limited and harvest is precluded. This landblock falls within the Hackleman, Kink/Inland Basin, and Park subwatersheds. Since peak flows were not of concern within this block, smaller drainages were not analyzed. The minimal harvest within this block is obvious from Fig. 4-38, which shows that of the total riparian area within the block, less than 3% of harvest and roading occurred with Class IV riparian areas.

Management Impacts to Riparian Area
as Percent of Total Riparian Area
Landform Block 4

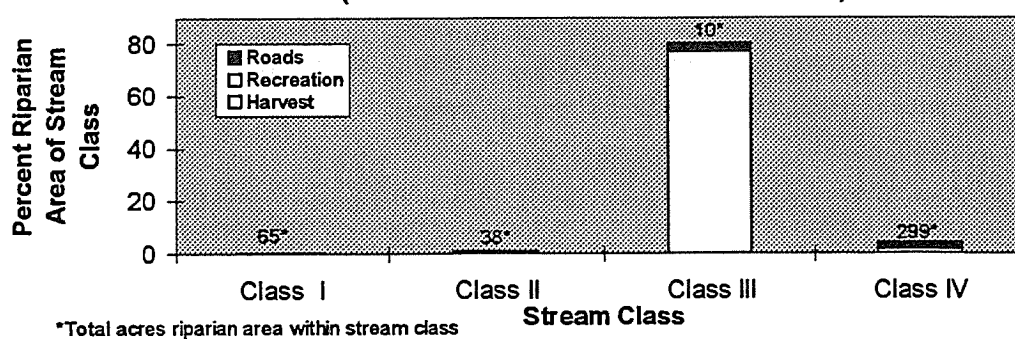
FIG 4-38



Data indicates that of the 10 acres of riparian area along Class III streams, almost all of the area (80%) has a recreation site (Icecap Campground) and is roaded. The small percentage of the Class I stream shown as roaded is along Fish Lake Cr. just north of Clear Lake (Figure 4-39).

FIG 4-39

Management Impacts to Riparian Areas by Stream Class
as Percent of Riparian Area in Stream Class
Landform Block 4
(excludes McKenzie River and Clear Lake)



Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that block 4 has 37 dispersed camping sites. That is 11% of the total 333 dispersed sites in this watershed.

Riparian: Twenty-one sites (or 57% of those in this block) are in a riparian reserve, with 20 of these sites concentrated in the Huckleberry Lake, Craig Lake, or Clear Lake Trail areas. Huckleberry Lake is 1 acre, at the 5250 foot elevation. Craig Lake is 2 acres, located at the 5100 foot elevation. Vehicles can access 8 of

the riparian camp sites, with 13 sites at Huckleberry Lake accessible on a closed road by foot only. The 21 riparian dispersed sites have a total of 24,225 sq ft, or 0.56 acres of total campsite area. The barren core of these sites equals 3,130 sq ft or 0.07 acres. That averages to 13% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very small core areas.

Non-Riparian: Sixteen of the dispersed campsites in this landform block are not close enough to water to be considered within a riparian reserve. These sites are near Huckleberry Lake, McKenzie Pass, and the Pacific Crest Trailhead area along Highway 242. These 16 sites are 12,525 sq ft in area, or 0.29 acres. Of this area, 7,645 sq ft or 0.29 acres is considered barren core. That averages 61% of core within these site areas. Twelve of these dispersed camps are accessible by vehicle. The remaining four by Huckleberry Lake are accessible by foot only.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets, and parking spurs. They may have water systems and garbage service. Boat ramp facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river. The following developed recreation facilities are located within landform block 4:

Campgrounds: Ice Cap Campground—There are 22 designated camp units in this campground. Seventy percent of these campgrounds is within a riparian reserve. Due to the elevation differences between the river and the campground facilities, this reserve location needs to be ground-verified. Cold Water Cove Campground—There are 35 camp units in this campground. Fifty-four percent of this campground is within the riparian reserve of Clear Lake. Due to the elevation differences between the lake and the campground facilities, this reserve location should be ground-verified.

Picnic/Day Use Area: Ice Cap Campground has 2 picnic sites near the entrance to the campground.

Boat Ramps: Cold Water Cove Campground has a paved boat ramp and parking for approximately 15 vehicles. There are also long wooden pole "skids" to help slide canoes and boats into the lake. All of this boat ramp is located within the riparian reserve of Clear Lake.

Sno-Parks: Potato Hill and Little Nash Sno-parks are in this landform block. The facilities connected with these areas are plowed parking and bulletin boards. Potato Hill covers 0.55 acres, with 44% falling into a riparian reserve. Little Nash covers 2.15 acres and is not in a reserve.

Viewpoints: Sahalie Falls and Koosah Falls Viewpoints are partly in this block. Mapping indicates that 94% of Sahalie Viewpoint and 100% of Koosah Falls Viewpoint fall into a riparian reserve of the McKenzie River. Due to the elevation differences between the river and the viewpoint facilities, these reserve locations should be ground-verified.

Administrative or Recreation Special Use Permit Areas: This block does not have any administrative or recreational special use permits within it.

Wilderness: Within this landform block are 24,090 acres of Wilderness which is 59% of the block. Most of those acres are within the Mt. Washington Wilderness, which in this landform is almost entirely inaccessible lava flow. The only trails located here are a mile of Pacific Crest Trail (PCT) near Little Belknap and another short section of the PCT as it crosses Highway 242 south into the Three Sisters Wilderness. Approximately 2500 acres of this landform are within the Three Sisters Wilderness. Due to the rough terrain, lack of water and trails, very little if any campsites would be expected to be found within this block. Stock use is restricted to the Pacific Crest Trail, and no grazing opportunities are apparent.

LANDFORM BLOCK 5

SCOTT MOUNTAIN GLACIAL PLATEAU AND VALLEYS

(Glacial Lakes, High Cascade Platform, Glacial Valley, and Yapoah-Anderson Creek systems of Wilson 1981)

Introduction

This Landform Block is influenced by the development of valley systems of Scott, Boulder, Twisty, Ollalie, Anderson, and Kink Creeks. It is primarily controlled by the previous topography of the Scott Mountain cinder cone and the westward glacial advance from the High Cascade Platform. Surficial deposits of glacial till cover most of the area, with the exception of Anderson and Olallie Creeks that contain recent High Cascade intracanyon flows that mask the previous topography. Unlike the northern Early High Cascade Platform (Landform Block 3) which was partially covered by the recent High Cascade lavas, the eastern portion of Landform Block 5, above the headwalls of the lower valleys, contains the majority of the High Cascade glacial lakes in the watershed (Figure 4-40).

Disturbance History - Mass Wasting

Valley sideslopes in lower portions of Scott and Boulder Creeks are susceptible to glacial terrace ravel and valley stress relief failure. This Landform Block contains 3 of the 19 road related failures in the watershed, confined to the lower Frissel and Scott Creek drainages in Western Cascade volcanics (Figure 4-41 and 4-42).

Landform block 5 contains SRI Units 3 and 235 potentially on all slopes; and Units 16, 301, 610, 610U, 614, and 71 on slopes greater than 70%.

Disturbance History - Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM), western hemlock (TSHE) and mountain hemlock (TSME) plant series. The block contains small pockets of Douglas-fir (PSME) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

The typical wind is from the west or southwest, blowing up-slope in this block. The east wind flows across the surface through most of this block. The

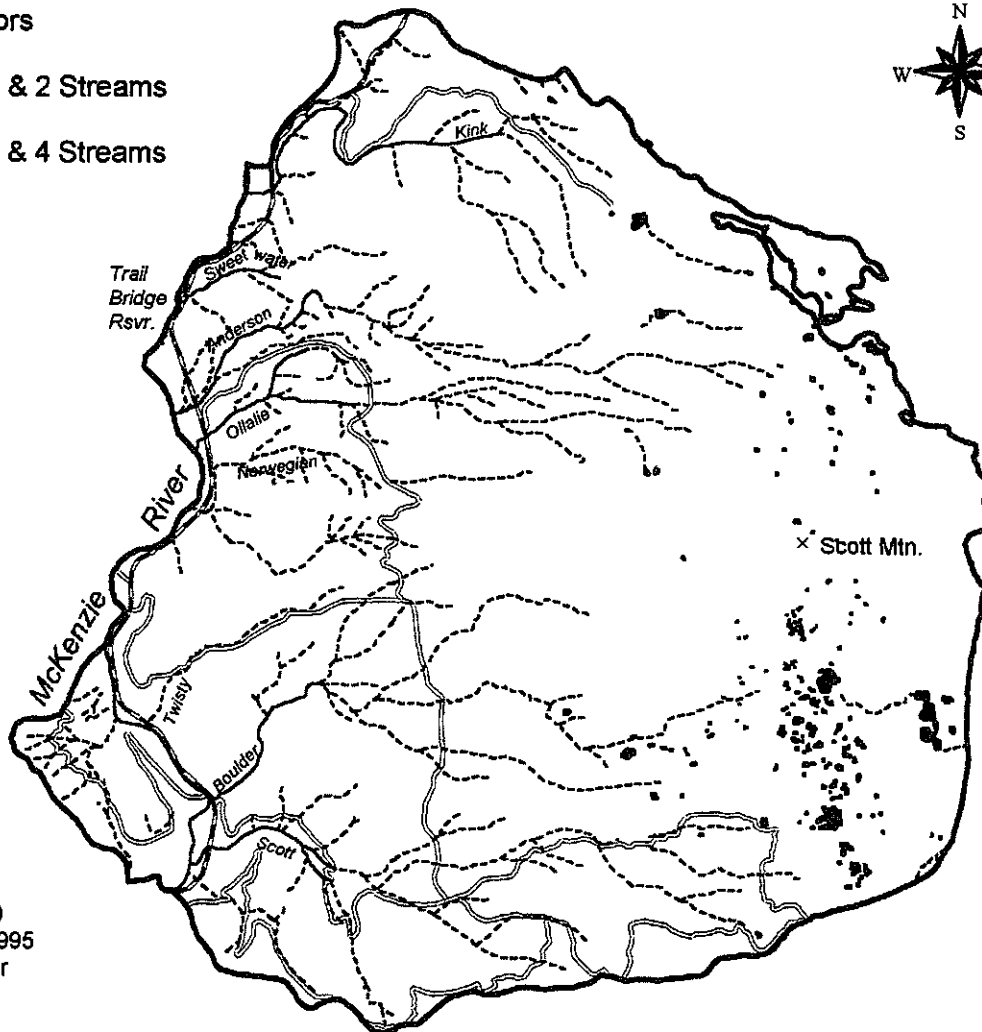
**Figure 4-40. Landform Block 5
Locator Map**

Arterials
Collectors

Class 1 & 2 Streams

Class 3 & 4 Streams

Lakes



Scale: 1:126,720
Date: July 27, 1995
File: Block5.apr



Figure 4-41. Landform Block 5 Potentially Unstable Areas

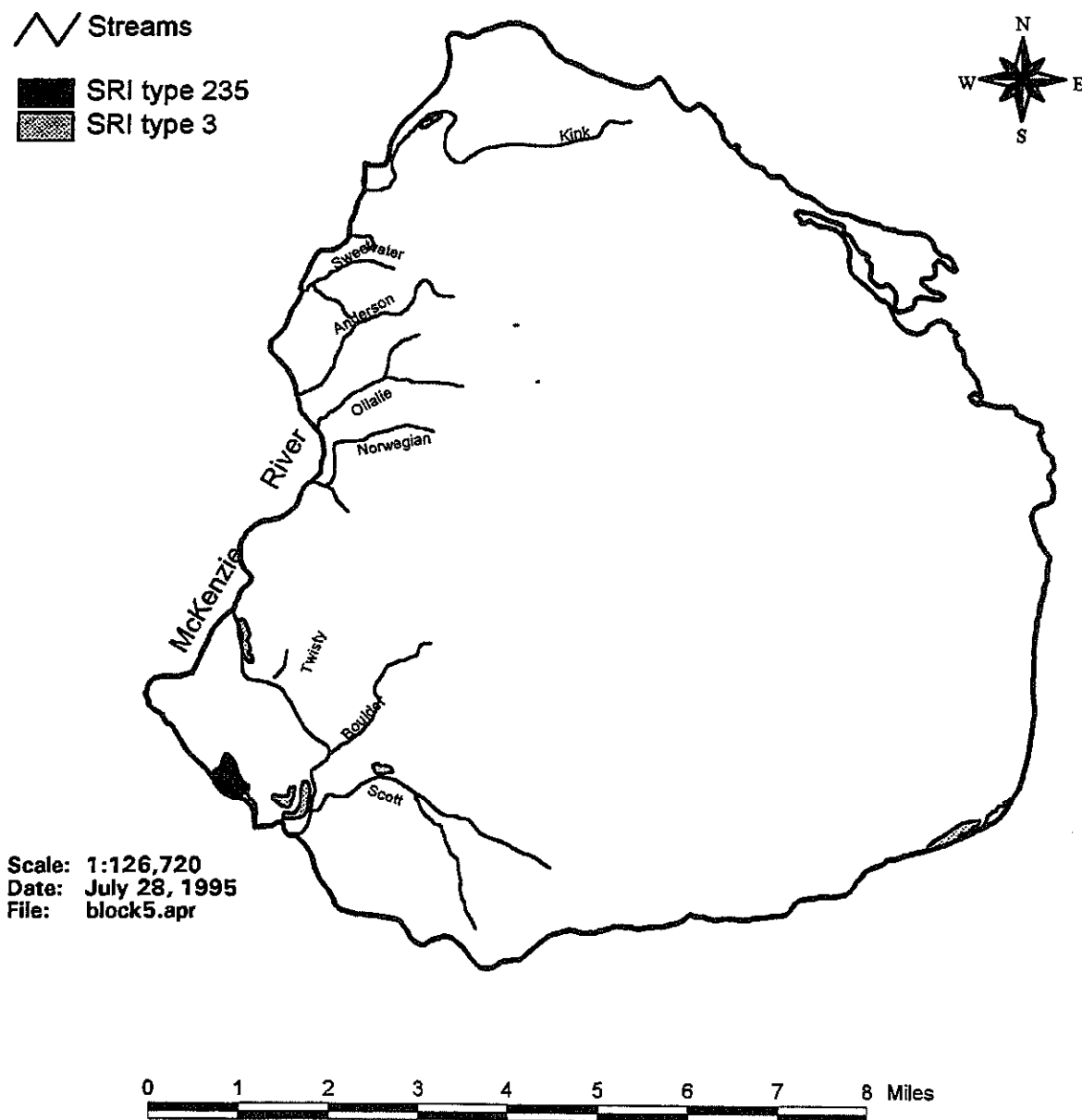
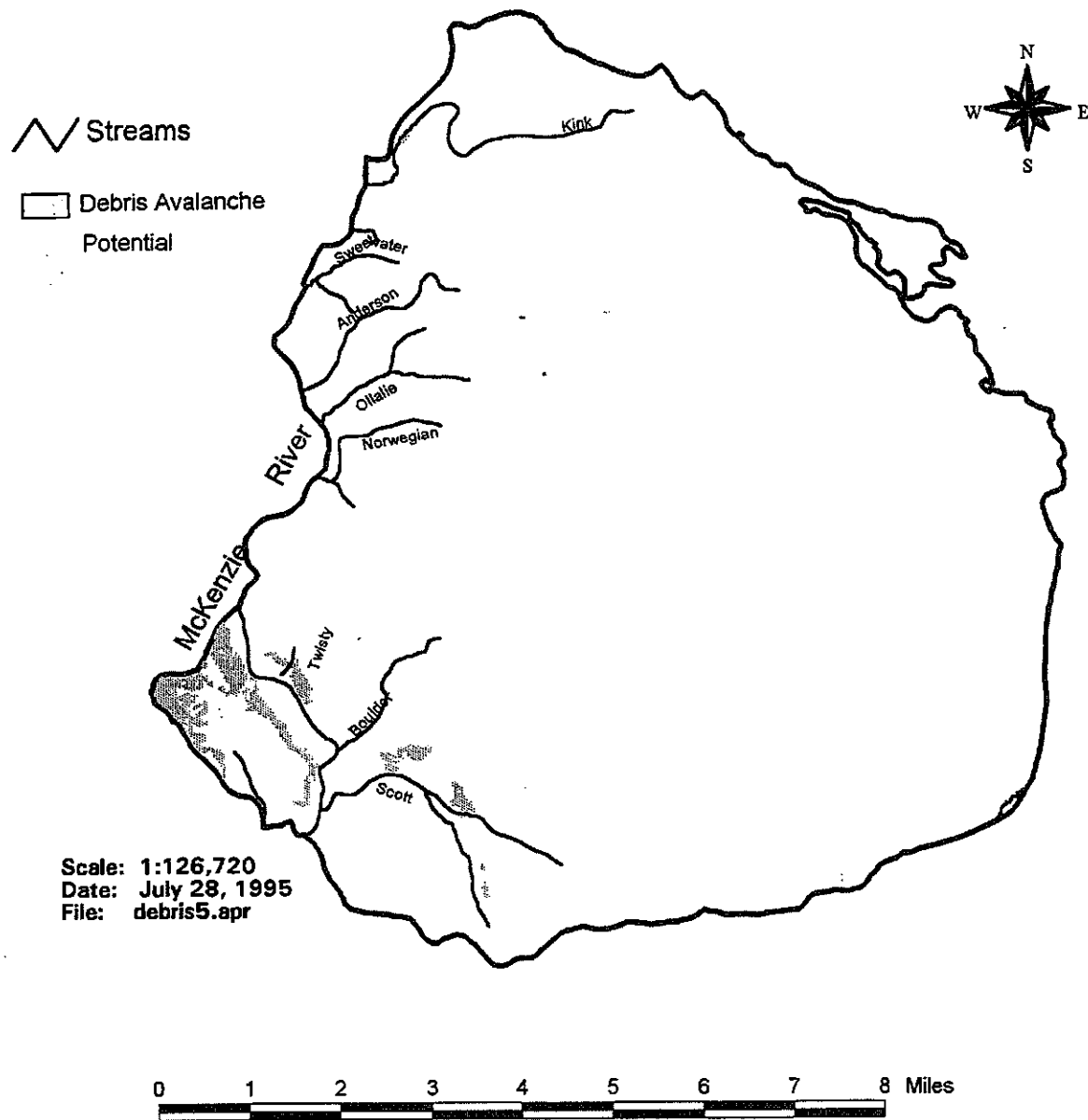


Figure 4-42. Landform Block 5 Debris Avalanche Potential



surface wind is channeled and strengthened by the gaps between Bunchgrass Ridge and Scott Mt.; Scott Mt. and Two Buttes; and Two Buttes and Deer Butte.

The area has a history of small-sized, frequent, low to moderate-intensity fires coupled with large-sized, high-intensity, relatively frequent, stand-replacing fires. The stand-replacing fires have a longer fire return interval than those of any of the other landform blocks. The area also has high meadows that burned rather frequently. These areas are currently being invaded by young trees.

Many high elevation meadows and huckleberry fields occur within this area. The areas surrounding these meadows and fields may have been influenced by sheep herders burning meadows in the late 1800's, and before then, by aboriginal burns to enhance berry productivity.

The forest patches in this block are mostly even-aged stands. The average size of the patches is small: about 61 acres. This is significantly smaller than the average patch size in 1900, which was about 261 acres. A Shannon diversity index indicates 5% increase in diversity from 1900 to 1995. The index shifted from 1.90 in 1900 to 2.00 in 1995. This shift reflects the increase in small patches created through clearcutting over the past 40 years.

Unique Habitats

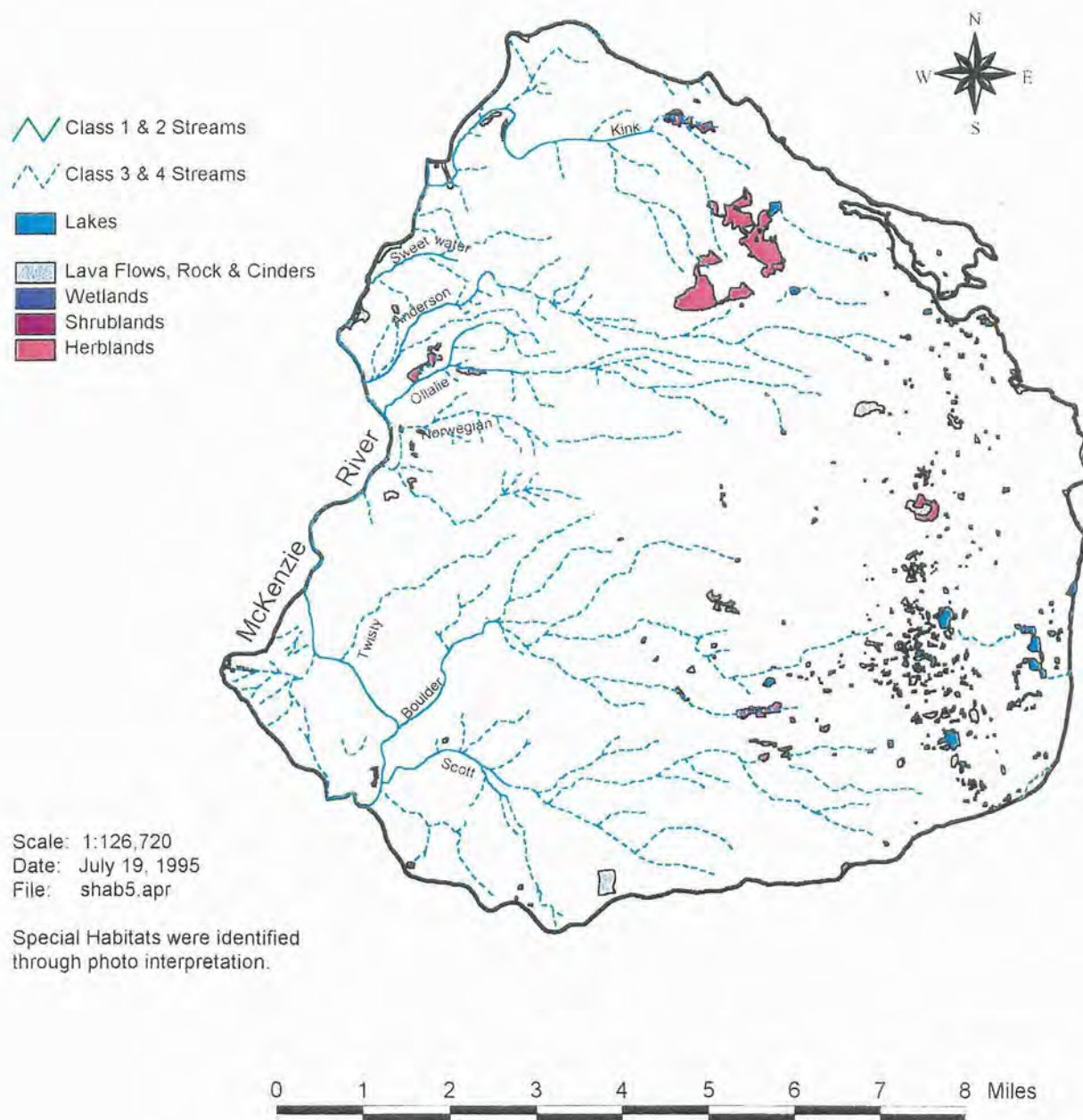
Table 4-11 and Figure 4-43 display the unique habitats that occur within this landform block. The predominant unique habitats are lava and talus.

Table 4-11: Unique Habitats within Landform block 5.

Habitat Feature	Acres
Bog	3.45
Wet meadow	30.04
Mesic meadows	47.34
Dry meadows	333.67
Herb/forb meadows	121.74
Shrub communities	14.08
Rock outcrop	9.13
Talus	380.48
Lava	660.78
Lakes	208.80
Reservoirs	9.32

Lakes, wet, mesic and dry meadows occur in small openings that are scattered throughout the dense stands of trees in this block. The majority of meadows are located in the wilderness. Wildfire, ignited either by lightning or Native Americans, was a natural element of the ecology of the high Cascades (Franklin

**Figure 4-43. Landform Block 5
Special Habitats**



and Dryness 1973). Fire suppression activities in this century have probably interrupted the natural fire frequency in much of the High Cascades (Franklin and Dryness 1973)

An area west of the wilderness is a large glacial deposit. The soils covering the glacial material have little water holding capacity and quickly dry out. Three meadows located in this area are Fingerboard, Bunchgrass, and Buttercup. Bunchgrass and small isolated areas of Fingerboard Meadow have had recent man-caused fires. No change in species composition has been noted in these meadows as a result of the fire. These meadows have been identified as seed collection sites for revegetation projects.

There are abundant high quality lakes in the wilderness area of this landform block that are providing high quality habitat for many wildlife species. They have generally not been inventoried, so the extent of their biota is unknown. Threats to the wildlife may include introduced stocks of fish that consume native amphibians. Fingerboard Prairie SWHA, Bunchgrass SWHA, and Buttercup SWHA are all providing high quality meadow habitat for wildlife, and they are protected by SWHA LMP allocations. Fingerboard Prairie is the site of a Migratory Bird Monitoring station, and abundant information is available on the bird species that utilize that area. Anderson Spring SWHA and Kink Creek SWHA are providing high quality habitat, also protected by SWHA designation. There are currently no threats to these habitats, with the exception of Fingerboard Prairie. Conifer invasion from lack of fire is reducing the available meadow habitat. Reintroduction of fire is being tested.

Sensitive Plants

Two sensitive plants and 3 species of concern occur in this landform block (Table 4-12). Both populations are stable at this time. Potential habitat for 15 sensitive plant species is found in this landform block. Table C-3 species present are a false truffle, *Thaxterogaster pingue*, located at Scott Lake; and *Allotropa virgata*. *A. virgata* is documented in six western hemlock stands, three of these sites occur in an uncommon western hemlock/rhododendron-salal plant association.

Noxious Weeds

Many non-native plants occur in the meadow complex that make up Fingerboard Prairie. These species are most likely a result of past livestock grazing that historically occurred in the meadows. The prevalence of noxious weeds and other non-native plants in these meadows is competing with the native vegetation. The reintroduction of fire in these meadows may reduce the presence of these introduced species.

Table 4-12: Sensitive and Rare Plants Located in Landform Block 5.

Landform Block 5	Status	Number of pops
<i>Romanzoffia thompsonii</i> - Thomson's mist maiden	S	1
<i>Carex atrata</i> var. <i>atrosquama</i> - blackened sedge	S	1
<i>Sidalcea cusickii</i> - Cusick's mallow	W	2
<i>Botrychium virginianum</i> - rattlesnake fern	C	1
<i>Corallorhiza trifida</i> - yellow coral-root	C	1
The Region 6 Sensitive (S) Plant List; Review (R) List and the Watch (W) List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern (C) List for locally rare species not included in the first three lists.		

Biological control and manual removal are the treatment methods used in this landform block for noxious weeds. Beneficial insects feed on the seed heads and roots of selected weed species. Over time, the insects reduce the growth and expansion of the weeds.

CHANNEL CONDITION AND AQUATIC HABITAT

Streams draining the relatively flat slopes of the high cascades and glacial deposits within this landform block are similar to the streams of Block 3 with relatively low channel incision. This reflects both the youngness of the channel and the porosity and storage capacity of the surrounding geologic material. The exception is the lower 2 miles of Scott Cr. and Boulder Cr., where the channels run through Western Cascades geology and into the McKenzie River glacial trough, resulting in more steeply incised, higher gradient streams. The streams within this block tend to be somewhat immune to large storm events, likely due to the porosity of the glacial deposits and the large storage capacity of the underlying lava flows. This is reflected in much of the drainage network consisting of Class IV stream channels. There is just not an extensive area of perennial flow. Whereas streams in the Western Cascades tend to be "flashy," the streams within the High Cascades have flows metered out on a more uniform basis. This is particularly true for the spring-fed systems of Ollalie, Sweetwater, and Anderson Creeks that flow from springs originating from the contact between the old High Cascades, and the new High Cascades lava flows.

Sediment production within this block was historically moderate. The area typically burned intensively throughout large areas. However the flat terrain and generally stable ground probably did not result in an extremely high sediment yield.

The recent High Cascade lava flow (<12,000 years old) across the early High Cascade lavas (12,000-4 million years old) provides the cold, spring-fed flow that currently supports spawning and rearing habitat for bull trout. Sweetwater, Anderson, and Olallie Creeks each flow across porous young lava flows and provide much colder water temperatures (2-6° C) than adjacent streams flowing across early High Cascade lavas (6-13° C). Although more deeply incised due to their longer period of existence, streams draining the early high Cascades in Landform 5 (Kink, Twisty, Boulder, and Scott Cr.) are less accessible to upstream migrating fish due to their channel's steep gradients over glaciated valley walls and low surface flow over incised glacial till. The channels of Sweetwater, Anderson, and Olallie Creeks do not possess the obstacle of steep glacial walls. Rather the recent lava flow inundated the steep valley walls and provided low gradient access to their spring-fed headwaters. This gradual toe of lava also determines bull trout stream geomorphology of shallow to moderately incised channel and gentle, rolling side slopes resistant to failure. Low levels of fine sedimentation are characteristic of bull trout streams, as well as undercut banks, high quantities of LWD, abundant margin habitat, and high channel complexity. The even flow of these spring-fed streams provide for a high level of channel stability. Frequent forb vegetated islands, that would be subject to annual rearrangement in adjacent flashy streams, persist for decades in Sweetwater, Anderson, and Olallie Creek. The spring-fed nature of the channel dampens rain-on-snow events and does not appear to allow transport of larger diameter LWD. Large wood found in-stream shows little sign of movement, often decomposing where it falls. Other bull trout stream characteristics include high levels of input and retention of fine organic matter. Large volumes of in-stream wood and a mature conifer canopy provide significant quantities of detritus with which bull trout juveniles are often associated (Goetz 1994). Low velocity habitats have deep beds of detritus that juvenile bull trout use as cover and foraging grounds for aquatic insects. Bull trout association with wood in these streams continues through adulthood, when they return to spawn and seek cover under large in-stream wood.

Historic bull trout use of subbasin tributaries has likely shifted to include these fairly recent sources of cold water. Bull trout are believed to be "glacial relicts," present during the retreating ice age and adapted to cold water habitats. As conditions of the landscape changed with volcanic activity and warming climate, bull trout use of tributary streams shifted. This may help explain current bull trout distribution. Bull trout specific requirements for spawning and rearing habitat are not currently met by Scott or nearby Lost Cr. (Landform Block 6), but may have been in the past. If habitat requirements were met, such as low temperatures and low levels of fine sedimentation, bull trout may have spawned and reared in streams adjacent to Sweetwater, Anderson, and Olallie Creeks.

Elsewhere in Landform 5, Twisty and Kink Creeks flow across the early High Cascade plateau before dropping steeply over the McKenzie's glaciated valley rim. Soils made up in large part of glacial till deposits characterize Landform 5 which possess large water storage capacity. Low gradient, uniform flow streams do not provide adequate energy to transport debris or sediment as compared to Western Cascade tributaries. Boulder and Scott Cr., each with their lower two miles incised in Western Cascades geology, possess more variable flow regimes and the ability to transport greater quantities of debris and sediment.

Recent disturbance in this landform include a large stand-replacing fire of unknown acreage prior to 1901 in the vicinity of Olallie Creek. In the mid-1980's, disappearance of surface water flow occurred on Olallie Creek near its headwaters. Large springs dried as the surface water found an alternate route. It is believed the upper springs found a subsurface route, through the porous lavas, to emerge downstream and abandon the former channel (near the junction of FS Rd 2657 and Rd 830). This unusual form of habitat disturbance may occur as spring-fed channels cut through their porous parent material.

The majority of the 349 lakes and ponds found within the watershed are located in Landform 5. Many are located on the glaciated flanks of Scott Mtn. Few of these lakes have inlets or outlets. Generally if surface flow is present, it is as a springtime, ephemeral inlet. Most high elevation lakes can be classified as at a very low level of productivity (low trophic status - ultraoligotrophic) and originally barren of fish life. No lakes in Landform 5 are expected to have been inhabited with fish historically (Fisheries Appendix). Rates of lake succession and enrichment by surrounding vegetation is very slow due to high lake elevation and parent geology. Although not recently surveyed, most lakes can be expected to continue to be classified as ultraoligotrophic. The native fauna of High Cascade lakes includes numerous bottom-dwelling caddisfly, mayfly, amphipods, and water beetles. Zooplankton communities are present in low productivity lakes. Amphibians include Cascade, red-legged and spotted frogs, western toads, Northwestern salamanders, and Pacific giant salamanders.

Landform Block 5 falls within the Boulder/Frissell subwatershed, and it is one of the three most heavily managed subwatershed in the Upper McKenzie Watershed (Deer subwatershed is more heavily managed, and Smith subwatershed has almost the same percent of its subwatershed managed as Boulder/Frissell) (Table 4-3). Smaller drainages within the Boulder/Frissell subwatershed have had up to 44% of their drainages harvested and roaded as in the case of Twisty drainage (Table 4-3). Scott Cr. drainage has also been intensely managed with 32% of the drainage harvested and roaded. Kink Cr. drainage is also located within this block, and has 21% of its area roaded and harvested. What this heavy management means to the stream systems is unclear. Much of this landform block has area located within the permanent snow pack, and the porous volcanic rocks probably act as moisture reservoirs

making it a low and moderate contributor to rain-on-snow events (Fig. 3-17b). For these reasons, the streams may not experience increased peak flows to the extent streams do that are located in the western cascade province. This is truly the case for the springfed streams of Ollalie, Anderson, and Sweetwater Creeks. For example, Sweetwater Cr. has 33% of its drainage roaded and harvested, with a road density of 4.5 mi/sq. mi, and yet the channel is in good condition (Table 3-3). The same is true for the non-springfed streams of Block 5 such as Boulder, Scott, Kink, and Twisty, whose channels are all pretty well intact.

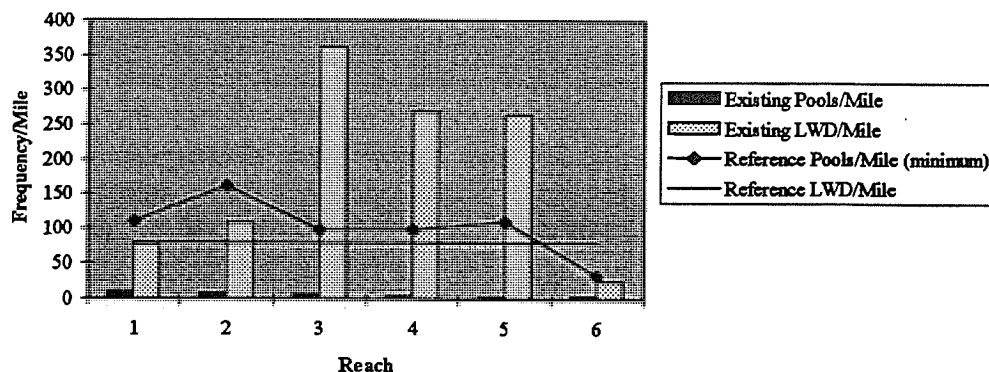
Kink and Twisty Creek Habitat Condition

On each side of the recent high Cascade lava flow, two creeks are located: Kink Creek to the north and Twisty Creek to the south. Both have similar channel geomorphology and aquatic habitat characteristics. Both stream channels travel across early High Cascade formations and drop over the steep glaciated valley walls to enter the McKenzie River flood plain. Both channels behave similarly, going seasonally dry as they traverse the McKenzie River's coarse glacial till. This seasonal barrier prohibits fish migration during summer and fall months.

Large volumes of LWD are present in Kink Cr. channel (Figure 4-44). An old-growth dominated riparian area contributes large diameter Douglas-fir to the channel, most often from windthrow. Few debris jams of large material are present suggesting high flows are rarely capable of transporting whole large diameter trees.

Figure 4-44

Kink Creek Large Pools and LWD/Mile: Existing and Reference



From USDA Forest Service Level II Kink Cr. survey, 1990. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

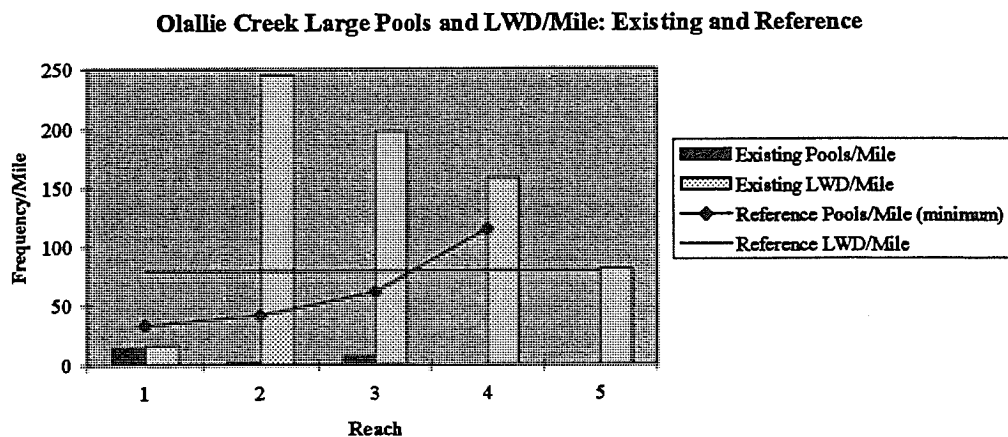
Old-growth riparian areas and buffer strips provide good recruitment potential to Kink Creek. Twisty Creek has far less volume of in-stream wood (Table x) and poor recruitment potential due to harvest activity near the channel. Pool

frequency on both Kink and Twisty Cr. is low. Low recorded large pool frequency is typical of habitat complexes found in Kink and Twisty Creek. Both streams may be characterized as boulder/plunge pool habitat complexes, where large pools are infrequent and pocket pools are common. A cutthroat population resides throughout Kink Cr.; no fish were found in a recent survey of Twisty Creek.

Sweetwater, Anderson and Olallie Creek Aquatic Habitat Condition

Large volumes of in-stream wood characterize Olallie Cr. (Figure 4-45) and Sweetwater and Anderson Cr., although diameters of in-stream wood in Anderson Cr. are smaller, averaging less than 24 inches. All three streams retain their LWD due to even spring-fed flow, rather than transporting wood to the McKenzie River.

Figure 4-45



From USDA Forest Service Level II Olallie Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 5.

Recruitment potential of large wood to the channel is good to excellent in all three streams. Several clearcuts adjacent to streams will delay natural rates of input. Stream bank stability is a concern where buffers have or are subject to blow down. Bull trout have been found to be particularly sensitive to land management activity with a low tolerance of increases in sediment level in spawning gravels. Significant reduction in survival of incubating eggs occurs with increases in fine sediment levels. Weaver and Fraley (1991) found increases in fine sediment composition beyond 35% of spawning substrate, decreased egg to emergent fry survival.

Large pool frequency does not reflect the high quantity of smaller pool area available in these streams. Due to the broad channel width and low gradient, large channel spanning pools are infrequent in these three streams. For this

reason, meeting reference conditions for typical Western Cascade streams may be unrealistic. Anderson Cr. survey, conducted by ODFW in 1991, may represent similar to reference conditions with pool:riffle ratios of about 1:4 for these stream types, although some habitat alteration may have occurred with moderate levels of management disturbance.

Bull trout production in the Upper McKenzie subbasin may be suppressed by limited rearing area in Anderson Creek. Recent monitoring of emerging fry migration in Anderson Creek suggests the stream does not have rearing habitat area sufficient for its fry production. Out-migrating fry likely suffer high percentage mortality once they reach the main stem McKenzie River. A recent study of habitat enhancement in Anderson Creek (USDA Forest Service 1993[d]) found addition of margin habitat resulted in increased use by juvenile bull trout. Competition for rearing space in Anderson Cr. may be verified by trapping at the confluence with the McKenzie River.

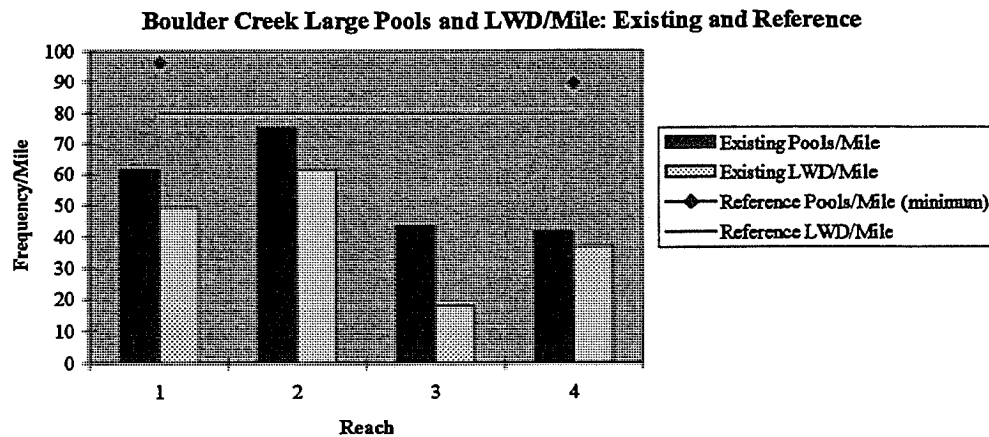
Olallie Cr. culvert beneath Hwy 126 is a passage barrier and will be treated during summer 1995. A parallel passage culvert will provide upstream migration for cutthroat, rainbow, and bull trout and spring chinook salmon to about 1.5 mile of historic spawning and rearing habitat.

The small geographical area of bull trout spawning and rearing streams, all located within a one mile radius, subjects the population to significant loss from disturbance. Additional protection of this important habitat will be necessary for higher probability disturbance such as wildfire, poaching, chemical spill, and sediment input.

Boulder and Scott Creek Aquatic Habitat Condition

Both Boulder and Scott Cr. are more deeply incised channels, characteristic of Western Cascade streams. Each streams' lower two miles have cut the Pleistocene high Cascade lavas and now incise underlying Western Cascades and McKenzie River glacial deposits. Their headwaters lie in the early high Cascades and glacial deposits. Their flow regime has a greater range of variability than adjacent Landform 5 streams. Boulder (Figure 4-46) and Scott Cr. each generally possess lower than reference levels of in-stream LWD. Both channels have poor recruitment potential of LWD due to previous harvest activity along some stream segments.

Figure 4-46



From USDA Forest Service Level II Boulder Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 2 and 3.

Buffer windthrow and bank cutting is common along both streams. Pools/mile are present in fair numbers, although below reference minimums. Lowered pool numbers reflect transport or salvage of LWD from channels, increases in peak flows and bedload deposition (pool filling). Debris jams are more frequent in Boulder and Scott Cr. as compared to other Landform Block 5 streams.

Both streams are occupied by resident cutthroat trout and sculpin. It is likely rainbow trout utilize both streams as spawning and rearing habitat. Spring chinook fry have been found in Scott Cr., likely moving from the main stem McKenzie to rear in low gradient portions of lower Scott Creek. Lower reaches of both streams are probable foraging areas for bull trout. Unlike Kink and Twisty Cr., these streams do not flow intermittently over McKenzie flood plain glacial till, but flow year round to the McKenzie River. An isolated population of cutthroat exist above a 9 foot falls at Scott Creek's rivermile 1.1.

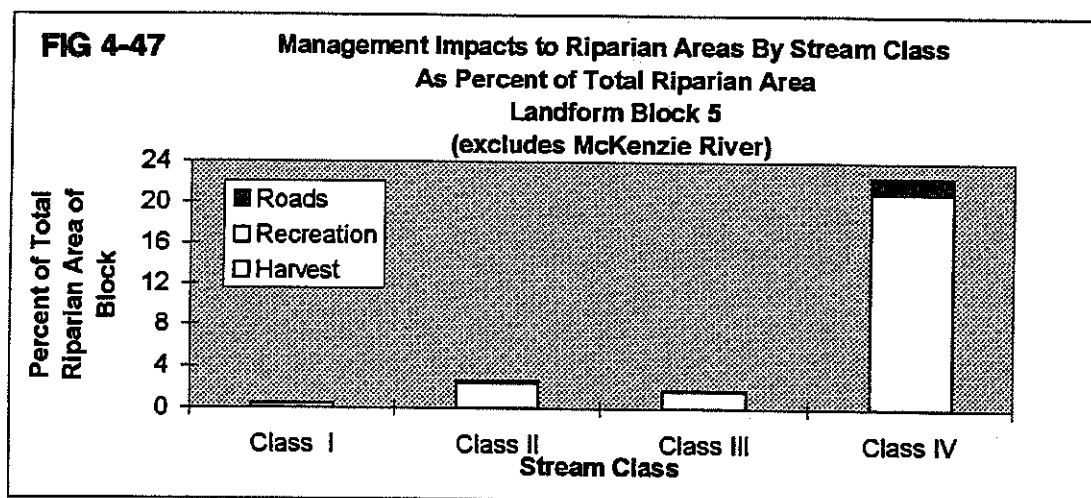
High Lakes Aquatic Habitat Condition

The Fisheries Appendix lists a portion of the lakes within Landform 5 and most of the lakes currently managed. By area, about 70% of wilderness lakes are stocked with non-native trout. All lakes in Landform 5 are believed to have been barren prior to introduction of trout in the early 1900's. No natural reproduction by fish occurs in this landform's lakes, and rainbow, cutthroat and/or brook trout are restocked every 1 to 4 years. Generally, larger and deeper lakes are planted to allow carry over of stocked fish and avoid mortality in shallow lakes freezing through. The impacts to native fauna from introduced species may be significant in these lakes. Introduced trout prey upon native aquatic insects and amphibians that have adapted to an environment free of an

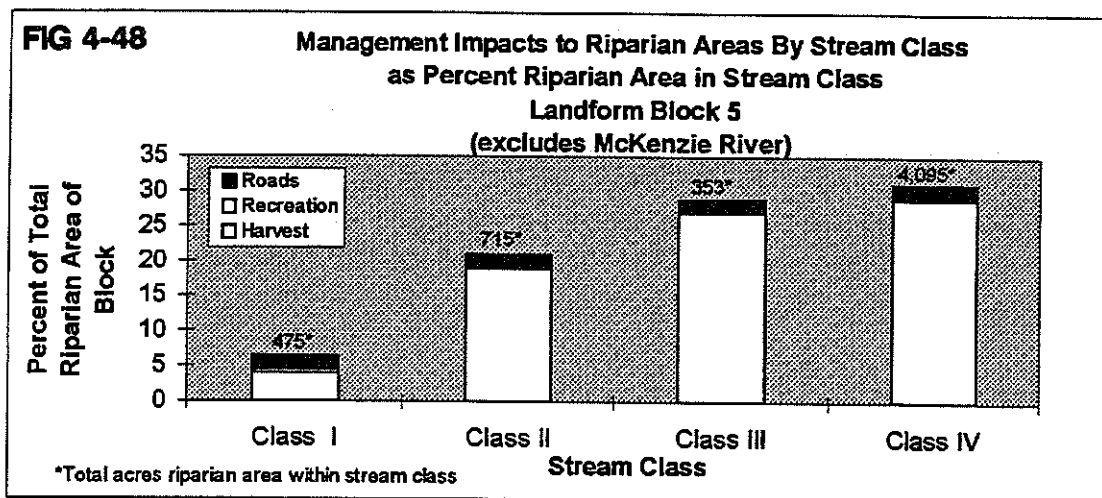
efficient aquatic predator. Human and stock impacts to wilderness lakes may significantly impact native fauna. Degradation of lake margins and riparian habitat consists of vegetation and LWD removal, barren banks, and potential impacts to water quality by enrichment. High impact lakes are generally easier access lakes with a popular fishery.

RIPARIAN RESERVES

Of the total riparian area within landform block 5, the area associated with Class IV stream channels has been the most heavily harvested and roaded (Fig. 4-47)



This is not surprising since much of the channel network is composed of Class IV streams. However, 21% and 29% of the riparian area of Class II and III streams, respectively, have been impacted when looked at as a percentage of riparian area along a given stream class (Fig. 4-48).



Boulder and Scott Creeks have the portions of Class II streams that are most impacted, and Anderson, Scott, and Twisty Creeks are the riparian areas associated with Class III's that most are affected. The 6% of the Class I riparian reserve impacted includes harvest in Sweetwater and Anderson Creeks riparian areas, and a small portion of Ollalie riparian reserve impacted by Ollalie Campground.

Human Disturbance and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that this landform block has 80 dispersed camping sites. This is 24% of the 333 dispersed sites in this watershed.

Riparian: Forty-six sites (or 58% of those in this block) are in a riparian reserve, with 33 of these sites concentrated in the Scott Lake area. Twenty-nine of these sites are accessible by foot only on a closed road. The remaining dispersed riparian sites are on Olallie, Anderson and Boulder Creeks, Irish Camp Lake, and Robinson Lake. The 46 riparian dispersed sites have 94,186 sq ft, or 2.16 acres of campsite area. The barren core of these sites equals 53,163 sq ft or 1.22 acres. That averages to 56% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very large core areas.

Non-Riparian: Thirty-four of the dispersed campsites in this landform block are not close enough to water to be considered within a riparian reserve. These sites are near Trailbridge Reservoir, Olallie Creek, Foley Ridge Road, Hand Lake area, and Robinson Lake Road. These 34 sites have an area of 45,883 sq ft, or 1.05 acres. Of this area, 3,990 sq ft or 0.09 acres is considered barren core. That averages 9% of core within these site areas. Five of these dispersed camps located in the Hand Lake area are accessible by foot only.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets, and parking spurs. They may have water systems and garbage service. Boat ramp facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river. The following developed recreation facilities are located within landform block 5:

Campgrounds: Olallie Campground—This campground is described under the mainstem McKenzie corridor.

Picnic/Day-Use Area--There are no day-use areas within this block.

Boat Ramps: None of the boat launches are in this block.

Sno-Parks: No sno-parks are in this landform block.

Administrative or Recreation Special Use Permit Areas: This block contains Camp Melakwa, a Boy Scout Camp operated under Special Use Permit. The facilities consist of wooden tent platforms, cabins, a piped water system, mess hall, covering 55 acres. All these areas fall within the riparian buffer of Melakwa Lake.

Wilderness: Landform block 5 has 10,016 acres, or 22% in Wilderness. This area is relatively accessible by trail, containing destinations such as Kuitan Lake, Scott Mountain, Tenas Lakes, Benson Lake. The landform boundary follows the foot of the lava flows, placing the flows in block 4, and leaving the gentler terrain in this block 5. Wilderness permit data shows this area is lightly traveled by recreational stock users.

LANDFORM BLOCK 6

LOST CREEK GLACIAL TROUGH

(Yapoah-Anderson Creek system of Wilson 1981)

Introduction

The Lost Creek/White Branch drainage represents three episodes of geologic formation. The original valley was deeply incised in Older High Cascades volcanics during uplift of the Central Cascade Range. Subsequently, the valley was filled by later "intracanyon" lava flows about 4 million years ago. Stream erosion at the margins of these flows and subsequent valley erosion by several events of glacial advance and retreat have left these older intracanyon flows perched above the valley as Foley Ridge (Flaherty 1981).

The valley glacial events were followed by two new episodes of intracanyon basalt flows from Younger High Cascade cinder cones; one about 7,500 years ago which erupted from Sims Butte and reached a point near the confluence with the main-stem of the McKenzie; and one from Collier Cone about 2,500 years ago which side-lapped the Sims Butte flow (Lund 1977). These flows were associated with pyroclastic ash eruptions which account for some of the sediment source for the watershed. Because of this and the much lower stream velocity in the Lost Creek drainage, the gradation of the sediments are much finer than those in the main-stem of the McKenzie.

Similar to the Recent High Cascades landform block, these younger, more permeable lava flows overlying glacial deposits provide for subsurface water flow, which originates from Collier Glacier, and emerges as springs in the lower valley such as Alder, Butte, and Payne Springs (Figure 4-49).

Disturbance History - Mass Wasting

Mass wasting in Landform Block 6 has been a result of differential weathering at the base of the Simms and Collier Butte flows on the sideslopes of Lost Creek (between Payne Springs and Cupola Rock). This created debris avalanches that were transported to the valley floor of Lost Creek due to the lack of sinuosity of the fourth order streams. Landslide and debris avalanche events also occur on the sideslopes of the cinder cones and volcanoes in the upper portions of the Landform Block, and potential exists for events to occur as a result of alpine glacial melting (Fig. 4-50 and 4-51).

Figure 4-49. Block 6 Locator Map

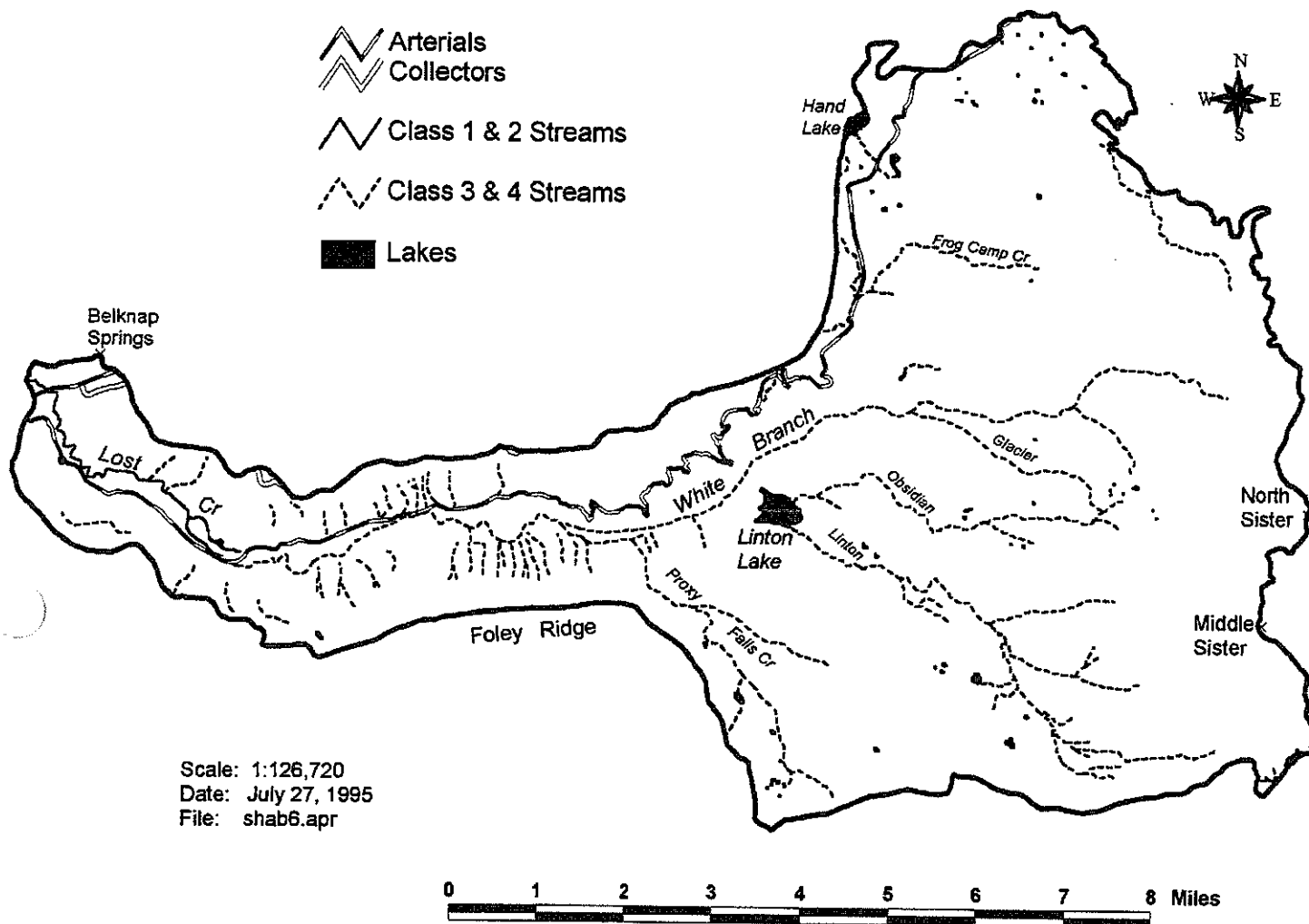


Figure 4-50. Landform Block 6 Potentially Unstable Areas

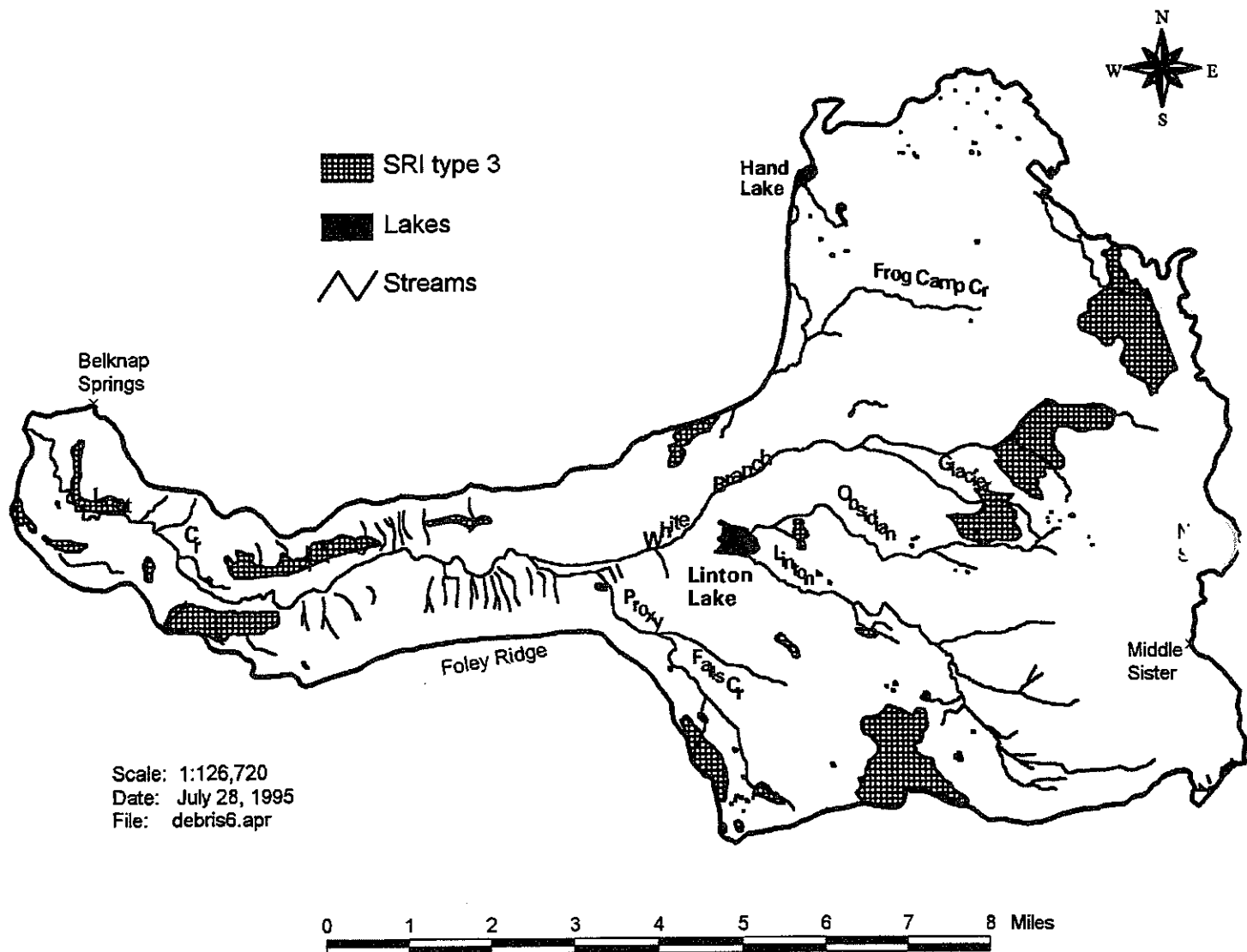
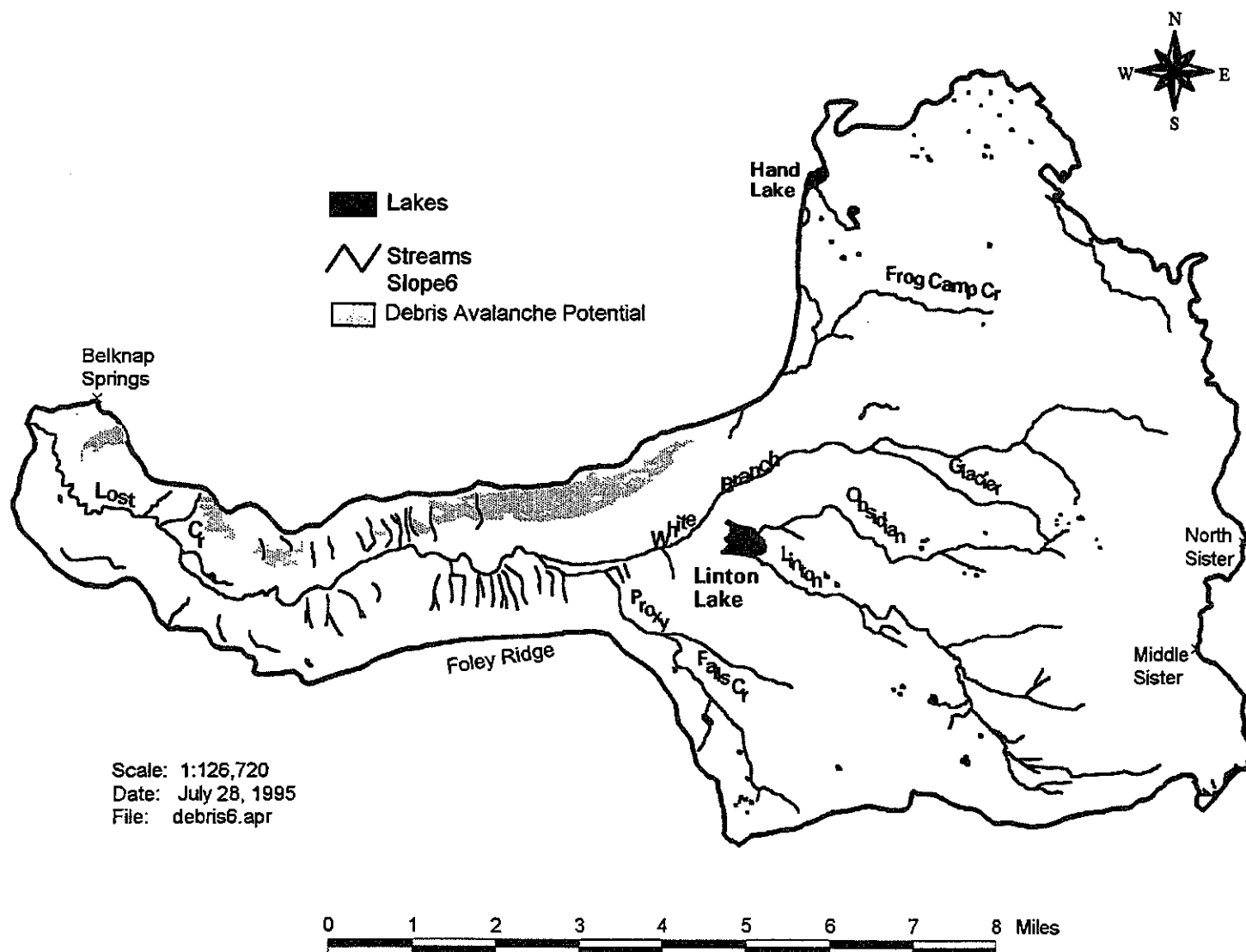


Figure 4-51. Landform Block 6 Debris Avalanche Potential



Landform block 6 contains SRI Unit 3 potentially on all slopes; and Units 61, 610, 610U, 614, and 71 on slopes greater than 70%.

Disturbance History: Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM), western hemlock (TSHE), mountain hemlock (TSME) plant series, and Douglas-fir (PSME) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

The typical winds in this area are from the west, blowing up-slope and up-canyon. The east winds blow across the surface on most of this block. That surface wind is channeled and strengthened by the gap between Black Crater and North Sister (Faith 1990). This same stream of wind slips down into the White Branch drainage to approximately 2500 feet elevation.

The area has a history of fairly frequent fires of varying intensity and varying sizes. This block is capable of producing large final fire sizes. Currently, average patch size is larger here than anywhere in the watershed. This is consistent with the amount of wilderness, the plant series, the stand density of this block, and long topography.

Along the ridgelines, lightning ignitions play an important role in the ecological process within this block, but fires here have been relatively small in extent due to the nature of fuel packing and abundance, and moisture at these sites. The area also has high meadows that are being invaded by young trees.

The forest patches in this block are a mix of even-aged stands and multi-aged stands. The multi-aged stands are located in the lower elevations of the block. The average size of the patches is small: about 74 acres. This is smaller than the average patch size in 1900, which was about 90 acres. A Shannon diversity index analysis indicates a 3% decrease in diversity between 1900 and 1995. The index changed from 1.90 in 1900 to 1.85 in 1995. The decrease is mostly related to fire suppression in the wilderness portions of the block that has created a more homogeneous landscape.

Unique Habitats

Table 4-13 and Figure 4-52 display the unique habitats within this landform block. The most dominant non-forest habitats are meadows and lava.

Figure 4-52. Block 6
Special Habitats

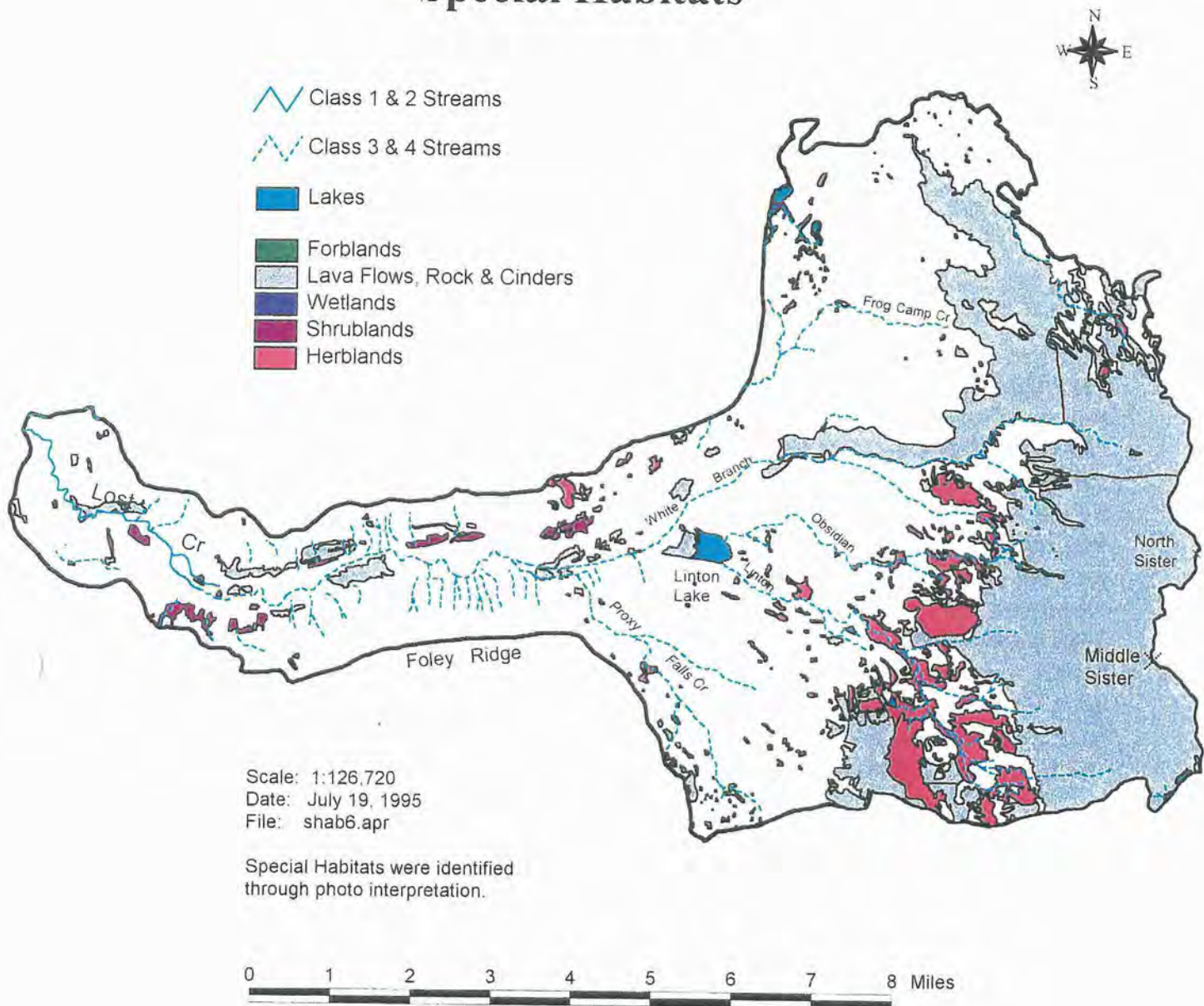


Table 4-13: Unique Habitats within Landform block 6.

Habitat Feature	Acres
Wet meadow	53.90
Mesic meadows	12.90
Dry meadows	21.25
Herb/forb meadows	1,743.53
Shrub communities	220.77
Shrub lava	96.22
Rock outcrop	4.55
Talus	124.44
Lava	4,463.57
Lakes	60.30

This landform block is unique because of the variety of non-forested habitats that are found and a range in elevation from approximately 1600 feet to over 9000 feet at the top of the Middle Sister. Much of the wilderness area is open subalpine parkland vegetation. Extensive huckleberry fields are found as well as many lakes and ponds with associated sedge vegetation are present. Plant associations of wet to dry habitats ranging from subalpine to low elevation meadows are scattered throughout the landform block. Threats to these meadows are a result of soil disturbances from recreationalists and grazing by pack animals. Many of these meadows tend to have fragile plant communities which are easily impacted by continual disturbance. These meadows may provide habitat for sensitive and other rare plant species. This summer, selected meadows will be field inventoried to assess the impacts from recreational use. Many of the subalpine plant communities have not been classified.

Cliff habitat in this landform block is providing high quality peregrine falcon habitat.

A unique feature of this area is the ecotone that exists between the younger unvegetated lava flow and the older vegetated flow that surrounds it.

Sensitive Species

Potential habitat for 15 sensitive plant species is present (Table 4-14). Three sensitive plant species and 3 species of concern have been located. Newberry's gentian (*Gentiana newberryi*) is the only known location on the Willamette National Forest. Newberry's gentian is a low growing alpine perennial found in moist meadows. Threats to this population are from hiking trails located in close proximity to these populations. The second sensitive species is the Northern bog clubmoss, found in open sphagnum bogs. Sighting information for this species is from an historical report; the area needs to be re-surveyed to determine current status of the species.

Table 4-14: Sensitive and Rare Plants Located in Landform block 6.

Landform Block 6	Status	Number of pops
<i>Gentiana newberryi</i> - Newberry's gentian	S	1
<i>Lycopodiella inundata</i> - bog clubmoss	S	1
<i>Utricularia minor</i> - lesser bladderwort	S	1
<i>Draba aureola</i> - golden alpine draba	W	5
<i>Lycopodium annotinum</i> - stiff clubmoss	W	2
<i>Oxypolis occidentalis</i> - western cow-bane	W	1
<i>Botrychium simplex</i> - little grape-fern	C	1
<i>Corallorhiza trifida</i> - yellow coral-root	C	2
<i>Isoetes</i> spp. - quillworts	C	1
The Region 6 Sensitive (S) Plant List; Review (R) List and the Watch (W) List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern (C) List for locally rare species not included in the first three lists.		

Table C-3 plant species that are found in this landform block are: *Gautieria magnicellaris* a rare mycorrhizal false truffle associated with high elevation old growth mountain hemlock and true fir conifers in the Mt. Washington Wilderness Area; *Thaxterogaster pingue* a false truffle found in a conifer stand adjacent to Huckleberry Lake and *Allotropia virgata* in two conifer stands (Botany Appendix). Additional habitat for many Table C-3 species occurs within this landform block.

CHANNEL CONDITION AND AQUATIC HABITAT:

Like Landform Block 5, much of this subwatershed drains gently sloping terrain of the High Cascades province and has new and old lava flows that have large water storage capacity. The nature of the springfed stream of Lost Cr., coupled with the storage capacity of the drainage area, determine the stable, even flows of the creek.

These conditions create stream habitat very similar to Landform 5's Sweetwater/Anderson/Olallie Creeks. The recent high Cascade lava flow upon which Lost Cr. flows overlies glacial deposits and older Pleistocene lavas. Cold water supplied by spring-fed flow originates from the western flanks of Middle and South Sister. The high water storage capacity of deep glacial deposits and

porous lavas provide for evenly supplied flow to Lost Creek. Changes in flow routes are a potential within this drainage, as observed recently in White Branch tributary with loss of surface flow as subsurface routes were apparently encountered by the channel. Disturbance in the past carried potential of massive debris torrents originating from glacial lakes at Lost Cr. headwaters. A similar torrent originating from nearby Skinner glacier flowed down Separation and Horse Cr. in 1933. Fire disturbance includes a large stand replacing fire along the south facing slope above Lost Cr. sometime before 1901. Fire in the Simms Butte vicinity was recorded in 1925 (480 acres) and 1935 (1,715 acres).

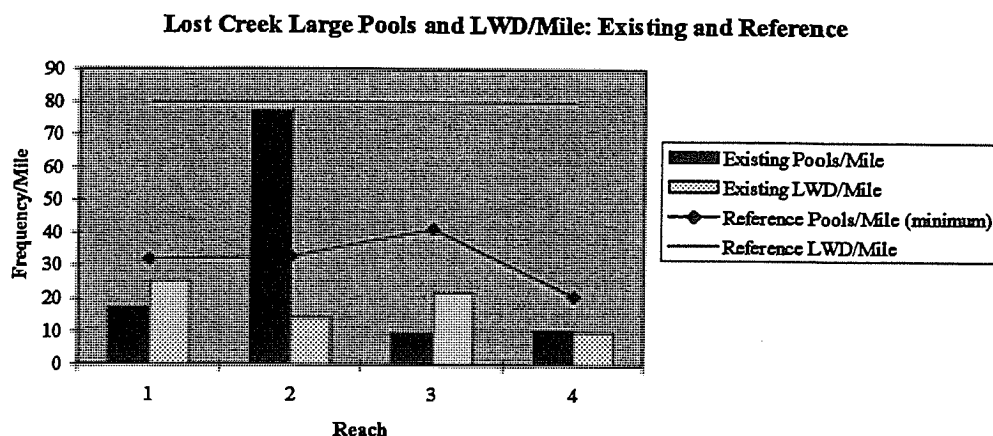
Lost Creek is an important spring chinook spawning and rearing stream. Cutthroat, rainbow and sculpin are known to inhabit the stream. It appears bull trout only use the stream currently as foraging habitat, entering its low gradient reaches to prey on abundant resident fish species and floating eggs of chinook salmon. Historic use of Lost Cr. by fish species may include spawning and rearing bull trout. Why bull trout do not currently use Lost Cr. as spawning and rearing habitat is not known. Theories include high concentrations of fine ash sediment in most habitats that does not allow optimal survival during incubation. All other habitat requirements of bull trout are apparently met by Lost Creek. The supply of ash to the channel comes from interception of ash layers adjacent to the channel supplied by steep side slope tributaries. If ash presence has not been continuous, perhaps bull trout used this stream as spawning and rearing habitat.

Similar to Landform Block 5, most lakes located in this landform are glacial scour lakes and were historically barren of fish. Linton Lake, isolated by a lava dam, may have had a native population of cutthroat in its past.

Lost Creek Aquatic Habitat Condition

Abundant LWD is present in Lost Cr. channel despite a large fire in the past century that burned stream adjacent conifers along most of its length. Although large diameter wood is present in low numbers (Figure 4-53), diameters smaller than 24 inches have been supplied to the channel.

Figure 4-53



From ODFW Level II Lost Cr. survey, 1991. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

Highly complex habitat exists in Lost Creek, in part due to its uniform flow and stable channel. Habitat conditions similar to Sweetwater/Anderson/Olallie Cr. are abundant side channel habitat in low gradients, stable islands and in-stream wood, and undercut banks. Large pool habitat does not meet references levels in Reach 1, 3 and 4 due to the broad, unconstrained channel. Large channel spanning pools are infrequent, except in Reach 2 with a steeper, constrained channel. Active beaver colonies utilize a broad, inner hardwood riparian zone in Reach 2 and 3. Large wood in the channel appears to remain where it falls in unconstrained reaches. Recruitment potential is good for large diameter wood along Lost Creek.

Larger high lakes in this landform (Fisheries Appendix) previously barren of fish life, are currently stocked every 1-4 years. Self-reproducing populations of brook trout are found in Spring Lake and brook and brown trout are found in Linton Lake.

RIPARIAN RESERVES

Data indicates that approximately 7% of the entire riparian area within the block has been roaded, harvested, or has an administrative or recreation site. Of the total riparian area within the block, Class IV riparian areas have been the most impacted (<4%) (Figure 4-54).

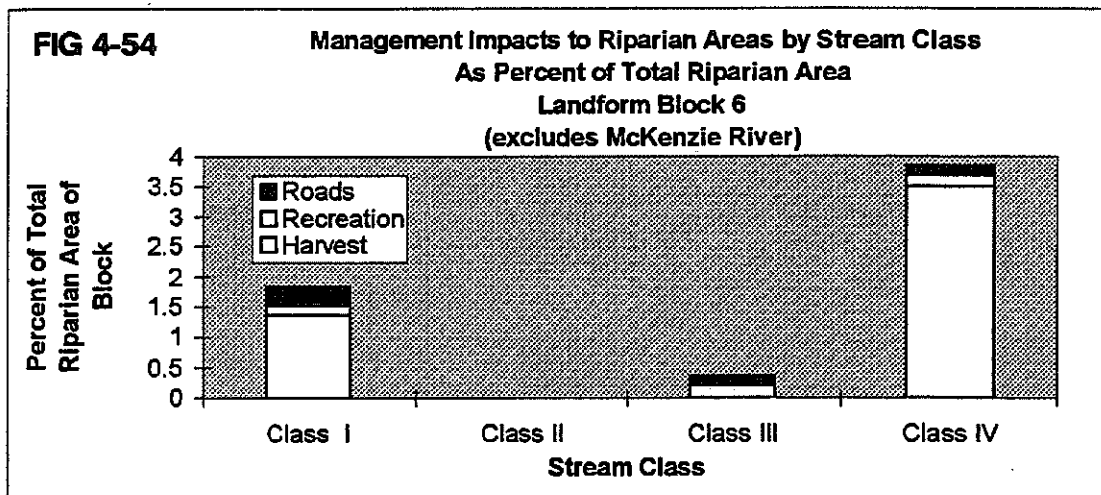
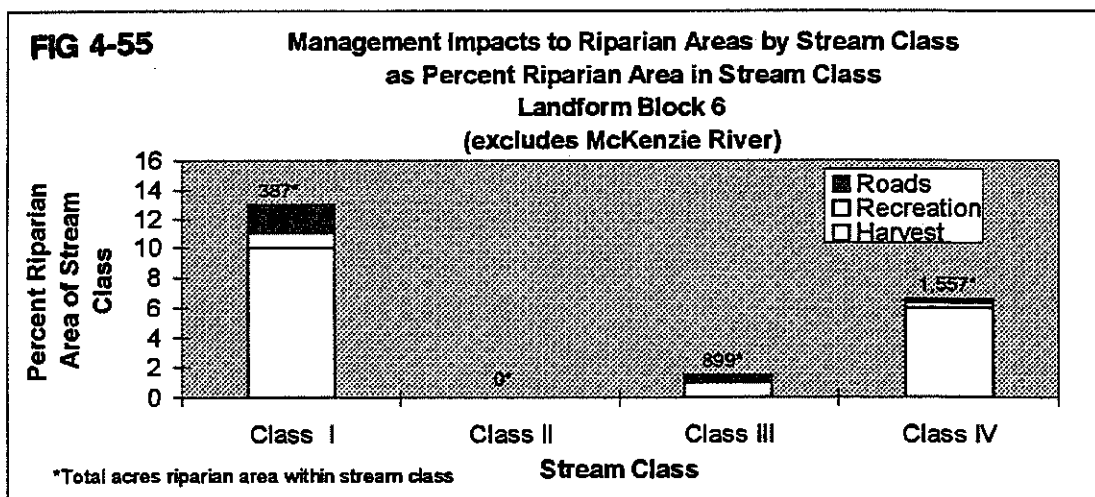


Figure 4-55 shows that Lost Cr. (Class I) has had nearly 13% of the riparian area impacted when considered as a percentage of the total riparian area for the Class I stream.



Harvest has occurred within 10% of the riparian reserve of Lost Cr., while Limberlost Campground accounts for 1% impact, and roads 2% impact to the Lost Cr. This combined encroachment into 13% of the riparian reserves probably has little to no effect on the channel function and water quality of Lost Cr., but may begin to contribute to decreased LWD in the channel, affecting habitat.

Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that this landform block has 31 dispersed recreation sites. That is 9% of the 333 dispersed sites in this watershed.

Riparian: Thirteen sites (or 42% of those in this block) are in a riparian reserve, with 5 of these sites located at Camper's Lake and 8 along Highway 242 in the vicinity of Limberlost Campground. Ten of the 13 sites are accessible by foot only; four accessible on a closed road off Highway 242, and six at Camper's Lake. The 13 riparian dispersed sites have a total of 12,516 sq ft, or 0.29 acres of campsite area. The barren core of these sites equals 1,410 sq ft or 0.03 acres. That averages to 11% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very small core areas.

Non-Riparian: Eighteen of the dispersed campsites in this landform block are not close enough to water to be considered within a riparian reserve. These sites are all off Highway 242. These 18 sites have an area of 17,290 sq ft, or 0.40 acres. Of this area 978 sq ft or 0.02 acres is considered barren core. That averages 6% of core within these site areas. Five of these dispersed camps are accessible by foot, the remaining 13 by vehicle.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets, and parking spurs. Some have water systems and garbage service. Boat ramp facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river. The following developed recreation facilities are located within landform block 6:

Campgrounds: Limberlost Campground--There are 12 designated camp units in this campground. All of the campground falls within a riparian reserve. Alder Springs Campground--There are 6 camp units in this campground. None of this campground falls within a riparian reserve.

Picnic/Day Use Area--No Day Use Areas are within this landform block.

Boat Ramps: No boat ramps are within this landform block.

Sno-Parks: No sno-parks are within this landform block.

Administrative or Recreation Special Use Permit Areas: This block contains White Branch Youth Camp, under Special Use Permit to the Churches of God of

Oregon. The facilities consist of cabins, dining hall and kitchen, lodge building, swimming pool, a hill for winter tubing. This facility covers 41 acres of which 30% falls within a riparian reserve.

Wilderness: Block 6 contains 29,791 acres of the Three Sisters Wilderness, which is 75% of this total area. Access to most of this area is off of Highway 242, which is closed in the late fall and opens again in early summer. The non-wilderness acres are in a narrow band of land following Highway 242 down from McKenzie Pass to its junction with Highway 126. This portion of the Three Sisters contains some of the most heavily traveled trails and destinations, including Linton Meadows, Proxy Falls, Obsidian, and the Middle Sister. These wilderness acres include three destinations which receive relatively high recreational stock use when compared with rest of the westside of the wilderness:

Trail # 26 Foley Ridge Trail is on the boundary of the watershed, but perhaps 75% of all the stock users on that trail go to Linton Meadows, which is within this block; **Trail #29** Obsidian Trail has stock users that either stay around Obsidian Creek or again continue to Linton Meadows. **Trail #30** Scott Trail leads through a meadow area near Four in One Cone that receives some grazing use by recreational stock.

MAINSTEM MCKENZIE

Introduction

The mainstem of the McKenzie traverses through Landform Blocks 4, 2B, 2A, 5 and 1. It winds its way along the North Santiam Fault Zone, which controls the North-South direction of the river. Just south of Belknap Hot Springs, the river changes course to a westerly direction as it breaches the ancient High Cascade escarpment and flows into the McKenzie Bridge-Blue River glacial valley. Through this area, the valley is wider due to glacial scouring. Through time, the river has generally been incising except during those periods of glaciation when the glacial outwash of sediment during glacial retreat overwhelmed the sediment transport capacity of the river. The result was aggradation of the streambed and floodplain. Since the time of glacial advances, the sediment supply has reduced and the river has downcut into the glacial deposits, creating terraces (Ligon 1991) (Figure 4-55a).

Disturbance History - Mass Wasting

Mass wasting along the mainstem corridor is mainly a function of the slopes adjacent to the river and State Highway 126. The Oregon Department of Transportation routinely inspects the cutslopes and monitors them for any change in frequency or size of rockfall occurrence. The following are the areas of greatest frequency:

Highway 126: Belknap Springs to Clear Lake:

M.P. 5.43 to 5.53
6.36 to 6.70
8.81 to 9.29
11.16 to 11.40

Santiam Highway :

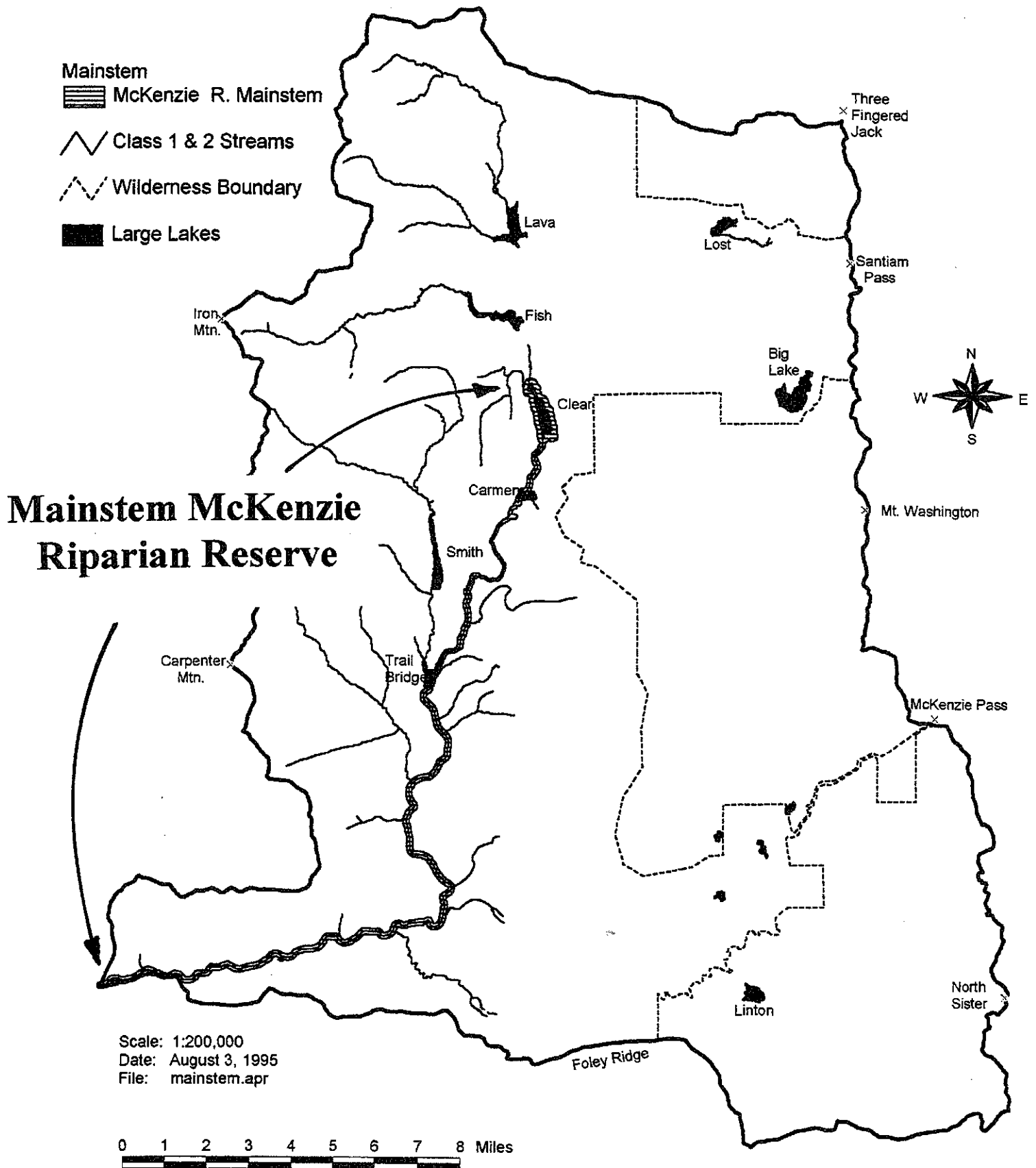
M.P. 71.23 to 71.31
78.41 to 78.47
78.75 to 79.46
84.93 to 85.20
85.83 to 85.85

CHANNEL CONDITION AND AQUATIC HABITAT

Introduction

The geomorphic and hydrologic processes described earlier in this document shape the landscape of this watershed. The valley and flood plain width, vegetation, and dimensions of the channel are products of the geology, climate, flow regime, and erosion in the subbasin. The aquatic habitat in a Cascade river or tributary is similarly a product of continual recruitment, storage and transport of bedload, erosion of banks, deposition on floodplains at high flow, and supply

Figure 4-55a. Mainstem McKenzie Riparian Reserve



of organic debris and nutrients. The degree to which conditions in aquatic habitat vary as a result of natural disturbance is the range of conditions to which communities have adapted. Natural disturbance include flood, fire, mass failure/debris flow, disease and insect infestation, wind throw, and climactic change (Swanson 1991). Beyond this background level of aquatic habitat variability, human influence can disrupt natural processes and drastically alter habitat condition, possibly beyond organism ability to adapt. Human alteration of aquatic habitat may result from dam building, timber harvest, fire suppression, road building, channelization, salvage of in-stream wood, or alteration of riparian vegetation.

Important Fish Habitats

Habitats essential to spring chinook within the analysis area include the main stem McKenzie River and Lost Creek (Figure 4-55a). Extraordinary holding periods for adult chinook require they hold through summer in deep pool habitats, primarily, but not limited to lower McKenzie reaches. Spawning habitats utilized by spring chinook are cobble and gravel rich low gradient riffles and pool tail-outs. Rearing habitats and winter refuge consist of side channels, river margins and lower tributaries. Recent efforts to restore rearing habitat in a side channel of the upper McKenzie have resulted in an encouraging increase in side channel utilization by rearing chinook salmon (USDA Forest Service 1994). After enhancement of flow and in-stream LWD of a McKenzie River side channel, a two-fold increase in the number of juveniles was observed by comparing pre- and post-project monitoring. Although additional monitoring will be necessary to extract conclusive evidence, early indications suggest rearing habitat is a factor limiting spring chinook production in the upper McKenzie subbasin. In addition to numerous rearing chinook in the restored side channel, were juvenile bull trout, attracted to a concentrated prey source. The side channel's recruitment of rearing chinook attracted predatory bull trout where there had been none prior to enhancement.

The main stem McKenzie River provides essential foraging and rearing habitat for bull trout. The main stem river used by bull trout above Trail Bridge Dam includes Trail Bridge pool and main stem McKenzie River above to Tamolitch pool. Adults and subadults utilize all habitats in the main stem while foraging. Their distribution (other than during spawning season) is determined by distribution and behavior of prey species. Adult bull trout are most often observed in deep pools utilizing available wood or undercut banks as cover. Main stem rearing habitats and winter refuge consist of side channels, river margins and tributary junctions. No evidence to date has been found of bull trout spawning in the main stem McKenzie below Trail Bridge dam. Spawning habitat appears to be limited to spring-fed tributaries. Above Trail Bridge dam, the main stem McKenzie River, with relatively lower flow, has been used as spawning habitat by the Trail Bridge population.

McKenzie Aquatic Habitat and Channel Condition

The main stem McKenzie River above Belknap Springs is somewhat constrained and travels through deep glacial deposits of cobble, rubble and boulders. The McKenzie River has been eroding relatively young mountains and, therefore, is very steep relative to its discharge. As a result, the river has a very high boundary shear stress and sediment transport capacity which exceeds its natural sediment supply. Most sediment entering the system is quickly transported out, resulting in an actively incising stream that has relatively small quantities of in-channel sediment and a coarse, armored bed. This process of downcutting and substrate coarsening may be accelerated with the presence of the Carmen, Smith, and Trailbridge dams, which cut off sediment supply to the river below these impoundments. Capturing of sediment upstream of the dams will cause scour below the dams immediately following dam closure. Erosion below the dam will continue until the gradient is reduced and/or the bed coarsens to a bed roughness that reduces the velocity below the threshold for the sediment transport (Petts 1979). Evidence of down cutting may exist in the change through time of number and length of side channels in the upper river. From Belknap Springs to Trail Bridge, the number of side channels dropped from 10 to 3 (1,039 meters to 669 meters) between 1949 and 1986, indicating possible channel down cutting and abandonment of side channels (Minear 1994, Table 5). Minear's study of the McKenzie River noted changes in channel and riparian condition by comparing aerial photos from 1949 and 1986 (Tables 4-15 and 4-16). Data collected included wetted channel area, side channels, large woody debris, exposed gravel bars, roads and dominant vegetation seral stage.

Table 4-15: Channel characteristics, side channel number and length, and exposed gravel bar area in the Upper McKenzie River in 1949 and 1986.

Reach	year	Channel Sinuosity	Channel Area (ha)	Number of Side Channels	Side Channel Length (m)	Gravel Bar Area (m ²)
Belknap Springs to Trail Bridge	1949	1.36	35	10	1,039	0
	1986	1.36	30	03	669	0
McKenzie Bridge to Belknap Springs	1949	1.14	38	07	998	165
	1986	1.14	33	11	1,263	6,457

from Minear 1994.

Table 4-16: Percent of riparian area by vegetation classes in the Upper McKenzie Watershed in 1949 and 1986. (Riparian area was defined as the area within 90m of active channels, plus floodplains)

Reach	year	% Riparian Resid/ Develop	% Riparian In roads	% Riparian <20 yr hwds	% Riparian 20-100 yr hwds	% Riparian <20 yr conifer	% Riparian 20-100yr conifer	% Riparian >100yr conifer
Belknap Springs to Trail Bridge	1949	0	1	0	0	0	35	62
	1986	0	5	1	2	3	49	39
McKenzie Bridge to Belknap Springs from Minear	1949	1	1	1	1	14	61	20
	1986	3	3	1	6	0	60	27

The uppermost reach in Minear's study (Reach 1) examined the river from Belknap Springs to Trail Bridge. Reach 2 is an examination of river from Belknap Springs to McKenzie Bridge, allowing use of her analysis to characterize historic and existing channel and riparian condition of the McKenzie River within the analysis area. This portion of the river remained mostly intact in the 1949 photos, the riparian area consisting of mostly conifer forest under federal ownership. The upper, less accessible reaches of the McKenzie, particularly above Belknap Springs, were developed or harvested relatively recently. In the 1986 aerial photos, Minear found significant changes in riparian and channel condition.

Minear (1994) found no significant change in channel area or sinuosity from McKenzie Bridge to Trail Bridge between 1949 and 1986. There are indications of channel down cutting and/or bedload coarsening in Minear's and similar studies. Changes in observed bedload composition between 1937 and 1991 indicate larger substrates are currently more abundant (Sedell et al. 1992). Table 4-17 depicts changes in pool frequency and substrate composition in the upper McKenzie River. This observation is consistent with other dammed rivers. The supply of sediment upstream of the Carmen-Smith-Trail Bridge dams has been intercepted by the dam and starves the river below of historic levels of sediment. The supply of in-stream wood upstream of diversions has also been intercepted, and with their absence is lost a source of scour, flow deflection and sediment storage for the river below.

Table 4-17. Changes in large pool frequency and percent bottom by substrate size for the Upper McKenzie River, 1937-1991 (Large pools are those greater than 20 meters² and deeper than 1 meter).

Reach	Year	Large Pools/ Mile	% Bottom Large Rubble (>150mm)	% Bottom Medium Rubble (75-150 mm)	% Bottom Small Rubble (6-75 mm)	% Bottom Fine Sediment (<6 mm)
Belknap Springs to Smith River Bridge	1937-	18.7	43	40	17	1
	38	11.1	84	09	05	2
McKenzie Bridge to Belknap Springs	1991					
	1937-	7.3	57	26	16	1
	38	8.8	79	15	06	0
	1991					

from Sedell et al 1991.

The results of Minear's analysis of 1949 and 1986 aerial photos indicated significant straightening of unconstrained reaches lower in the McKenzie River. The simplification of the lower main stem channel over the course of 37 years was attributed to reduction of peak flows (by Cougar and Blue River impoundments), lack of in-stream structure (LWD) to deflect flow, channelization by rip-rap, roads, and alteration of riparian vegetation. Although no straightening of the more constrained upper reaches was observed, low quantities of in-stream LWD, placement of channel constraining road fill and rip-rap, alteration of riparian composition, a coarsening bedload, and side channel abandonment indicate channel simplification has occurred in the Upper McKenzie River.

Channel complexity is reduced where bank erosion is eliminated by rip-rap. Rip-rap causes the channel to deepen and narrow as it scours holes against the hardened bank. This stabilizes the channel location which leads to a reduction in the formation of mid channel bars and islands (Ligon 1991). Places where this is apparent on the McKenzie River is the lower section of the watershed beginning at Belknap downstream to the downstream boundary. The rip-rap is discontinuous and is first noted at Belknap Hotsprings, then again at Paradise Campground downstream. Approaching the town of McKenzie Bridge, riprapping of the river increases dramatically as the number of houses located on the river banks increases. Boulder placement on the banks is particularly heavy beginning upstream of an old, large island with residences and a church located on the river banks. As the river periodically shifts the location of the dominant channel from one side of the island to the other, it shifts the location of maximum erosion from one bank to the other (Ligon 1991). Hardening of the banks with riprap opposite from the island is likely causing the channel to scour and fix its location, leading to an eventual elimination of one of the two channels. If there are no major flows in the near future to shift the dominant channel from the right side of the island to the left (as one looks downstream), it appears as though the left side of the island would be the channel to be dewatered.

There is one section located downstream from the mouth of Frissell Cr. where the highway impinges on the river and riprap has been placed to protect the road. In this location, the riprap has effectively caused channel constriction, resulting in channel widening and the formation of a mid channel bar directly upstream of the constriction.

A recent survey of large woody debris (LWD) in the active channel of the McKenzie River from Trail Bridge Dam to Scott Creek found about 18 pieces/mile measuring 24 inches in diameter or greater by 50 feet or longer (USDA Forest Service 1992). Historic levels of in-stream wood are greater but are not quantified. Extensive salvage of in-stream wood occurred in the reach from Belknap Springs to Trail Bridge Dam following the 1964 and 1972 floods (Sedell op. cit.). Further reduction of in-stream wood continues following completion of Carmen-Smith-Trail Bridge Complex and interception of recruited wood from Smith River drainage, Hackleman Cr., and main stem McKenzie River above the dams. Historically, LWD likely consisted of greater numbers of off-bank and bank parallel whole trees (Paula Minear, pers. comm.) although not typically channel spanning. Frequent log jams were located at the head of islands and side channels. Channel spanning accumulations were only occasional and consisted of jams on large boulders. In-stream wood perceived as flood hazards or of commercial value have been removed historically. In recent history the channel has been maintained for boat and raft navigation below Olallie Campground where boaters have removed in-stream wood perceived as navigation hazards. Today, although present in reduced numbers, in-stream wood is accumulated at the head of islands, on rocks, and at side channel inlets. Off-bank and parallel to the bank large wood is most typical of debris that remains in the channel.

ODOT uses 40 to 50 thousand cubic yards of volcanic cinders in the Santiam Pass area each year. About 40% of that amount is distributed within the Upper McKenzie Watershed. Ten to 15% of the cinders spread on the highways are recovered and reused. The cinders generally fall within 100 feet of the highway edge. About 50% of the zone of cinder influence is also within a riparian area.

The influence of cinders in the riparian area is nominal. The cinders have neutral pH so the acidity of the soil is not altered. The bulk density of the soil adjacent to the highway may be somewhat lowered. The cinders occasionally fall into the McKenzie River and its side channels. The cinders in the water have slightly increased the available spawning habitat by raising in-stream gravel levels. The cinder gravel mostly provides habitat for fish requiring smaller substrate, such as cutthroat, rainbow, and brook trout.

Deicers have not been used on the roadways within this watershed. ODOT is considering use of a deicer composed of calcium-magnesium-acetate. The chemical compound is benign and tests have shown no impacts to riparian areas.

Riparian vegetation is removed when the culverts and ditches adjacent to the highways are cleared. This results in a temporary increase in surface erosion. However, the maintenance of the drainage system reduces overall chances of a large failure. In the past, material cleared from the highway ditch line was dumped over the sideslope, impacting riparian vegetation. This practice displaced and killed riparian vegetation. The practice was discontinued about 10 years ago.

Streamflows and Aquatic Habitat

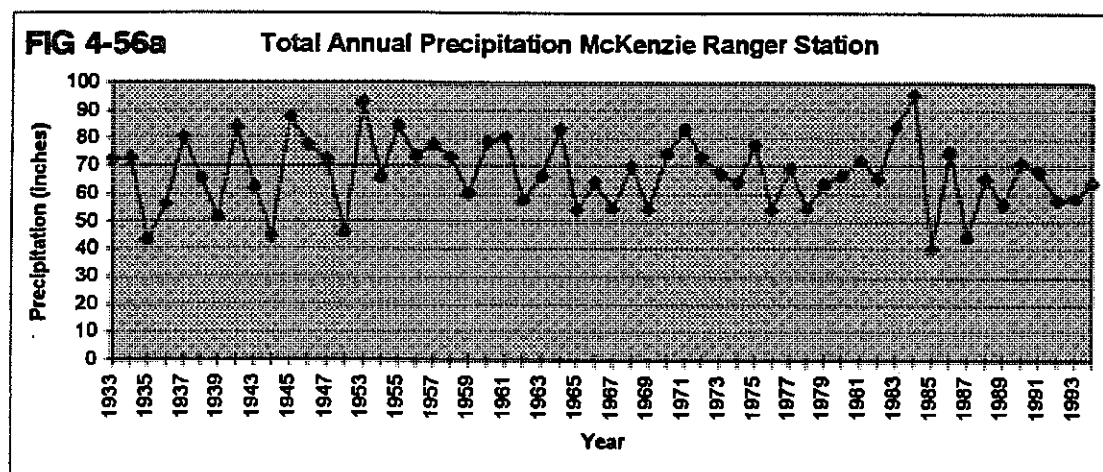
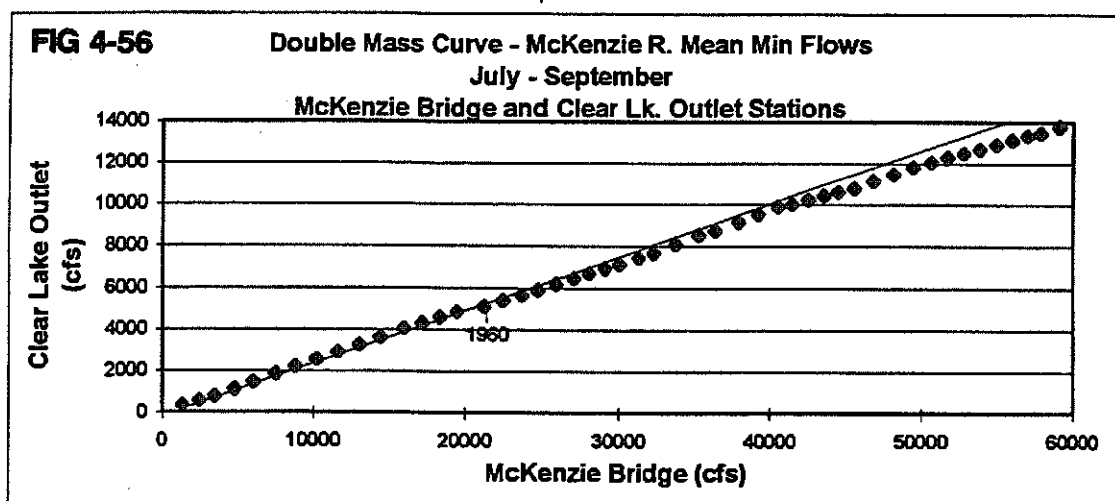
Analysis of streamflows on the McKenzie River were conducted to determine if changes in flows had occurred resulting from construction and operation of the Carmen-Smith Project. The project includes three dams, one located on Smith River known as Smith Reservoir, and two located on the main McKenzie River known as Carmen Dam and Trailbridge Dam. Carmen dam serves as a diversion reservoir, supplying water through a tunnel to Smith River reservoir. Water is then diverted from Smith Reservoir to Trailbridge Reservoir where power is generated. The project was completed in 1963. Analysis of discharge data described below indicates that there has been a decrease in summer low flows and no change in peak flows following construction of the Carmen Smith project.

At the time of exploratory work in the late 1950's, the idea of constructing one large dam at the Carmen site and omitting Smith Reservoir was quickly abandoned when many large holes in the Beaver Marsh area were discovered to drain water from the McKenzie River into lava tubes. In addition, the extremely fractured and porous nature of the basalt that would form the abutment of the west side of Carmen dam face would make it difficult to hold water within the reservoir (Progress Report 1959). Therefore, the decision was made to go with a minimum diversion requirement for diverting the McKenzie River to Smith Reservoir.

A double-mass curve of annual maximum mean flows from the McKenzie Bridge and Clear Lake outlet USGS gaging stations was used to determine if a shift in flows had occurred at the McKenzie Bridge Station relative to the Clear Lake outlet station. A shift in the data was not noticeable for flows from 1948-1993, indicating that annual maximum mean flows did not change as a result of the Carmen Project. Indeed, a t-test on the data supports the double-mass curve analysis, with no significant difference in the means before and after construction of the Carmen Project (0.95 confidence level). A t-test performed on

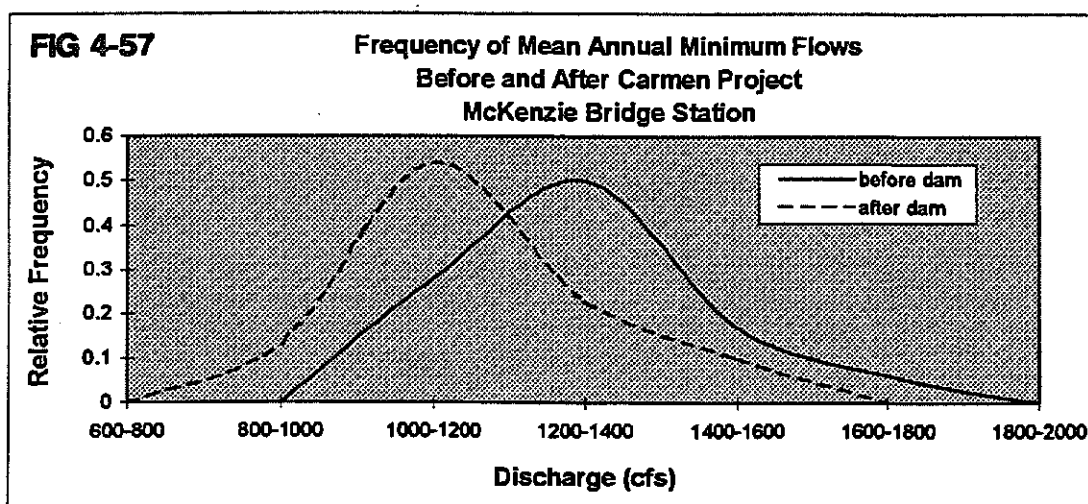
instantaneous peak flows also resulted in no significant difference in means before and after construction of the Carmen Project (0.95 confidence level).

Analysis of summer low flows has caused some sleepless nights and frustrating days. A double mass curve of mean minimum flows for July-September for USGS gaging stations at McKenzie Bridge and Clear Lake Outlet for the years 1913-1915 and 1948-1993 is displayed in Fig. 4-56. The curve reveals that summer low flows increased at the McKenzie Bridge station relative to the station at the Clear Lake outlet beginning in water year 1960. A look at the total annual precipitation as recorded at the McKenzie Ranger District since 1933 yielded no significant difference in precipitation before and after construction of the Carmen Project (t-test confidence interval = 0.95) (Fig. 4-56a).



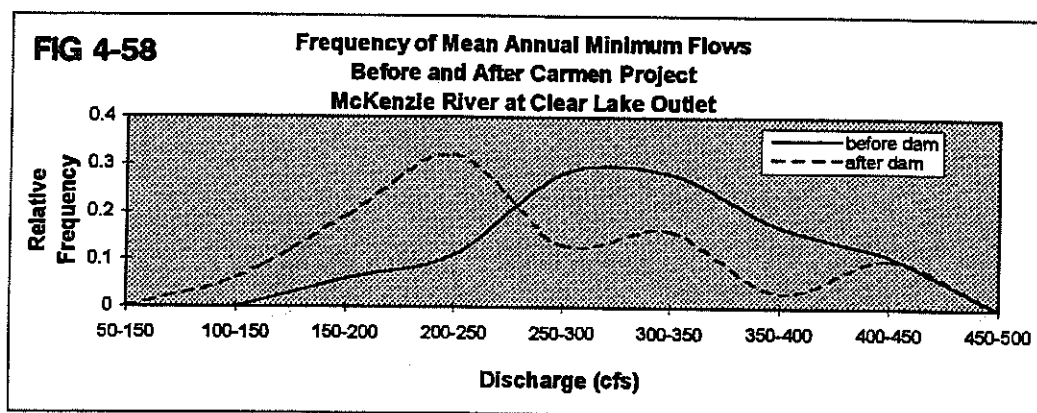
Streamflows during summer months have been noted to increase following logging activities due to reduced evapotranspiration and greater soil moisture levels (Harr, et al. 1979; Klock and Lopushinsky 1980; Cheng 1989; Bartos 1989; and Keppeler and Ziemer 1990). Increases in summer streamflows were also documented in the H.J. Andrews Experimental Forest near Blue River, Oregon (Rothacher 1971). Extensive logging began in 1960 to clear the reservoir (Place pers. comm.), and has continued since that time with a peak in the 1980's.

To determine the magnitude of change and to test for significance of the change in summer low flows at the McKenzie Bridge station, a t-test was performed on the data and a graph constructed of the relative frequency of flows before and after construction of the Carmen Project. The t-test and the relative frequency graph both showed changes in low flows before and after the Carmen project, but surprisingly, the change was to lower flows following construction of the project (Fig. 4-57).



This was contradictory to the double-mass curve which showed an increase in low flows beginning in 1960.

To resolve this discrepancy, a t-test was performed and frequency plot constructed of summer low flow data for the Clear Lake outlet station. This data also showed a reduction in low flows following construction of the Carmen Project (confidence interval = 0.95) (Fig. 4-58).

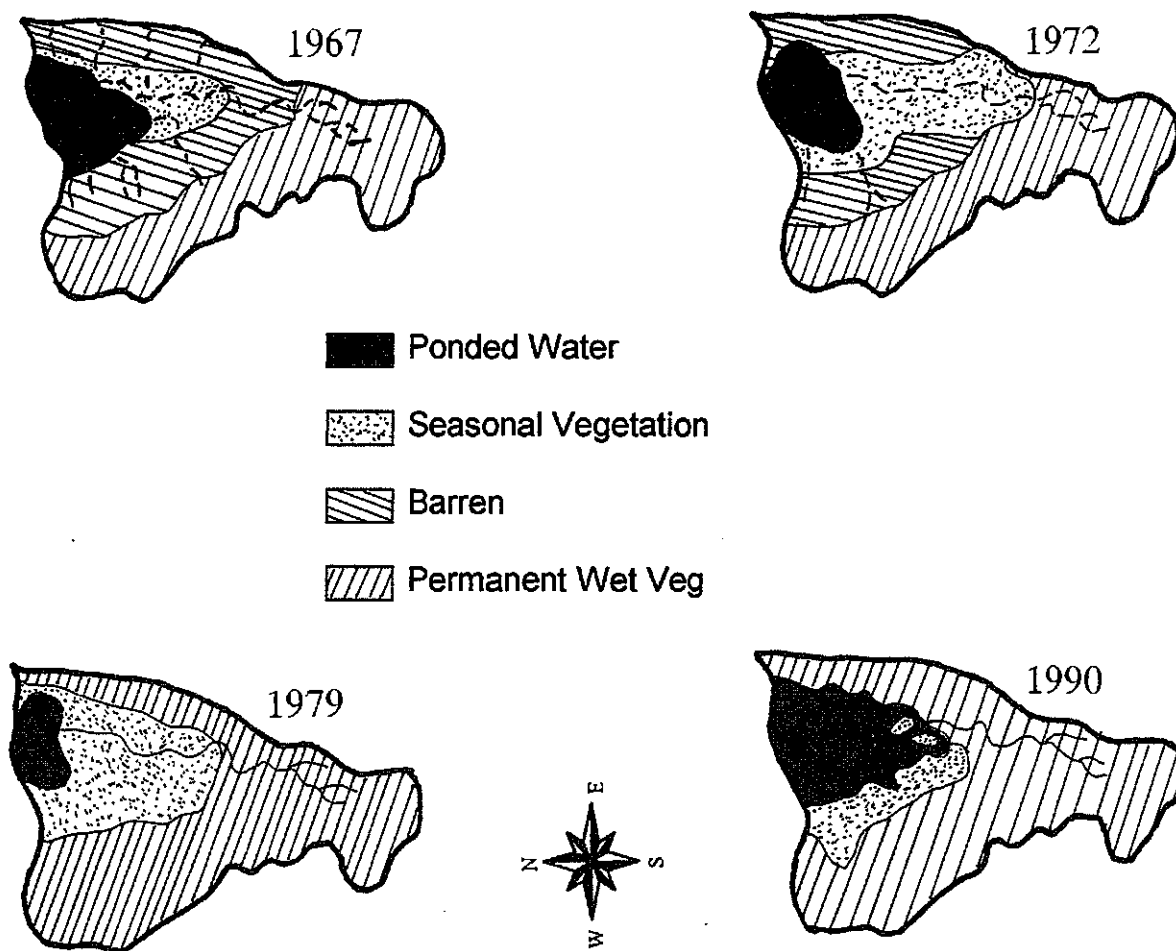


Both McKenzie Bridge and Clear Lake outlet stations had lost water during July, August, and September, but more water was lost at the Clear Lake outlet relative to the McKenzie Bridge station (difference in mean annual minimum flows before and after Carmen Project are 173 cfs and 54 cfs for McKenzie Bridge and Carmen Outlet, respectively).

A possible scenario for the changes in flow is as follows: during construction of the tunnel between Carmen Reservoir and Smith Reservoir, a fault system was encountered that allowed water to come gushing into the tunnel (Staples, pers. comm). As much as 10,500 gallons/minute (23 cfs) came pouring into the tunnel, requiring the tunnel drivers to work in wetsuits for the remainder of the project. The source of the water is more than likely from the Ikenick drainage, which is located directly above the tunnel, and which also flows directly into Clear Lake. Water from the Ikenick drainage was intercepted in the fault and redirected into the Carmen Project.

Figure 4-59 is a time-series drawing of the pond near the headwaters of Ikenick Cr. The four year series of 1967, 1972, 1979, and 1990 show a progressive depletion of the area of long-term ponding of water as indicated by the change in vegetation. The actual area of ponded water would not provide an accurate picture of long-term changes in water availability, as the area of actual ponded water would change depending on the amount of precipitation for the given year and the time of year the photo was taken. In 1967, the actual area of ponded water is small, however, the area of barren ground attests to a large area that, on a year-to-year basis, holds water long enough to preclude any kind of permanent, wet vegetation. Moving through the photo series, the area of barren ground continues to decline, while the area of seasonal vegetation continues to increase, followed by an increase in area of permanent, wet vegetation. Although changes such as this could be due to beaver activity in the area, it verifies that there has been a progressive depletion in the quantity of water once ponded in the Ikenick headwaters. This trend cannot be explained by precipitation changes, since there has not been trend of decreasing precipitation since 1967 (with the exception of years prior to the 1990 photo for the years 1987-1989).

**Figure 4-59. Vegetative Changes
of Ikenick Pond**



Scale approx. 1:3200

Ikenick Pond located T14S,R7E,Sec.18

Theoretically, the water from the fault is captured through drain valves and incorporated into the flow to Smith Reservoir. However, the first 1,500 ft. of the tunnel is composed of extremely porous, volcanic rock (Core, pers. comm.) that the water from the fault could easily flow into, thus capturing and redirecting the water into another part of the groundwater aquifer. Additionally, water that is evaporated from the surface of Smith Reservoir, coupled with the possible loss of water through the fractured basalt and porous lava adjacent to the reservoir, could be the cause for reduced summer flows at the McKenzie Bridge station following construction of the Carmen Project.

The overall effect on streamflows at the McKenzie Bridge USGS station is a decrease in summer low flows due to the Carmen Project, but a corresponding increase in summer low flows due to harvest. The net result is reduced streamflows during July, August, and September. However, the magnitude of the decrease is tempered with increased flows resulting from harvest. In other words, low flows may have been lower if it were not for additional water made available from timber harvest.

This reduction in summer low flows following completion of the hydroelectric complex may influence resident and migratory fish populations. Most studies of the effects on fish from changes in flow have been conducted on anadromous fish, where reduction in low flows have been found to affect migration and spawning success (Bjornn and Reiser 1991). Migration routes too shallow for passage are not likely, as the McKenzie continues to retain sufficient depths to provide passage to the Carmen Spawning Channel. The extent to which reduction in low flow has modified spawning beds may be of concern. In combination with a coarsening bedload, lower summer flows may result in lower available spawning bed area. Optimal spawning conditions include ideal discharge and maximum available spawning area (including preferred velocity, depth and substrate composition). Alteration of these components may reduce spring chinook spawning success. The flow regime subsurface and in the river channel below Carmen Dam extending to Trail Bridge Dam has been significantly altered by diversion of McKenzie River flow. This segment of the McKenzie River ran intermittently prior to construction of the Carmen-Smith-Trail Bridge hydroelectric facilities.

Hydroelectric projects may pose a risk to fish in other ways. Two unscreened hydroelectric intakes are present in the upper McKenzie River. The largest, operated by EWEB, draws outlet flow from Trail Bridge pool through a turbine generator and may pose a risk to bull trout and native fish residing above the

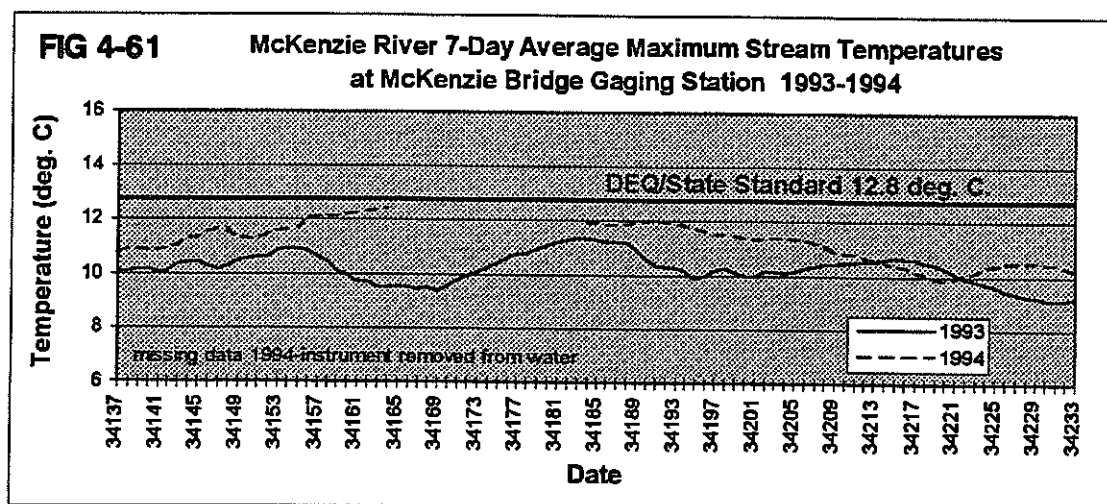
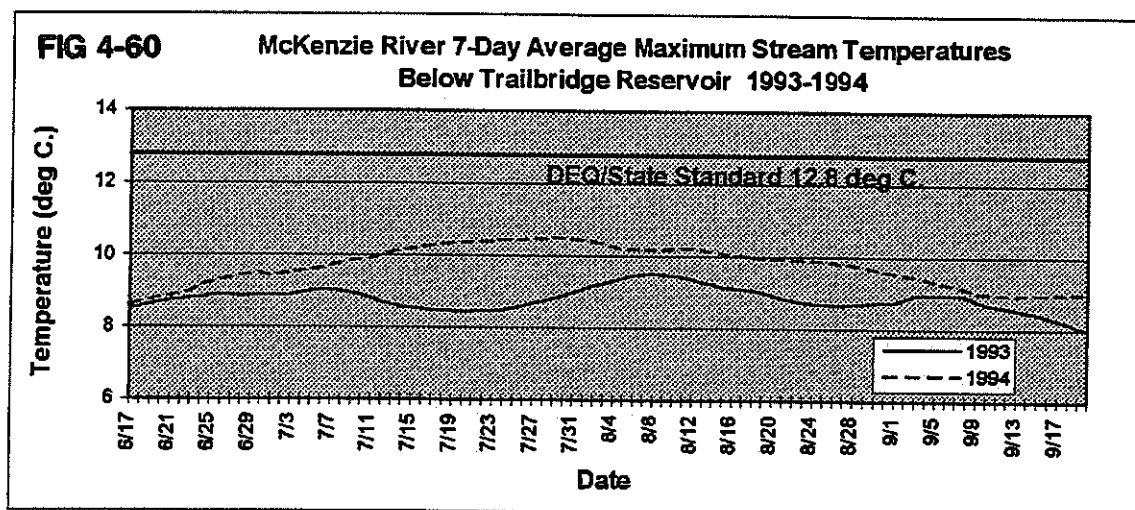
dam. A small, privately owned generator is driven by flow diverted from the main stem McKenzie below Belknap Springs and may pose a risk to spring chinook, bull trout and native fish utilizing side channels as rearing and foraging habitat and to upstream migrating adults. The privately owned generator is currently under FERC review for licensing.

The question was asked during issue identification in this analysis process: Have utility mitigation efforts supplemented loss of spring chinook habitat since dam construction? The Carmen Spawning Channel has operated since 1961, during the construction of the Carmen-Smith-Trail Bridge hydroelectric complex. The spawning channel was designed to replace spawning habitat for 100-200 returning adult chinook. The criteria used to evaluate success of the channel to mitigate for habitat loss was the number of returning adults. The return to the spawning channel has not maintained pre-dam runs, its use paralleling depressed upper river returns and returns to relatively unaltered spawning habitat in Lost Creek. One of the limitations of the spawning channel identified by Smith (1993) is limited rearing area within the mitigation channel itself. Loss of rearing habitat above Trail Bridge dam was not mitigated for and likely represents a factor limiting spring chinook production in the upper McKenzie River. Other sources of loss managed by EWEB utility may reduce chinook use of the upper river and spawning facility. Poor adult fish passage facilities at Leaburg dam and an unscreened water diversion at Walterville canal have been identified as sources of migrant loss and are scheduled for improvement.

Although resident population needs were not identified in original mitigation efforts, EWEB continues to be an active cooperator in bull trout recovery efforts. Restoration of habitat fragmented by construction of Carmen-Smith-Trail Bridge Complex and Hwy 126 has occurred cooperatively between EWEB, management agencies and special interest groups.

Water Temperature

Stream temperature data on the Upper McKenzie River was collected at the gaging station below Trailbridge Dam from 1976-1985, and during the summer of 1993 and 1994. Summer stream temperatures were also recorded at the gaging station at McKenzie Bridge (located across from the McKenzie Ranger Station) during 1993 and 1994. Water quality standards established by the state and published by the Oregon Department of Environmental Quality have recently been reassessed for stream temperatures. New standards, which are not yet published, require that the moving average of the 7-day maximum stream temperature not exceed 55 deg. F. (12.8 deg. C) for anadromous spawning and rearing streams such as the McKenzie River. Figures 4-60 and 4-61 display the 7-day average maximum stream temperatures for 1993 and 1994 at the Trailbridge station and the McKenzie Bridge station.



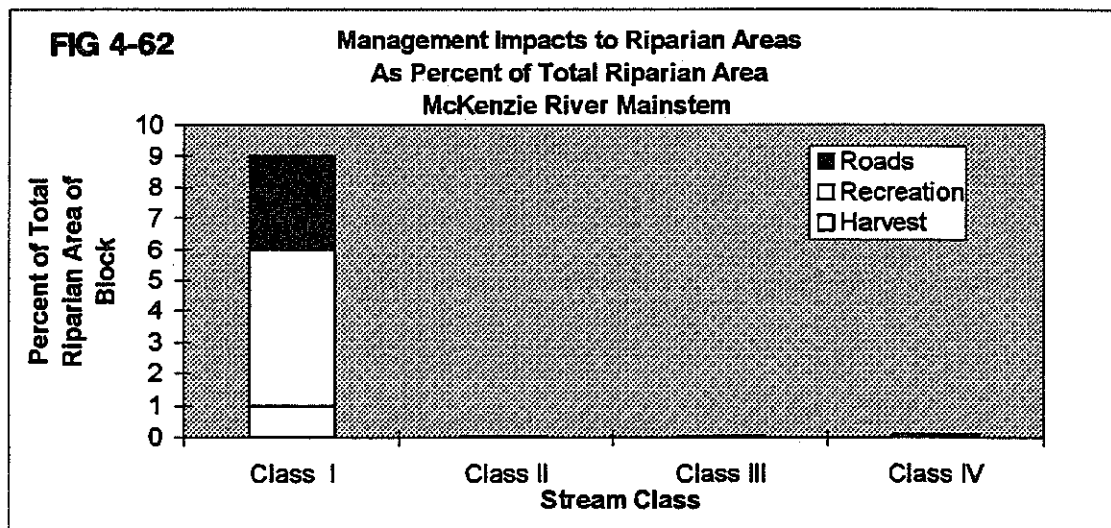
Both graphs indicate that stream temperatures are within State Standards, although the maximum temperatures for the summer of 1994 were not recorded because the instrument had been removed from the water.

Historically, maximum stream temperatures for the McKenzie River near the confluence with the Willamette River ranged from 55.4 deg F (13 deg C.) to 62.6 deg F. (17 deg C.) (USDA Forest Service, Pacific Northwest Region 1993). Although the current mode of the maximum stream temperatures fall within the historic range, current maximum stream temperatures exceed the historic range with temperatures as high as 71.6 deg F. (22 deg C.) at the mouth of the McKenzie River. Although no data exists for historical maximum stream temperatures for the upper McKenzie River watershed, it is likely that maximum stream temperatures have increased at the McKenzie Bridge station as early as 1965 in association with the harvest of riparian vegetation along tributary channels. However, it is also likely that current maximum stream temperatures are returning to historic ranges as riparian vegetation becomes reestablished along tributary streams. The exception may be Deer Cr., a major

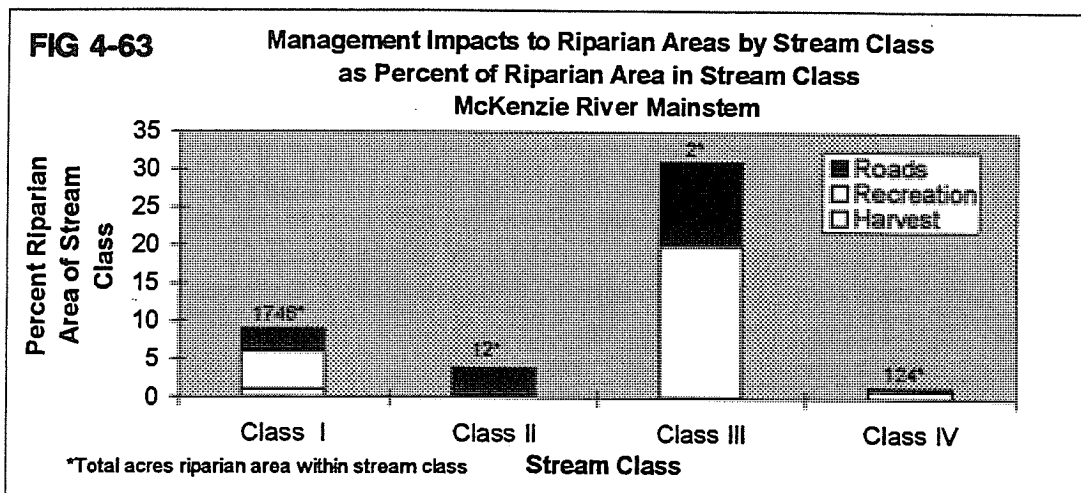
tributary to the McKenzie River whose riparian vegetation is limited due to the presence of a power line (see discussion on Deer Cr. stream temperatures in Landform Block 2a).

Riparian Reserves

In the McKenzie River riparian area, the recruitment source of large wood for the channel and flood plain has been modified from historic levels. Data reflecting relatively recent development (timber harvest, roading) in the upper McKenzie subbasin (as compared to earlier harvest of the lower subbasin) is depicted in Table 4-3. A shift in riparian seral stage occurred between 1949 and 1986 above Belknap Springs. Mature conifers in the riparian area have decreased from 62% to 39%, with a corresponding increase in younger conifers, hardwoods and riparian roads (Minear 1994). Along the mainstem McKenzie River, recreation and administrative sites together with roads, combine to affect the riparian reserve within the corridor (Fig. 4-62).



With approximately 1% of the harvest within the reserve, harvest, recreation/administrative sites, and roads combine to impact a total of 9% of the reserve. Much of this area is located linearly along the length of the river, unlike harvest units that encompass the total width of the reserve. This translates to 8 miles of stream length that is roaded or has a recreation/administrative site along one side of the river. Although this does not significantly alter stream shade, channel stability, or LWD recruitment, this level of impact is approaching a level that could become detrimental to stream channel condition (bank stability; LWD amounts) and water quality (bank stability/sediment input; stream temperature)(Figure 4-63).



Data shows that of the Class III streams entering the McKenzie River corridor, 31% of the riparian reserves are roaded or have recreation/administrative sites within them (note however that the total amount of riparian reserve within Class III streams is only 2 acres, thus, only 0.71 acres are impacted).

Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that the mainstem McKenzie corridor has 34 dispersed camping sites. That is 10% of the 333 dispersed sites in this watershed.

Riparian: By definition, all of the 34 camp sites are within the riparian reservoir of the McKenzie River. If the sites were further away from the river, they were tallied in the landform block adjacent to the river. The area of these river camp sites equaled 36,835 sq ft or 0.85 acres. The barren cores equaled 25,246 sq ft or 0.58 acres. That averages 69% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very large core areas. Eighteen of the thirty-four camping sites were accessible by foot, mainly from the McKenzie River Trail. The remaining sixteen sites were accessible by vehicles, seven of those at Deer Creek.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets and parking spurs. They may have water systems and garbage service. Boat ramp facilities usually are graveled ramps accessing lakes or reservoirs. Launches sometimes have log skids to help drift boats and rafts access the river. The

following developed recreation facilities are located, at least partly, within the mainstem McKenzie River corridor.

Campgrounds: McKenzie Bridge—There are 20 camp units in this campground, covering 41 acres. Forty seven percent fall within the riparian reserve of the McKenzie River. Paradise Campground—There are a total of 64 camp units in this campground, covering 78 acres. Thirty five percent fall within the riparian reserve of the McKenzie River. Olallie Campground—There are 17 designated camp units in this campground, covering 11.5 acres. Eighty five percent fall within the riparian reserve of the McKenzie River.

Picnic/Day Use Areas: McKenzie Bridge—There are 6 picnic sites within McKenzie Bridge Campground, all are within the riparian reserve. Paradise—There are 4 picnic sites within Paradise Campground: all are within the riparian reserve.

Boat Launches: There are five boat launches located on National Forest within the McKenzie corridor. McKenzie Bridge Campground launch is 1 acre. It has a paved loop road, parking for approximately 5 vehicles with boat trailers, a gravel ramp, informational bulletin board displays, and seasonal placement of portable toilets. McKenzie River Trailhead Boat Launch is 0.5 acres. It has a gravel highway edge parking strip for 4 vehicles with boat trailers, a dirt ramp, informational bulletin board displays, and seasonal placement of a portable toilet. Paradise Campground Boat Launch is 0.5 acres. It has a paved loop road, parking for approximately 10 vehicles with boat trailers, a dirt ramp, a graveled raft staging area, informational bulletin board displays, and vault toilets close by. Frissell/Carpenter (aka Buck's Bridge) Boat Launch is 0.8 acres. It has highway pull-off parking for approximately 8 vehicles with boat trailers, a wooden pole skid ramp, informational bulletin board displays, and seasonal placement of a portable toilet. Olallie Boat launch is 1 acre. It has a gravel road, parking for approximately 10 vehicles with boat trailers, a gravel ramp, informational bulletin board displays, and seasonal placement of a portable toilet.

Sno-Parks: No sno-parks are within this riparian corridor.

Viewpoints: Sahalie Falls and Koosah Falls Viewpoints are partly in this corridor, but described under block 4.

Administrative or Recreation Special Use Permit Areas: Eugene Water and Electric Board (EWEB) has offices, shops, and employee homes located here. Those facilities covers approximately 10 acres, with an estimated 75% falling into riparian reserve. Both these figures need to be more accurately measured.

Wilderness: There are no wilderness acres within the mainstem McKenzie riparian buffer.

CHAPTER 5

SIGNIFICANT FINDINGS AND RECOMMENDATIONS

INTRODUCTION

The following Tables 5-1 through 5-4 summarize significant findings and recommendations documented in the Upper McKenzie Watershed Analysis. Additional information that led to recommendations can be found in Chapters 3 and 4.

Table 5-4 displays mitigation measures for projects that could potentially occur within a riparian reserve. The mitigations were developed based on the assumption that riparian reserves serve the following 6 functions:

1. Maintain and Restore structure and function within the natural range of variability
2. Maintain or restore riparian dependent species' habitat within the natural range of variability.
3. Conserve transition zone between upslope and riparian habitat.
4. Provide travel and dispersal corridors for wildlife, fish and plant species.
5. Provide connectivity between late successional patches.
6. Maintain processes within the range of historic variability.

Additional documentation that led to the mitigation recommendations for wildlife is provided in the Wildlife Appendix. Detailed documentation supporting these recommendations will be available from the rest of the watershed analysis team in an addendum to this WA.

Table 5-1: Summary of significant findings and recommendations documented within the watershed analysis. Detailed information can be found in Chapters 3 and 4. The type of action is provided to identify like-projects. Prioritization of recommendations should be conducted with the Ranger District Staff.

WATERSHED-LEVEL FINDINGS

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
SOIL/WATER RESOURCES		
Western Cascades streams are high gradient, less stable, and more prone to debris slides and slumps when compared to High Cascades.	Need culvert inventories to determine and prioritize high risk areas.	INVENTORY
There is a significantly smaller number of acres affected by mass wasting from road-related events compared to natural events. With over 900 miles of roads, there have only been 17 failures. However, sediment delivery volumes from road surfaces is unknown.	Develop strategy to determine where to install sediment traps. Install traps at representative sites to evaluate typical surfacing and subgrade types to determine if there is a significant contribution from the road system. Use the Lowell Test Road Sediment Study as a guide.	DEVELOP STRATEGY
Historic range of variability for areas of mass wasting is around 5% of the land mass. Clearcuts and high intensity wildfires can significantly increase this rate in areas of potentially unstable soils.	Project-level slope stability analysis should be accomplished for any regen units in areas of potentially unstable soils. In the case of wildfire, rehabilitation plans should include strategy for assessing increased mass wasting in these areas.	INFO FOR FUTURE PLANNING
There is no apparent impact on mass wasting due to prescribed fire management activities.	Consider winter debris avalanche initiation on expected high intensity burns in draws on side slopes greater than 80%.	INFO FOR FUTURE PLANNING
LWD references values based upon Western Cascade geology streams are not applicable to spring fed systems.	Develop reference values for low gradient streams.	ESTABLISH REFERENCE
The probability of a large subduction earthquake off the Oregon coast with a magnitude 8.0 or greater is high, but the distance from the probable focus to the watershed will provide attenuation which will reduce damage. EWEB dams have been inspected and designed to withstand any probable earthquake loads, however, local crustal generated earthquakes can be a hazard and can cause landslide and debris avalanche dams.	Initiate earthquake awareness program and include landslide damming effects on streams in any emergency response contingency plans.	INITIATE NEW PROGRAM

WATERSHED-LEVEL FINDINGS

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
VEGETATION RESOURCES		
The watershed had a fire return interval between 1772 and 1830 of 78 yrs. Between 1830 and 1910 it was 87 yrs. Based on our current (1910-Present) suppression program, the return interval is 587 yrs.	Reinitiate levels of disturbance. It may take several treatments to safely bring some stands within a historic range. Use prescribed fire (management ignited or prescribed fire) where feasible.	INFO FOR FUTURE PLANNING
Insects (WSBW) and disease (Mistletoe/Canker) have increased with fire suppression.	Investigate treatment in Pacific silver fir in Block 5 to reduce stress and Mistletoe/Canker 2A & 2B.	INFO FOR FUTURE PLANNING
All white pines in watershed have been significantly reduced by WP Blister Rust.	Emphasize planting disease resistant white pines in areas within historic range.	INFO FOR FUTURE PLANNING
More impact from phelinus will be seen as more stands are allowed to develop late successional characteristics.	Monitor progress of disease. Areas of high recreation use should consider site conversion to hardwoods and resistant conifers	MONITOR
There is a 40 yr. return interval for WSBW in Pacific silver fir blocks.	Expect a new outbreaks in the watershed. Take steps to reduce stand density and proportion of highly susceptible species	INFO FOR FUTURE PLANNING
Many of the stands in this block have high density conditions contributing to high levels of stress.	Emphasize stocking control through Precommercial thinning and Commercial thinning. Use Prescribed fire.	INFO FOR FUTURE PLANNING
Douglas-fir series abundance: Change from historic conditions: - Decrease of early seral - Increase late seral - same mid seral	Consider long-term conversion of late-seral stands to early seral conditions	INFO FOR FUTURE PLANNING
Grand fir series abundance:- Change from historic conditions: - Decrease early seral - very little now - Increase mid seral - significantly more now - Increase late seral - slight	Consider long-term conversion of mid-seral stands to early seral conditions	INFO FOR FUTURE PLANNING
Western hemlock series abundance: Change from historic conditions: - Increase early seral - within historic range - Decrease mid seral - outside historic range - Increase late seral - outside historic range 1900	Use management techniques to encourage mid-seral stands to develop late seral attributes. Maintain a steady level of early seral conditions.	INFO FOR FUTURE PLANNING

WATERSHED-LEVEL FINDINGS

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
VEGETATION RESOURCES		
Pacific silver fir series abundance: - Change from historic conditions: - Increase early seral - mostly harvest - Decrease mid seral - Increase late seral - outside historic range from 1900	Use management techniques to encourage early-seral stands to develop mid-seral attributes. Maintain a steady level of early seral conditions.	INFO FOR FUTURE PLANNING
Mountain hemlock- Change from historic conditions: - Decrease early seral - outside historic range 1900 - Decrease mid seral - Increase late seral	Consider long-term conversion of late-seral stands to early seral conditions	INFO FOR FUTURE PLANNING
There has been a loss of old growth system function from edge effect in leave blocks.	Opportunity for large block minimum fragmentation strategies in these areas.	INFO FOR FUTURE PLANNING
Stand replacement fires in all blocks resulted in maintenance of some Old Growth structure. Blocks 3 (some), 6, 5 lower maintenance compared to blocks 1, 2A/B, 4 and some 3, 6.	Blocks 1, 2A, 2B, 4, and 6 are best areas for long-term maintenance and development of late successional forests in varying sizes and species.	INFO FOR FUTURE PLANNING
Shorter fire return interval occur on South aspects, with longer intervals in the valley bottoms.	Areas with longer return intervals would be more suitable for late successional management.	INFO FOR FUTURE PLANNING
Fires driven by east winds have had most significant affect on landscape diversity historically.	This orientation could be used as a guide for shape of larger stands in blocks 2B, 3, 5, and 6	INFO FOR FUTURE PLANNING
Fire is critical for maintenance of meadow vegetation and subalpine habitat.	Prescribe low intensity surface burns in dry meadows and subalpine areas. Particularly Fingerboard & Bunchgrass meadows. Monitor for species composition changes.	RESTORATION
Historic air quality levels were at PM 10-13. They are now at PM 5-10. The lowest air quality in 1994 was 6 times less than the "limit" or allowable levels measured at THSI.	Historic air quality conditions are not legally acceptable. Continue to meet State of Oregon standards.	INFO FOR FUTURE PLANNING

WATERSHED-LEVEL FINDINGS

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
VEGETATION RESOURCES		
Documented in the watershed are: 6 R-6 sensitive plants; 18 plants on Forest watch/concern/review list; 18 ROD S&M species (10 species are strategy 1).	Continue to inventory and monitor sensitive populations. Known sites managed for protection in 1995 include six spp in 4 sites on SWH and 4 spp in 19 sites on MCK.	MONITOR AND INVENTORY
Habitat for 242 ROD C-3 PLANT species occur in the watershed, including 8 vascular plants, 12 bryophytes, 166 fungi, and 56 lichens. An additional 19 species are suspected to occur.	Identify potential areas for survey where species are at risk. Retain a diversity of tree species at PCT & CT treatments. Leave clumps of diverse species of different sizes. Leave all hardwoods. 10-40 ac patched of LS/OG forest well distributed across the watershed.	INFO FOR FUTURE PLANNING
16 <i>Allotropa virgata</i> sites occur in forested stands in 2A, 2B, 3, 4, 5, & 6.	Survey and manage 16 ALVI sites on MK.	SURVEY
Hwys 20/22/126 are main corridors for noxious weeds and non-native plant dispersal & establishment. ODOT practices may encourage noxious weeds & non-native plant establishment.	Monitor highways for noxious weed & non-native presence and expansion. Continue to work with ODOT to prevent further weed expansion.	MONITOR
Construction & maintenance of roads introduces & spreads noxious weeds & other non-native plants.	Implement FSM 2080 direction in all proposed timber sales & road maintenance programs. Use weed free fill material for road work projects. Clean soil from road equipment prior to use.	INFO FOR FUTURE PLANNING
Watershed contains 7 rare forested plant associations. Eleven forested PAs listed as common for the District are rare in the watershed.	Inventory stands to determine rarity of plant association. Rare forested PAs need to be analyzed and ranked by watershed.	INVENTORY
WILDLIFE RESOURCES		
W.Footed Vole: Unknown population levels in watershed.	Riparian reserve buffers in low elevation streams that are wide enough to capture riparian veg and a portion of the transition zone will be needed to adequately protect this species.	INFO FOR FUTURE PLANNING
Red Tree Vole: 2 records of occurrence in the WA. Research shows they do not occupy stands over 3000' elevation, but this may not be correct. Concerns for this species include low mobility and need for late successional forest.	Conduct surveys in all series where Douglas-fir occurs. Provide patches of late successional habitat at least 20 acres in size interconnected throughout the landscape by riparian reserve network or mid-seral stands to facilitate movement for many species.	SURVEY, INFO FOR FUTURE PLANNING

WATERSHED-LEVEL FINDINGS

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
WILDLIFE RESOURCES		
Snag levels for all landform blocks are currently above 40%, though some are approaching this benchmark.	High priority to conduct snag inventories in unmanaged stands to validate assumptions used in analysis.	INVENTORY
Early Seral Habitat: 14% of species in watershed dependent on it. This habitat was historically produced from fire disturbance. Snags and large woody debris were present post-disturbance. Early seral wildlife species evolved with these structures. Currently available habitat is not effective for these species because of a lack of structural elements. Creation of early seral habitat will decrease by 50% in the next decade.	Use techniques in forest management to mimic past fire effects by considering size, shape, and complexity of structure that would have occurred post-disturbance in the different series. Leave snags and LWD at ROD levels or greater. Evaluate viability of early seral species into the future to determine minimum amounts and pattern of effective early seral required on the landscape.	INFO FOR FUTURE PLANNING
Mid Seral Habitat: No wildlife species rely on this habitat for breeding. However, 4% of the species in the WA can use early and mid or mid and late. Mid seral habitat historically succeeded from early seral stands with greater structure, and species that use it have greater probability of success if structural elements are present. 50 years of cutting without leaving structure has resulted in a decrease in the potential species richness in the WA.	Manage early seral habitat to provide structure in future mid seral stands. Create snags and LWD in existing mid seral stands where of appropriate diameters are available to increase potential species' richness..	INFO FOR FUTURE PLANNING
Late Seral Habitat: 4% of the wildlife species in the watershed breed primarily in LS habitat. Concern for low mobility species such as the red tree vole still exist. None of these species require large contiguous blocks of LS habitat (>40 acres).	Provide for blocks of LS habitat within the matrix interconnected with corridors, stepping stones, or permeable mid seral habitat. Maintain existing high quality blocks until additional blocks develop into LS. Prioritize regeneration cutting to occur in small, non-effective blocks.	INFO FOR FUTURE PLANNING

WATERSHED-LEVEL FINDINGS

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
WILDLIFE RESOURCES		
Riparian Habitat: 25% of species in WA associated with riparian areas. Riparian buffers that protect the integrity of the riparian vegetation and water quality will be critical to maintain these species, especially in class I-III streams. Class IV riparian areas contain minimal riparian vegetation	Maintain protective riparian buffers on class I-III streams that include the riparian vegetation and a portion of the transition zone. Class IV buffer widths may be altered to reflect the range of historic variability of natural disturbances. However, 50-11-40 guidelines should be considered, and there should be no net loss of existing LS habitat in riparian reserves designs iff possible. If portions of buffers are narrowed, other areas may need to be increased.	INFO FOR FUTURE PLANNING
RECREATION/VISUAL RESOURCES		
Detailed analysis of visual resources has not been conducted.	Conduct more detailed visual analysis for projects in visual allocations.	INFO FOR FUTURE PLANNING
Forty out of forty-five developed sites in WA fall partly inside a riparian reserve. Several others are totally within riparian reserves. Eight Special Use Permit rec areas are within reserves.	For sites within riparian reserves, document the location of the riparian reserve within the site complex, and review proposed projects & current actions for consistency with the ROD. Develop site plans as needed to mitigate impacts.	EVALUATE ROD CONSISTENCY
All developed fee campgrounds are near water. Most campgrounds are at capacity for weekend use, July through early September. No current plans propose how to address future capacity expansion needs.	Initiate a future use/needs study to determine demand projections. Focus on potential development of Reservoirs (vs. Rivers, Lakes) for water based recreation expansion.	FUTURE NEEDS STUDY

WATERSHED-LEVEL FINDINGS

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
RECREATION/VISUAL RESOURCES		
The very high percentage of Recreation Development occurring in riparian reserves (88%) reflects human desire for water access.	Recognize that existing facilities often mitigate human impacts to buffers by controlling access, while still allowing enjoyment of water based recreation.	INVENTORY
Gray water disposal sumps are lacking in most campgrounds. 44 sumps are in the watershed. Proper gray water disposal is required by state law. 12 pit (unlined) toilets are located within the watershed. These are potential pollution sources. 2 boat ramps are in poor or replacement status, and 3 boat docks are needed. Facilities in these shore areas mitigate existing recreational use.	Develop a plan for managing riparian areas, and seek funding for high priority action items.	DEVELOP STRATEGY
59% or 195 out of 333 total inventoried dispersed campsites were in riparian reserve.	Enter all data from 1988 LAC inventories into computer program. Re-survey dispersed sites in critical riparian reserves and compare changes. Develop mgmt strategies to minimize impacts as needed.	INFO FOR FUTURE PLANNING
88 out of 333 dispersed sites were originally in developed, managed campgrounds.	Determine if areas such as Lost Lake are best managed as dispersed sites or if facilities are needed again as mitigation.	ASSESS MGMT
At least 15% of the dispersed sites have previously had the roads closed to them.	When closing road access in future implement monitoring to determine long range changes in site impacts.	MONITORING
Of campsites in riparian reserves, 37% were accessible by foot, 63% by vehicles. Of the non-riparian sites, 10% were accessible by foot; 90% by vehicles.	Evaluate Americans with Disability Act conflicts when considering road closures to dispersed sites that are to remain open to foot travel (equal access to recreation opportunity issues).	MONITORING
It appears that campsites in riparian reserves have more barren core than non-riparian sites (58% vs 26%).	Evaluate why riparian campsites are more prone to developing barren cores: is it because unroaded dispersed sites have more tent campers who travel throughout sites more? or does more foot traffic causes more barren areas?	DEVELOP REC PLAN FOR RIPARIAN RESERVES

LANDFORM BLOCK 1 (PORTION AMA)

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
The majority of "high" potential contributing area to rain-on-snow is located within the west and south west facing slopes north of the McKenzie River.	Utilize this information in future management.	INFO FOR FUTURE PLANNING
Fire runs uphill in this block to the ridgetop. Fires were generally large in size and stand replacement.	Stand size and shape in future planning should reflect the "inverted teardrop" shape seen under historic disturbance patterns.	INFO FOR FUTURE PLANNING
Pond Turtle: 2 documented sitings in this block. Population levels are unknown, but expected to be low because of the lack of warm ponds at low elevations. Some sidechannels of the McKenzie may provide habitat.	Recommend pursuing potential of purchase or exchange wetland on adjacent private lands to protect habitat. Continue monitoring of areas with known sites. Enhance side-channels w/loafing sites in the McKenzie River.	INFO FOR FUTURE LAND EXCHANGE

LANDFORM BLOCK 2A (AMA)

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Most road related slope failures are from side-cast construction on slopes greater than 70% and most occurred in Landform Blocks 2A and 2B in Western Cascade above 2,000 feet elevation.	Continue road restoration work. Prioritize work according to impact on Bull Trout population and Access and Travel Management Plan.	RESTORATION
Deer Cr. temps are above state standards, but the standards are unrealistic to meet.	Establish canopy closure and decrease width: depth ratios. Determine new temp standard using Budworm Cr. temps as guide.	RESTORATION
Increases in water temps in Deer Cr. were seen following transmission line construction and harvest of riparian vegetation.	Increase cover and decrease width: depth ratios.	RESTORATION
Downhill winds occur in this block. There are frequent, daytime, down- valley winds in upper portion of Deer Creek drainage.	Wind will significantly influence fire behavior in this landform block.	INFO FOR FUTURE PLANNING

LANDFORM BLOCK 2A (AMA)

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Historic fires were small, stand replacement. The drainages typically burned because of a chimneying effect. Fire return intervals for stand replacement fires were long, resulting in the potential to develop small to moderate sized old growth patches.	Landscape mosaic should reflect a very diverse and complex patchy pattern of small stands with high contrast between adjacent stand conditions.	INFO FOR FUTURE PLANNING
Deer Creek drainage landscape management has altered aquatic habitat condition by increasing peak flows and altering rates of LWD recruitment outside the historic range of variability.	Identify opportunities to restore slope, riparian vegetation and stream bank stability. Identify and treat high risk roads and culverts. Treat deficiencies in channel complexity and recruitment potential.	RESTORATION
High stream temperatures in Deer Cr. have exceeded tolerances of historic spring chinook spawning populations.	Pursue means of restoring riparian vegetation in lower Deer Creek. Restore channel complexity with reintroduction of in-stream wood.	RESTORATION
Passage barrier culverts on Fritz Creek isolate native cutthroat.	Restore passage.	RESTORATION

LANDFORM BLOCK 2B

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Most road related slope failures are from side-cast construction on slopes greater than 70% and most occur in Landform Blocks 2A and 2B in Western Cascade volcanics above 2,000 feet elevation.	Continue road restoration work. Prioritize work according to impact on Bull Trout population and Access and Travel Management Plan.	RESTORATION
Fires historically were stand replacement events of low to moderate intensity. Return intervals were long, however ridgetops tended to burn more often. Fires usually resulted in a mosaic of small patches. This area also experienced some of the largest fires in the watershed around 1900.	Landscape pattern should reflect a mosaic of large and small patches.	INFO FOR FUTURE PLANNING

LANDFORM BLOCK 2B

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Historical grazing at Lava Lake and some campgrounds (Lost Prairie, & Trailbridge) facilitated the expansion of noxious weeds & other non-natives in the watershed.	Prioritize species for active control. Rehabilitate campgrounds to prevent further establishment of noxious weeds & non-native plants.	RESTORATION
Noxious weeds are encroaching sensitive plant habitat at Iron Mtn.	Eradicate noxious weeds, particularly St John's-wort at Iron Mtn.	RESTORATION
Bald Eagle: The animals at the known site have difficulties in successfully nesting. Difficult to determine impacts contributing to this. Fish Lake may be a potential area to improve habitat for nesting.	Continue monitoring of site to determine reproductive success. If no success in 1995, consider improvements to other potential nesting areas..	MONITOR RESTORATION
Sandhill Crane: One of 2 known nest sites on the WNF occurs in the WA. has been threatened w/ grazing in the past.	Continue to monitor site. Maintain hydrological regime of Lava Lake to protect habitat.	MONITOR
Historical grazing at Lava and Fish Lakes have significantly impacted channel condition.	Aid recovery by planting native vegetation along stream courses within the meadows.	RESTORATION
Lava, Fish and Clear Lake system native cutthroat are being displaced by introduced brook trout.	Participate in brook trout management with resource management agencies.	COOPERATION

LANDFORM BLOCK 3

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Fires historically were medium to large, stand replacement events combined with small spot fires. East winds probably affect the movement of fire in this area more than others. The Airstrip fire is an example of this affect on vegetation patterns.	The pattern created by an east-wind, stand replacement event would conflict with several other objectives for this area, such as visuals, wildlife habitat, etc. Resolution will require further study.	INFO FOR FUTURE PLANNING
Introduction of non-native trout into high mountain lakes has likely impacted native fauna.	Determine high lakes biota and water quality in managed and unmanaged lakes.	INVENTORY
Lost Lake shoreline and lake bed have high user impacts.	Reestablish native riparian hardwoods and sedges.	RESTORATION

LANDFORM BLOCK 3

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Wolverine: Several sitings in the WA down to 3000' elevation. Majority in Santiam Pass area. Unknown current population levels, but they were historically probably always low. Loss of disturbance in the higher elevations may have reduced habitat quality for this species.	Continue monitoring in the Santiam Pass. Manage human use of wilderness areas to benefit this species. Prescribed fire in the wilderness would benefit this species through the production of early seral stage habitat.	MONITOR RESTORATION
Great Gray Owls: 3 potential sites in the area. Sites do not appear to be strongly associated w/meadow complexes: foraging in clearcuts and shelterwoods.	Continue to monitor sites. Provide foraging habitat through regeneration harvest within the home range of known sites that have limited availability of natural openings.	MONITOR
Black-backed woodpecker: Very few records in the WA, primarily in the Santiam Pass area. Require 100% snag levels and prefer patches of insect-infested trees.	Leave 100% snag levels in higher elevation habitat. leave pockets of insect-infested trees on the landscape. Conduct surveys to determine extent of habitat use in higher elevations.	SURVEYS, INFO FOR FUTURE PLANNING
Flammulated Owl: Unknown if occurs in WA, but if it does, it's probably in this block. No records on the WNF, and few on the Deschutes NF., but no surveys have been done. Highly associated with pines.	Reintroduction of pine species will benefit this species. Snag levels as prescribed for Black-backed woodpecker will benefit this species. Conduct surveys to determine presence in higher elevation areas.	RESTORATION, SURVEY
Several analysis areas are not meeting ELK HE values. Moderate emphasis area will not be able to meet Hec because of the limited capability of the vegetation to produce high quality cover.	Reevaluate emphasis area ratings based on capability of the land. Increase HEF in areas through development of permanent forage areas; wider thinning in plantations to extend early seral stage, browse cutback, short rotation patches, and seeding culover areas with native plants where appropriate.	RE-EVALUATE MGMT
Big Lake has conflicts between motorized and non-motorized lake users, and potential conflicts between fisher persons and water-skiers if fishing pressure is increased.	Study the demand vs the capacities for water skiing vs. canoe or row boat use. Determine potential increase in conflicts if hatchery stocking of fish was increased. Prioritize repairs/expansion of facilities in Big Lake vs. reservoir potentials.	STUDY DEMAND VS USE
Campground users who can't tolerate noise from motorized boats and nearby OHV's in the Big lake area are displaced; but there are ample other opportunities for other recreational experiences. This is the only high elevation lake where motorized travel is allowed in the watershed.	Through demand studies, determine if need for quiet lake setting would be greater than demand/acceptance for motorized recreation use of Big Lake. Study opportunities to lessen noise conflicts with regulation or education to enhance sharing of Big Lake. Evaluate riparian impacts of motorized lake use.	STUDY DEMAND VS USE, EVALUATE IMPACTS

LANDFORM BLOCK 3

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Road and trail users may have conflicts with sharing between hikers, horses, OHV's and mountain bikes in the Big Lake area.	Develop an ATM plan.	DEVELOP ATM PLAN
Motorized vehicles are illegally entering wilderness and using Pacific Crest Trail in the Santiam Pass area.	Post boundaries clearly, sign Pacific Crest Trail , publish brochures and maps that give clear information on legal travel routes. Develop ATM plan.	DEVELOP ATM PLAN

LANDFORM BLOCK 4

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Because of the extensive lava and pumice and high levels of lightning strikes, historic fires were frequent, low intensity, and usually small.	Base future landscape planning on this type of pattern.	INFO FOR FUTURE PLANNING
The only known occupied Townsend's Big-eared bat hibernaculum occurs here. The cave receives heavy human use, and bat numbers appear to be declining. Additional areas with potential for caves have been mapped, but use is unknown.	Develop a cave management plan for Sawyers that limits human use during hibernation. Continue to monitor the site.	DEVELOP CAVE MGMT PLAN

LANDFORM BLOCK 5

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
The majority of "high" potential contributing area to rain-on-snow is located within the west-facing, gently sloping terrain of the "flat country".	Use this information during future planning.	INFO FOR FUTURE PLANNING
The largest expected fire sizes occur in this block.	This landform block may be a good candidate for min-frag mgmt. However, this may conflict with big game management objectives.	INFO FOR FUTURE PLANNING
High meadows historically burned frequently. They are currently being invaded by conifers.	Prescribed fire may be need to maintain the meadow resource.	RESTORATION
Rearing habitat is likely a factor limiting bull trout production in Anderson Creek.	Verify with a trap on lower Anderson Creek. Enhance Anderson Cr. as needed. Enhance McKenzie R. margin and side channel habitat downstream of Anderson Cr..	MONITOR

LANDFORM BLOCK 5

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Introduction of non-native trout into high mountain lakes has likely impacted native fauna.	Determine high lakes biota and water quality in managed and unmanaged lakes.	INVENTORY
Dispersed sites occur near Olallie, Sweetwater and Boulder Creek, and they may be impacting fish resources.	Conduct survey of these dispersed sites and develop recommendations to mitigate impacts.	SURVEY
Great Gray Owls: Highest density of GGO's on WNF in this block. Do not appear to be strongly associated w/meadow complexes.	Continue to monitor sites. Evaluate landscape level management strategies.	INFO FOR FUTURE PLANNING
Several analysis areas are not meeting HE values for elk. High emphasis area will never meet Hec because of shorter FRI that do not promote the development of high quality optimal thermal cover	Reevaluate emphasis area ratings.	INFO FOR FUTURE PLANNING
Stand replacement fire events may adversely affect bull trout habitat.	Management activities that will reduce potential for stand replacement events should be considered to protect bull trout habitat.	INFO FOR FUTURE PLANNING
Hazard tree felling in campgrounds may produce an of excess woody material beyond what is minimally needed to meet minimum habitat needs for species that utilize the area.	Survey all developed recreation sites and map large woody debris. Develo LWD plan.	SURVEY DEVELOP LWD PLAN

LANDFORM BLOCK 6

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Fires were historically low intensity, frequent events or high intensity low to moderate frequency events. These usually resulted in medium sized patches on the landscape.	Most of the block is wilderness. It would be good candidate for a prescribed natural fire program. PNF will help maintain vegetation within its historic range of variability.	INFO FOR FUTURE PLANNING
Introduction of non-native trout into high mountain lakes has likely impacted native fauna.	Determine high lakes biota and water quality in managed and unmanaged lakes.	INVENTORY
High quality potential habitat for peregrine falcons occurs in this block.	Continue monitoring. Develop management plan for new site.	DEVELOP MGMT PLAN

MCKENZIE RIVER CORRIDOR BLOCK

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
McKenzie River has high capacity for transport, leaving large channel substrate. Substrate coarsening is potentially aggravated by Carmen Project.	Need to get historical channel X-section data at USGS gaging stations to verify assumption..	INFO NEED
Downcutting of McKenzie River channel below Carmen Project may have de-watered side channels.	Validate downcutting theory using X-section data of USGS stations. If true, assess improvement projects.	RESTORATION
McKenzie River meets or exceeds state water temp. standards.	Maintain cool water temps.	INFO FOR FUTURE PLANNING
Summer low flows have decreased following Carmen Project (1965).		RESTORATION?
Of all the landform blocks, the mainstem McKenzie River has the highest percentage of roads and recreation sites (3% and 5%, respectively)	Evaluate impact of this development in context of entire system	EVALUATION NEED
At-risk native fish species coexist in the Upper McKenzie River. The Upper McKenzie provides a significant portion of Willamette Basin spring chinook and bull trout habitat. Due to the Upper McKenzie's position and condition in the basin, it is providing refuge for those species.	Maintain or enhance habitat necessary to both species. Restoration of predator species (bull trout) requires restoration of prey species (spring chinook).	RESTORATION
The life history requirements of spring chinook and bull trout require greater lower McKenzie and Willamette River channel complexity.	Participate in lower basin restoration with other resource management agencies and private landowners.	COORD. NEED
Previous studies suggest interception of large woody debris and sediment by dams has resulted in upper McKenzie channel coarsening and downcutting.	Verify comparing past and present channel cross sections.	INFO NEED
Salvage and river-user removal of in-stream wood has reduced an essential source of McKenzie River channel complexity. Interception of LWD by dams and at road crossings (ie Fish Lake Cr.) continues to reduce channel and lower basin complexity.	Develop an instream LWD plan for this landform block.	DEVELOP LWD PLAN

MCKENZIE RIVER CORRIDOR BLOCK

SIGNIFICANT FINDING	RECOMMENDATION	ACTION REQUIRED
Coarsening of the Upper McKenzie bedload and reduced summer low flows may have combined to reduce spring chinook spawning habitat.	Determine available spawning habitat area and composition. If found a limiting factor, restore.	RESTORATION
Historic mainstem rearing area was greater than is currently available.	Restore side channel habitat as mainstem complexity is restored.	RESTORATION
The un-screened turbine intake at Trail Bridge Dam may represent a risk to bull trout residing above the dam.	Determine risk to bull trout population.	RISK ASSESSMENT NEED
Mainstem and Trail Bridge bull trout population size may not be sufficient to maintain viability.	Monitor spawning population size. Provide for genetic interchange between South Fork, McKenzie and Trail Bridge populations. Determine population need of passage at Trail Bridge Dam.	MONITOR, INFO NEED
Habitat critical to mainstem bull trout spawning and rearing is found within a 1 mile radius and is subject to risks from wildfire, highway chemical spill, poaching, and sedimentation from land management activity.	Design and apply risk reductions.	RISK REDUCTION NEED
Bull trout spawning, rearing and foraging habitat upstream of Trail Bridge has had its wood recruitment and adult salmon migration interrupted by dams.	Restore bull trout habitat with addition of LWD in lower Smith River and McKenzie below Tamolitch Falls. Transport adult spring chinook above Trail Bridge to spawn and approach native community prey base (similar to ODFW trials in SF McKenzie).	RESTORATION
Brook trout are a risk to the Trail Bridge bull trout population.	Monitor spawning and rearing population. Participate in management of brook trout with resource management agencies.	MONITOR
The extent of hatchery origin spring chinook influence upon the wild chinook and wild rainbow populations is unknown.	Assist resource management agencies monitoring upper river spring chinook salmon.	COOPERATION NEED
13 potential harlequin duck nest sites occur on McKenzie. They do not appear to be disturbed by boaters. Loafing sites in the McKenzie may have been diminished through the removal of instream LWD.	Continue monitoring river. Maintain riparian reserve that protect riparian vegetation and part of the transition zone. Enhance availability of instream woody debris and protect existing loafing islands/rocks/logs.	MONITOR, RESTORATION

Table 5-2: Recommended Riparian Reserve Widths by Landform Block within the Upper McKenzie Watershed. These may change based on interdisciplinary team input during site-specific project analysis.

LANDFORM BLOCK 1

STREAM CLASS	PROCESSES/RISKS TO FUNCTION
CLASS I STREAMS Recommendation: No change from ROD recommendations. Potential to increase based on valley form using site-specific information. Critical to protect hardwood riparian vegetation.	Processes/condition: Includes the McK. System includes associated wetlands and hardwood swamps, flood terraces, and unconstrained channel; portion of McK is w/in the Wild and Scenic River corridor; in AMA; low elevation; abundant hardwoods, which is unique to the watershed; wide riparian veg with nice transition zone; flooding has a big influence on floodplain formation and riparian vegetation; abundant insect and disease disturbance; diverse structure; 2-300 yr FRI Hi intensity; 100-150yr FRI low intensity. Risks: Hwy bisects riparian habitat; prvt land influences processes and function; River trail through riparian vegetation; 3 boat launches; removal of woody debris is decreasing complexity
CLASS II STREAMS Recommendation: No change from ROD recommendations. Potential to be wider if site-specific riparian vegetation is considered.	Processes/condition: Glacial terrace does not allow most of surface water to flow to the McK River; mouths of these streams look like class I vegetation (ie influenced by flooding; abundant hardwoods); FRI variable: between that described for class I and IV's. Risks: N. Bank road bisects riparian vegetation.
CLASS III STREAMS Recommendation: No change from ROD recommendations.	Processes/condition: Includes 3 streams that connect directly to the McK River; majority of channels deeply incised; FRI variable (between that described for class I and IV). Risks: Impacted by the powerline
CLASS IV STREAMS Recommendation: Could reduce width if bank stability and LWD input is maintained. Potential: 100' or LMP guidelines. Recommend no net loss of late successional habitat within reserves if widths reduced in site-specific areas to maintain dispersal and refugia habitat for wildlife. More intensive on-the-ground analysis is needed.	Processes/Condition: Most streams in this block are class IV's; many run subsurface before reaching the McK River; they traverse an active landslide in several places;; variable fire affects: S slope DF 50-70yr FRI hi intensity; 100-130 yr in WH stands; N slopes 130-150 yr FRI, partial stand replacement and underburns. Risks: Prone to debris slides; impacted by powerline corridor.

LANDFORM BLOCK 2A

STREAM CLASS	PROCESSES/RISK TO FUNCTION
CLASS I STREAMS Recommendation: McKenzie mainstem--no change from ROD recommendation, though potential to increase in lower two miles of Deer Creek to capture broader riparian vegetation zone. Deer Cr.--no change from ROD.	Processes/condition: Includes McK River and Deer Cr.; McK in Wild & Scenic allocation; flood plain influence heavy in Deer Cr area; no influence by private landowners; somewhat constrained/incised in glacial till; lower McK around Deer Cr. has broad valley bottom with a wide transition zone; abrupt transition zone elsewhere; on the S. aspects even-aged stands; fire effects in Deer Cr. similar to McK floodplain in lower 2 miles, upper portion steeply incised, behaves more like a class II in landform block 1 (ie shorter FRI). Risks: Hwy impacts to riparian vegetation localized; hwy not impacting 100yr flood plain; 2 boat launches; repositioning of instream wood occurs to minimize extreme hazards to boaters; fire effects in McK River floodplain same as in Landform block 1,
CLASS II STREAMS Recommendation: no change from ROD.	Processes/Condition: W/in AMA; source of large amounts of sediment and large woody debris for mainstem McK; capable of abundant sediment storage; steeply incised to headwalls, where glacial cirques flatten out and become broader; 150-200yr FRI hi intensity, and 100YR FRI low intensity; Risks: Slopes above 2500 and >70% slope show higher potential for mass movement than anywhere else in the watershed
CLASS III STREAMS Recommendation: no change from ROD.	Processes/Condition: In AMA; source of sediment and LWD to mainstem; small portions go through an earthflow area; intersections between class II and IV's angle <70%, which inhibits debris avalanche transport; channel form same as that described in class II above; FRI same as described below for Class IV's. Risks: Slopes above 2500' and >70% show higher potential for mass movement than anywhere else in the watershed;
CLASS IV STREAMS Recommendation: potential to decrease except in slide prone areas and areas with potentially unstable soils, where an increase may be appropriate. Maintenance of banks and LWD input in cirque headwall areas important. No net loss of late successional habitat in riparian reserve to maintain habitat for riparian and late successional dependent species, and dispersal.	Processes/Condition: In AMA; source of sediment and LWD to mainstem; 100-200yr FRI hi intensity w/75-150yr low intensity; highly variable depending on topography; patchy forest pattern with potential for retention of old growth patches over time; channel form same as that described in Class III above. Risks: none noted.

LANDFORM BLOCK 2B

STREAM CLASS

PROCESSES/RISKS TO FUNCTION

CLASS I STREAMS Recommendation: No change from ROD. Potential to increase where broad floodplains occur and in areas where existing vegetation is degraded (ie Hackleman near Hwy 20).	Processes/Condition: includes McK R., Smith below the reservoir, Hackleman, & Park; in AMA; McK in Wild & Scenic River Allocation; domestic water supply for campgrds including Clear LK Resort; mainstem is constrained w/in a basalt canyon from Carmen to Clear Lk; floodplain evident below Beaver Marsh and from Trailbridge partly up to Tamolitch pool; no boat launches above Olallie; no repositioning of instream wood above Olallie; 200yr FRI hi intensity; 100yr FRI low intensity; mainstem veg highly variable, patchy; channel constrained in lava. Risks: River trail in rip zone ; hwy influencing riparian veg at Trailbridge Res. & to a large degree at Hackleman (influence on snags & LWD); Hackleman may be influenced by cinder accumulations in lower gradient areas; transport of wood from Hackleman and Smith intercepted by hwy and reservoir prior to reaching McK and Clear Lk.
CLASS II STREAMS Recommendation: No change from ROD. Potential to increase in broad valleys bottoms in High Cascades or in glacial valleys.	Processes/Condition: In AMA; includes Crescent & Park that flow into Lava Lk; no outlet; not a transport system. Smith; steeply incised in W. Cascade portion, except for in glaciated valleys; fires similar to Class I: patchy forested vegetation, with the exception of Parks Cr., where shorter FRI and more uniform patches occur from higher severity fires; Ikenick, w/ exception of lower reach, is not a transport system. Risks: Browder and Hackleman would have transported materials if not interrupted.
CLASS III STREAMS Recommendation: No change from ROD. Potential to increase in High Cascades to protect riparian transition zones and floodplains, especially in Ikenick, Lower Parks, and Crescent Creeks.	Processes/Condition: Numerous debris avalanches in N. side of Hackleman (from Echo MTN) and near steeply incised W. Cascades portion; these are energy transport systems; Park & Crescent Cr. in Hi Cascades are response systems; temps more variable on lower gradient streams; in W. Cascades, highly variable FIR, dependent on slope and aspect. S slopes 75yr, N slopes 200yr FRI hi intensity and partial; low intensity FRI 40-100 yrs. In Early High Cascades, 100yr FRI hi intensity, large fires created uniform patches, lower likelihood of underburning. Risks: >3000' road related failures occur on slopes >70%.
CLASS IV STREAMS Recommendation: Potential to decrease in New Cascades to reflect influence of fire on vegetation pattern. In W. Cascades, potential will be variable on a site-specific basis to reflect the patchy range of historic variability of the vegetation and topographical influences.	Processes/Condition: W. Cascades is a source of sediment and LWD; FRI same as Class III; Park/Crescent spring fed, dry up in summer. Risks: >3000' road related failures occur on slopes >70%.

LANDFORM BLOCK 3

STREAM CLASS	PROCESSES/RISKS TO FUNCTION
CLASS I STREAMS	None in landform block
CLASS II STREAMS Recommendation: No change from ROD, with potential to increase to protect wet meadows/bog.	Processes/Condition: Lost Lk Cr. has a broad valley bottom with associated wetlands; uncommon spruce bog community within the watershed; 100-200yr FRI mod to high intensity; 40-100yr FRI low intensity underburn outside of spruce bog; infrequent fire influence in bog; abundant snags; high fine sediment deposition. Risks: Hwy bisects the system and contributes cinders;
CLASS III STREAMS Recommendation: No change from ROD.	Processes/Condition: Includes Lost Lk Cr. and one of its spring-fed tributaries; same FRI as Class II above; dissects ancient earth flow, which is transporting fine sediments; streams beds become deeply incised upslope. Risks: none noted.
CLASS IV STREAMS Recommendation: No change from ROD.	Processes/Condition: Low density of Class IV's, majority in wilderness; same FRI as described above for Class III's. Risks: None noted.

LANDFORM BLOCK 4

STREAM CLASS	PROCESSES/RISKS TO FUNCTION
CLASS I STREAMS Recommendation: No change from ROD	Processes/Condition: Includes East bank of Clear Lake and Great Spring. Risks: None noted.
CLASS II STREAMS	None in landform block
CLASS III STREAMS	None in landform block
CLASS IV STREAMS Recommendation: See landform block 3	Processes/Condition: Very, very low density of streams. See discussion in landform block 3. Risks: None noted.

LANDFORM BLOCK 5

STREAM CLASS	PROCESSES/RISKS TO FUNCTION
CLASS I STREAMS Recommendation: No change from ROD, with exception for potential increases to protect bull trout spawning habitat. Same considerations for McK a described in landform Blocks 2A/2B.	Processes/Condition: Includes McK R and lower Scott, Anderson, and Boulder Cr. Bull trout breeding and rearing habitat; in Wild & Scenic Corridor; see discussions of McK in 2A and 2B; springfed seeps provided historic bull trout habitat; FRI on McK same as 2A/2B; FIR on Anderson/etc. 150-200yr partial and stand replacement w/75-100yr FRI low intensity; small to medium forested veg patches typical. Risks: Dispersed rec sites on Olallie/Anderson/Boulder; areas on the McK River where hwy is impinging riparian system causing aggradation upstream of rip-rap; Scott Cr homes influencing riparian veg; transmission line impacting riparian veg on a limited and local basis; low standard road access close to McK; informal boat launching; road impingement on main channel by Frissel;
CLASS II STREAMS Recommendation: No change from ROD.	Processes/Condition: Bull trout foraging habitat (lower tribes); Twisty hits glacial deposits in McK floodplain and seasonally goes subsurface; Boulder and Scott are incised in W. Cascades. Risks: None noted.
CLASS III STREAMS Recommendation: No change from ROD.	Processes/Condition: Some enter McK directly; flow in glacial deposits; low gradient; usually not incised; non-transport; 100yr FRI hi intensity. typically large patches. Risks: None noted..
CLASS IV STREAMS Recommendation: Potential to decrease based on fire-influenced patterns. No net loss of late successional habitat to continue to provide habitat for riparian and late successional associated species and dispersal habitat.	Processes/Condition: FRI same as for class III; low density of class IV's in High Cascades; same form as class III's above.. Risks: None noted

LANDFORM BLOCK 6

STREAM CLASS	PROCESSES/RISKS TO FUNCTION
CLASS I STREAMS Recommendation: No change from ROD. Potential to increase in wide valley bottom near springs.	Processes/Condition: Confined w/in lava flow; foraging bull trout habitat; spring fed; low gradient; wide valley bottom near springs; Limberlost Crnpgrnd in riparian veg; 200yr FRI mod to high intensity; patchy patterns; 75-100yr FRI low intensity. patchy flare-ups, variable; little floodplain veg in this area. Risks: Hwy influences riparian veg; human degradation at Lost Cr. springs has started and may increase;;
CLASS II STREAMS Recommendation: No change from ROD. Not an issue since in wilderness.	Processes/Condition: Occur only in wilderness Risks: None noted.
CLASS III STREAMS Recommendation: No change from ROD. Potential to increase around swampy depositional areas.	Processes/Condition: Ash sediment contribution from this system; response system; swampy, depositional areas; same fire as landform block 1; Risks: Primarily in recreation allocations
CLASS IV STREAMS Recommendation: No change from ROD. .	Processes/Condition: Active debris avalanche chutes; contributes coarse sediment, LWD, and some ash; same FRI as block 1, though may be 150-200yr FRI in western hemlock zone Risks: None noted..

Table 5-3: Recommended riparian reserve widths for the Upper McKenzie Watershed. This table was created by comparing ROD default reserve widths to the WNF LMP riparian buffer widths. The range between the two sets of direction is shown in this table if the LMP buffer was greater than the ROD default.

Riparian Reserve Area	TSHE Reserve Width 180' SPT*	ABAM Reserve Width 150' SPT	PSME Reserve Width 140' SPT	ABGR Reserve Width 140' SPT	TSME Reserve Width 100' SPT
Class 1 *	360' - 400'	300' - 400'	300' - 400'	300' - 400'	300' - 400'
Class 2	360'	300'	300'	300'	300'
Class 3	180'	150'	150'	150'	150'
Class 4	180'	150'	140'	140'	100'
Class 5	no buffer				
Constructed Ponds and Reservoirs	180'	150'	150'	150'	150'
Wetlands >1 ac *	180' - 600'	150' - 600'	140' - 600'	140' - 600'	100' - 600'
Lakes and Natural Ponds *	600'	600'	600'	600'	600'
Wetlands <1 ac *	180' - 600'	150' - 600'	150' - 600'	150' - 600'	150' - 600'
Unstable and Potentially Unstable areas *	180'	150'	140'	140'	100' - 125'

* SPT = SITE POTENTIAL TREE

* Individual prescriptions will be based on site-specific conditions and fall within the range specified by the Willamette Forest Plan as amended.

Table 5-4: Minimal, general suggestions for managing projects within riparian reserves to ensure consistency with the Aquatic Conservation Strategy Objectives. These recommendations may change during interdisciplinary review based on site-specific information. An overriding assumption is that the activity will maintain or enhance the riparian area.

SPECIAL FOREST PRODUCTS	No harvest/collection in late successional stands	okay as long as consistent with Forest EA	
SPRING FERTILIZATION	Application prohibited. Avoid open water	No fert in stands in spring if stand has lichens sensitive to chemicals. May need to increase buffer to avoid impacts of drift.	
FALL FERTILIZATION	same as above	same as above Avoid prolonged persistence of fert on ground prior to rains.	
PRE-COMMERCIAL THIN	Retain stream bank trees. Thinning in all classes needs to be based on site-specific info on tree composition to meet specific objectives. No machinery within 50' of watercourse.		25' no thin on at least 20% of class IV stream miles w/in an ind. project area or w/in each watershed to provide heterogeneity on the landscape. 25' no thin on class III's unless ACS objectives can only be met through PCT. Retain all hardwoods and yew. Prefer red cedar as leave trees.

Table 5-4 continued

COMMERCIAL THIN	No heavy equipment w/in 50-75' (based on site-specific info). Generally full suspension; partial where needed based on site-specific conditions.		Variable (25-50') no thin buffer on at least 20% of all stream class miles w/in an individual project area or w/in each watershed to provide heterogeneity on the landscape. Target areas w/low LWD. Consider fire/landscape effects when designing where to leave no-thin areas. Retain all existing snags and down logs. Leave at least 2 trees per acre for LWD of the DBH class thinned. Minimum canopy closure should be approximately 50% post-thin.
REGENERATION HARVEST			Used only to create landscape patterns within the range of variability and to meet site-specific mgmt objectives.

Table 5-4 continued

UNDERSTORY BURNING			Burn to meet management objectives, including protection of duff, LWD, and overstory trees.
HAZARD TREE REMOVAL	Leave if tree falls within creek, wetland, meadow or other special habitat. Fell into channel onto floodplain, or into woods if possible. Placement and amount of trees should be based on specific enhancement objectives.		Leave felled hazard trees on site unless they fall within the road prism; or more than 240 lineal feet/acre of trees >20" dbh, and >20' minimum piece length are available in forested areas of the site; or if tree is impeding normal function of the admin site.
PRUNING	No pruning within 25' of water.	No more than 30% of eligible trees should be pruned .	
HIKING/HORSE/MTN BIKE TRAIL CONSTRUCTION	Emphasize maintenance to reduce impacts of existing trails w/in 25' of open water. Minimize construction of new trails within 25' and minimize total miles and construction parallel to stream w/n the reserve		
SNOWMOBILE/ CROSS COUNTRY SKI TRAILS	Same as above.		Leave all trees felled during construction on site

Table 5-4 continued

BLOWDOWN	No removal of trees from channel or floodplain unless a safety or fire hazard concerns requires repositioning.		Blowdown must be considered "catastrophic" as defined by the ROD prior to removal. Leave 500 lineal feet/acre of >20" dbh, >20' minimum piece length or largest available
ROAD CONSTRUCTION			Minimize construction in riparian reserves. Construction generally will not maintain or enhance riparian reserve condition.
ROADSIDE BRUSHING			No expected impacts from this activity.
ROAD OBLITERATION OR RECONSTRUCTION			Use native plants, sterile varieties, or annuals if objectives can be met with available plants. Appropriately sized culverts, fish passages, hardening the fill, fill stabilization, landslide repair, and erosion control through surfacing improvements are all beneficial to the riparian reserve.
BIG GAME SEEDING	Inappropriate to seed with non-natives w/in riparian reserve	same	

Table 5-4 continued

PUMP CHANCE CREATION	Remove where irreversible resource impacts could take place (ie near bull trout spawning habitat) or mitigate with education on spill effects and create spill plans.		Manage to reduce potential for chemical spills and treat appropriately.
RIPARIAN PLANTING	Plant appropriate species local to area. Consult botanist for selection.		
SNAG CREATION			No mitigation suggested for this activity
BROWSE CUTBACK			Balance with site-specific concerns
LWD OR ROCK PLACEMENT	Potential to impact C-3 plant species. need surveys in potential habitat prior to activity. Place rock only in channels that naturally had that kind of material.		If falling trees or topping to create/obtain LWD material, no overhead reduction in conifer canopy closure or significant change structure of late successional stands can occur.
RIP-RAPPING			Minimize use. Allow river to reclaim floodplain where possible, or use natural materials to redirect flow.

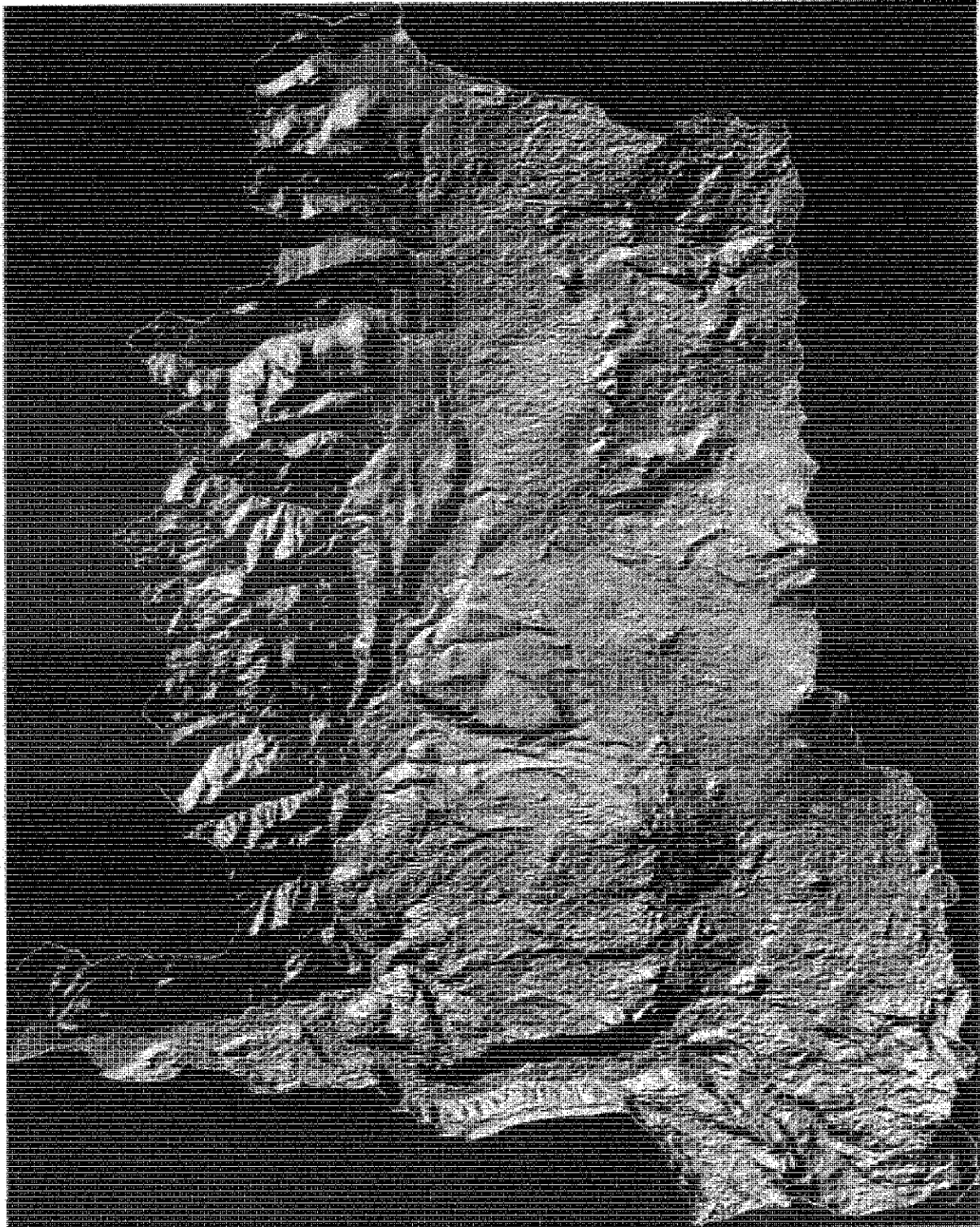
Table 5-4 continued

ODOT DITCH CLEANING	Need to continue to consult with District personnel to determine appropriate timing to avoid impacts to water.		
RECREATION DEVELOPMENT AND MAINTENANCE			These projects will need to be analyzed on a site-specific basis with an extensive WA
FIREWOOD			Not permitted in riparian reserve except in road prisms.
MINING CLAIMS			Proposals for commercial claims will be evaluated on an individual basis. .

Upper McKenzie Watershed Analysis

Willamette National Forest

August, 1995



United States
Department of
Agriculture



Forest Service
Pacific Northwest
Region

UPPER McKENZIE

WATERSHED ANALYSIS

August, 1995

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Willamette National Forest**

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Botany *

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Wildlife *

* Available upon request

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Appendix C - Information Management/Analysis

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- Silviculture Appendix

- Botany Appendix *

- Geology Appendix *

- Fisheries Appendix *

- Wildlife Appendix *

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APPENDIX B

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APPENDIX C

INFORMATION MANAGEMENT/ANALYSIS

EXISTING DATA

A Paradox database is available that lists all existing data for this watershed. The database can be obtained from the WA team leader at the Mckenzie Ranger District. This data table is continually being appended to include new data, so a hard copy is not provided here.

GIS LAYERS:

A description of all available GIS layers will be appended to this document at a later date.

ANALYTICAL PROCESSES

AQUATIC / RIPARIAN HABITAT DOMAIN

Issue:

Management practices such as road building/maintenance, timber harvest, and slash treatments may have changed the frequency and spatial distribution of mass wasting and surface erosion. This can result in increased turbidity and filling of large pools with sediment.

a. What is the range of variability, temporally and spatially, of natural and management-induced disturbance regimes?

Table 1-1

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Tran Layer	Yes P007	Forest-wide Clipped to SUBWA	Annotate with Road Related Landslide Data Base (GEOTECH).	GIS - Paper
Geology Layer	Yes G001	State -wide Clipped to SUBWA	Annotate with local lithology and structure from USGS/DOGAMI/and thesis maps.	GIS - Paper
Stream Layer	Yes H006	Forest-wide Clipped to SUBWA		GIS
SRI Layer	Yes G002 G003	Forest-wide Clipped to SUBWA	Query critical soils - 25/33/35, 255/334.	GIS - Paper
Vegis Layer	Yes V004	Forest-wide Clipped to SUBWA	Query for managed stands - landslides.	GIS
Topo Layer	Yes A007	Forest-wide Clipped to SUBWA	Query for areas <30% slope 30 - 50% 50 - 70% 07 - 70% Query for Elevations 2000 - 2400' 2800 - 3200'	GIS - Paper
Fire History	Yes A003 A006 A009 A011 F101 V035	District	From District H.J. Andrews records, State Climatologist.	Paper

Table 1-1 (continued)

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Landslide & Debris Flow History	No/Yes	G004 G005 G007 G015	Air photo interpretation bracketed for 39, 53, 59, 67, 79, & 90 photos.	Paper
Precipitation Data	Yes	State-wide	NOAA, District, H.J Andrews records.	D.B. Paper

Description of General Analytical Process:

- Determine if any relationship exists, delineated spatially and temporally, in mass wasting (landslide, debris flow, erosion). Frequency and magnitude between natural regimes (topography, geology, climate and fire) and management activities such as timber harvest, road construction, prescribed fire.
- Analyze historical air photos in time-bracketed sequence (39, 53, 59, 67, 79, 90) for disturbance history by SUB watershed. Locate landslides debris flows major erosion features and survival debris fans. Determine size and date of occurrence if possible. Determine sediment delivery volume.

b. What are the processes operating within the uplands and riparian areas? More specifically, what are the sediment delivery mechanisms and relative rates to streams by landform or slope position?

Table 1-2

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
INFO on relationships between land form geology, fire history, harvest and sediment delivery answered in 1a.	Answer to be obtained in 1a.	Subwatershed		
Stream Habitat	F001			
Stream Channel	F004			

Description of General Analytical Process:

- Determine relative rates of sediment delivery due to geology, landform, fire frequency/intensity during pre-management period (1800's - 1900's?).
- From answers obtained in 1a, determine relative rates of sediment delivery due to environmental/physical factors (#1), plus rate changes due to fire suppression, harvest, and roads. Post-management relative delivery rates.
- Use stream surveys to locate slides, sediment sources and areas of severe aggradation or degradation.

PRODUCTS:

- Map of pre-management relative sediment delivery rates.
- Map of post-management relative sediment delivery rates.
- Narrative describing basic channel conditions including sediment size, relative amounts and changes in these parameters due to management. Stratified by geology/landform and potentially subwatersheds.

Issue:

Increases in peak flows resulting from timber harvest and extension of the drainage network by road systems may have reduced channel complexity through scouring and down cutting of the channel, isolating side channels, and transport of large woody debris out of the system. The overall effect may be a reduction in pool numbers and sizes, less diverse sediment distribution within the channel, and a more uniform water velocity distribution along the stream channel.

a. Where have management activities affected the magnitude and frequency of peak flows and have increased peak flows reduced channel complexity and modified aquatic habitats beyond the range of historic variability?

Table 1-3

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Plant series for mapping transient snow zone				
Aspect (DEM's)	A007			
Soil depth (SRI's)				
Road density by PSUB on decade basis	P012			
Answers from 2F	Streams which seem to have highly unstable banks			
PPT. intensity map	Yes NOAA			
Stream surveys	F003 F004			
Harvest history	V006			

Description of General Analytical Process:

1. Construct map showing potential areas contributing to ROS based on plant series (rain zone, ROS, snow zone), aspect and soil depth.
2. Calculate hydrologic recovery (aggregate recovery percentage, ARP) for current recovery by subwatershed. Calculate recovery for one or two previous periods of high harvest rates.
3. Compare recovery values by PSUB to those mid-point values outline in LMP.
4. Compare amount and location of harvest units to areas that are potentially high contributing areas to ROS. Where many harvest areas are located in high contributing areas and recovery values are low, peak flows are potentially increased.
5. Compare road densities and potentially high contributing areas to ROS. High densities in high contributing areas would indicate increased peak flows.
6. For streams where peak flows potentially higher from harvest (step 4) or from roads (step 5), look at stream surveys for bank stability and pool frequency parameters. Where bank stability poor (and not due to geologic material), on pool frequency poor and evidence of extensive scour, then increased flows probably modified aquatic habitat.
7. Calculate percent harvest and roaded by subwatershed and smaller drainages. For areas with less than 20% harvest, go to step 6.

PRODUCTS:

- Map of potential areas contributing to ROS categorized by high, medium, low.
- Table of ARP by subdrainage.
- Table of percent harvest and roaded by subwatershed and drainage.

Issue:

Harvest of riparian vegetation, establishment/maintenance of recreation sites, and roads within the active floodplains has likely resulted in altered processes and functions of the riparian ecosystem, reduced amounts of large woody debris, increased stream temperatures, and reduced channel complexity.

a. To what extent and to what degree has the riparian area and floodplain of Class I, II, III and IV streams been altered due to management? How has this alteration affected the aquatic ecosystem?

Table 1-4

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Harvest Units	V006 (Veg 4)			
Roads Layer	P007			
Stream Class Map	H006			
Aerial extent of recreation sites in riparian areas	No	Fullquad	Mapped from aerial photos.	
Designation of riparian area widths by valley segment type	No		Map valley segment types using topo maps and aerial photos. Assign riparian widths for each valley segment type.	

Description of General Analytical Process:

1. "Buffer" stream classes with riparian area widths.
2. Overlay roads and harvest units and recreation sites.
3. Determine area of riparian area that contains harvest units, roads, and recreation sites by stream class.

PRODUCTS:

- Table showing % of riparian by stream class impacted by harvest units, roads, and recreation sites.

b. Where is there a deficit of large wood in or adjacent to stream channels in the Upper Mckenzie sub-basin?

Table 1-5

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Stream surveys	F001 F003 F004			
Miner Thesis for Mainstem	F006			

Description of General Analytical Process:

1. Compare current levels of LWD determined from recent surveys to previous surveys.
2. Compare current levels of LWD from recent surveys to reference levels based on average bankfull width and channel gradient.

PRODUCTS:

- Tables depicting current vs historical or reference amounts of LWD for mainstem and tributaries.

c. How has the quantity of in-stream wood changed over time in the Upper McKenzie River?

Table 1-6

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Definition of navigability	Navigability report, 1976. W&S Mgmt plan pg. 1&2			
Aerial photos				
Paula Minear Thesis	F006			

Description of General Analytical Process:

1. Talk to guides Dick Helfrich, Jim Goodpasture.
2. Through discussions with guides, documentation in Minear Thesis, and examination of aerial photos through time, document quantities and trend in wood input removal.
3. Determine ownership of wood in channel. Is it based on navigability? If so, is Upper McKenzie River deemed navigable?

d. What riparian areas are deficient in long term sources of wood?

Table 1-7

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Stream surveys or Valley segments	F003 F004 No		Valsegs to be manuscript on full quads and digitized.	
Veg size class	V006			
Insect and Disease	Yes			

Description of General Analytical Process:

1. Set up four categories of size classes from veg layer. Size class 1-3, 3.5-4.5, 5-5.5, more than 6.
2. Determine average height of site potential tree.
3. Buffer streams with width of site pot tree, and segment by reach breaks (from surveys) or valsegs.
4. Identify areas of good - excellent sources of streamside LWD, and areas of poor sources for several stream segments.
5. For each segment, determine what the size class is for pixel in buffer.
6. Calculate percentages of size classes for each segment deemed "good" sources and those deemed "poor" to determine criteria for assigning reaches as "low" and "high".
7. Assign those areas not categorized "low" and "high" to "moderate".
8. Overlay dead/disease/root rot areas to determine areas of potential high loading.
9. Grow stand through time (?).
10. Slope (?).

PRODUCT:

- Map showing stream network with large woody debris potential ratings of low, med, high.

e. Where have stream temperature and streambank instability exceeded the historic range of variability?

Table 1-8

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Stream Temp - Budworm	Yes (not on sheet) 1991-1994			
Stream Temp - REAP	A012			
Stream Temp - Deer Creek	Yes (not on sheet)			
Clipper Watershed report	1976-77, 1984, 1991-94			
Stream Temp - Mckenzie River	H015 H018			
Answers to 1b Natural & mgmt caused sediment del. mechanisms				
Stream surveys	F003 F004			
Miner Thesis	F006			

Description of General Analytical Process:

Temp:

1. Determine natural range of variability based on Budworm temps and work by D.Bates and RAP team.
2. Compare natural range to current McKenzie River temp data.
3. Use clipper watershed report that analyzed stream temp in Deer Creek.

Stability:

1. Use stream surveys to locate streams that seem to have high percentage of unstable banks.
2. Use info gained from 1b to determine if natural or management caused.
3. Use stream surveys and Minear thesis to determine if mainstem McKenzie has increased bank instability.

PRODUCTS:

- Narrative and potentially a graph of temps.
- Narrative and potentially a map showing reaches with increased bank instability.

Issue:

Highways 126, 242, 20 and 22 pass through the watershed, often through riparian areas. Both highways are managed and maintained by the Oregon Department of Transportation (ODOT). The management techniques used by ODOT may affect the condition of the riparian zone and the riparian vegetation.

- a. In what ways have maintenance of these highways altered the riparian habitat, considering activities associated with surface maintenance, winter gravelling, use of de-icers, and roadside vegetative management?

Table 1-9

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
ODOT management practices	Yes	Highways	Check with engineering sources	

Description of general analytical process:

- Compare expected impacts of management practices with desired condition for riparian areas. Consider context and intensity of predicted impacts.

- b. What management practices currently foster invasion and establishment of noxious weeds?

c. How effective are current management strategies to reduce the invasion and establishment of noxious weeds along travel corridors?

Table 1-10

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
ODOT's and District's current mgmt practices along travel corridors.	Yes	UPMA	From ODOT and District Engineer	Paper per com.
WNF Integrated Weed Management Plan	Yes	Forest Wide		Paper

Description of General Analytical Process:

- Describe ODOT's current practices along Hwy 126 and 242. Are these practices effective?

Issue:

The location of facilities, boat access points, and dispersed camp areas (within and outside of wilderness) may either be causing impacts or mitigating impacts of people using shorelines of rivers, lakes, and reservoirs.

- a. What impacts are occurring and at which recreation areas?
- b. Where are unacceptable impacts occurring?

Table 1-11

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Developed and Dispersed campgrounds on GIS	No	1" mile	Digitize from quads.	
Recreation use info.	Yes		RRIS reports	
ROS & WROS zones on GIS	NO	1" mile	Manuscript from hard copies and digitize	
Facility condition reports of developed Rec. sites	Yes		Hard copies	

Description of General Analytical Process:

- Inventory of dispersed and wilderness campsites, listing those that are within a "riparian setting" to be defined. Categorize by light, medium, heavy use. Show the distribution of sites in close proximity to each other. Get the standard used by the South Fore WA. See if we can quantify "scenic impacts" due to litter, vegetation loss in scenic areas. Inventory of ROS- use forest plan map of ROS, through GIS use capacity RVD/acre/year to see what we are offering vs. supposed demand by ROS. List the forest plant management areas, each is assigned a VQO, make a map of VQO then overlay GEGIS and WA boundary to give condition of landscape with harvest units. For developed recreation sites, list replacement needed items from facility condition report in RRIS. List seasonal facilities brought in to access launches as mitigation. List needed facilities (gray water sumps), age of existing septic systems.

Issue:

Potential impacts from point-source pollutants accidentally entering the water bodies from spills, leaks, draining hot spring, cleaning boats, rock sources, or from ODOT rock piles, may exist in the watershed. Non-point source pollutants such as nitrogen also have potential to enter streams within the watershed from forest fertilization activities.

- a. What are some of the probable contaminants that could potentially enter, or are currently entering, the McKenzie River and what are their sources and effects on the aquatic ecosystem?

Table 1-12

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
List kinds of products trucked over pass Hwy 20 & 126	No		ODOT, HAZMAT teams, EWEB report.	
Info on hot springs, boat cleaning at Clear Lake, rock sources, septic systems			Pat Hutchins, Kathy Keable, County - septic systems, EWEB GIS data layer.	
Forest fertilization records, application rates, where				
State applied herbicides				
DDT application				

Description of General Analytical Process:

1. Determine kinds of contaminants, where located, and rates of input or potential input.
2. Do literature search to determine effects on plants and animals in the water.

Issue:

Roads, dams, channelization, and slides may have isolated and fragmented components of the Upper McKenzie aquatic refugia system.

- a. What is the historic and current distribution and abundance of trout, salmon and non-game fish in the Willamette basin?
- b. Where and what elements have isolated and fragmented trout, salmon and non-game fish habitat.
- c. What role does the Upper McKenzie sub-drainage play in providing refugia for aquatic organisms?

Table 1-13

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Level II surveys (OSU, USFS, ODFW) and REDD surveys	F001 F003			Oracle Paper
Salmon counts at Leaburg, Carmen, Tribs, EWEB/ODFW/USFS	F003			Paper
Biological probes USFS/ODFW	F005			Paper
Basin reports ODFW/USFS	F007			Paper

Description of General Analytical Process:

1. Construct map of pre-dam fish distribution (game sp) and current distribution (include summary of barriers to migration). Determine: habitat loss due to construction of barriers/habitat degradation (% area lost)
2. Estimate historic range of abundance for game species and compare to current range of abundance.

PRODUCTS:

- Summary of aquatic inventory info available.
- Map of fish species distribution, historic and existing.
- Upper McKenzie's role in providing different organisms refugia.
- Identify data gaps (e.g. sculpin distribution.).

Issue:

The 3 dams within the Carmen-Smith Project may have had an impact upon the aquatic ecosystem within McKenzie and Smith Drainage's through the disruption of substrate and large woody debris transport, resulting in coarsened bedloads, downcutting and channelization below the dams. The hydrologic regime downstream of the dams may be affected by modifications in the timing and rates of streamflow and dewatering portions of the McKenzie River channel.

- a. Have possible changes to the flow regime altered the timing of migration for historic juvenile or adult spring chinook?

Table 1-14

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
USGS gauging data Trail Bridge and Leaburg	H002 H003			
Salmon counts (upstream/down- stream migrants) at Leaburg/Carmen	F003			
State Basin reports	F007			
Dam project reports	F006			

Description of General Analytical Process:

1. Identify minimum allowable flow for spring Chinook migration [literature search may provide flow requirements].
2. To determine if peak flows have been dampened, compare frequency and magnitude of peak flows between pre- and post- Trail Bridge/Carmen/Smith dams. Examine previous migration to flows.

PRODUCTS:

- Identify potential conflict between flow alteration and spring chinook migration. If migration timing has been altered, determine flows necessary to restore historic migration in the Upper McKenzie.

b. To what extent have the dams modified the average flows during spring through late fall months, average daily maximum flow, and instantaneous peak flows? If the flows have been modified, how has it affected floodplain processes and function, their associated riparian area habitat, sediment transport and distribution, and aquatic habitat?

Table 1-15 FLOW ANALYSIS

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Discharge - Clear Lake	H020			
Discharge - McKenzie Bridge	H016			

Description of General Analytical Process:**Flow Analysis:**

1. Do double mass plot of instantaneous peaks and annual max means for Clear Lake station and McKenzie Bridge station check for shift in line following 1963 (following completion of Carmen-Smith project).
2. Do double mass plot of minimum monthly flows for Clear Lake and McKenzie Bridge stations. Do 4 plots stratified by run off season: Oct-Dec, Jan- March, April - June, July - Sept. Check for shift in line following 1963.
3. Do T-test for average annual max mean flows, annual minimum mean flows, and annual instantaneous peaks. Use McKenzie Bridge station data. Two variables: 1. data prior to dam construction, 2. data following dam construction. Determine if significant difference in flows before and after dams.

Table 1-16 EFFECTS ANALYSIS

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Stream condition study COE/Sedell et al.. Masters Thesis Paula Minear	F006			Paper
USGS gauging data; Trailbridge	H002			Paper
Aerial Photos (Veg. Cond.)	A002			Photos
Side Channel area, LWD count	NO		Ground recon.	Map Paper

Description of General Analytical Process:**Effects Analysis:**

- Much of this analysis complete in P. Minear thesis (riparian composition, channel condition, riparian development).
- Examine 1945 and later aerials and below dam channels. Measure side channel area between McKenzie Bridge and Trailbridge and verify on current aerials, if possible. Count in-stream LWD. Determine rearing area lost following dam construction.

PRODUCTS:

- A measure of side channel loss and quantities of in-stream wood.

Issue:

The stocking of non-native stocks (e.g., rainbow trout and brook trout) in the Upper McKenzie River may have influenced wild stocks through competition, hybridization or incidental catch mortality. Stocking of hatchery trout in the Upper McKenzie River and fishless wilderness lakes may have additional effects upon the terrestrial and aquatic ecosystem by concentrating recreational use and influencing predator/prey populations.

- a. Where have non-native fish impacted wild stocks in the Upper McKenzie sub-basin?
- b. What is the distribution and abundance of non-native aquatic species in the Upper McKenzie?

Table 1-17

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
ODFW stocking reports	F003			Paper
Biological Probes USFS; ODFW	F005			Paper
ODFW creel census	F003			Paper
Level II surveys (lakes and streams) Basin reports	F001 F007			Oracle Paper

Description of General Analytical Process:

1. Map ranges and estimated abundance of exotics.
2. Document areas of known conflict with indigenous stocks.
3. Document areas of naturalized species.
4. Determine: Sub-basin area occupied by exotics including lake area formerly fishless.
 - stream miles not occupied by exotics.
 - all lake area with past and present indigenous.
 - lake area with extirpated species.

PRODUCT:

- Overlay of various species to compare to distribution of indigenous species. Of particular interest are those in conflict (e.g. Brook trout/Bull trout, Brook trout/Cutthroat trout). This will answer : Where have conflicts occurred?

c. Where and how have terrestrial and aquatic components of the ecosystem been impacted by non-native fish stocking?

Table 1-18

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
ODFW stocking records streams/lakes	F003			Paper
Level II stream and lake surveys	F001			Paper
State Creel census	F003			Paper
Wilderness guard encounters/campsite condition surveys	?			?

Description of General Analytical Process:

- Use exotic species distribution to identify areas of fishing attraction. Determine from survey narratives the extent of terrestrial impact. Predator/prey impacts will rely on literature survey and species (of amphibians for example) likely to occur within a given area. Determine waters barren prior to stocking and now stocked by ODFW, compare lake survey water quality results for potential elevated enrichment.

PRODUCTS:

- Summary of terrestrial environs subject to fishing pressure with emphasis on overimpacted sites. A summary of the extent of terrestrial and aquatic alteration due to stocking.

d. How do current sportfishing regulations influence recreational use and wild fish stocks in the Upper McKenzie sub-basin?

Table 1-19

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
State Creel census	F003			Paper
Campsite use records	?			?
Wilderness guard encounters	?			?
Population estimates ODFW	?			?

Description of General Analytical Process:

- Narrative summary of state management objectives and methods to distribute stocked fish. Where stocked fish occur with native fish, describe potential conflicts. Summarize impacts to native populations through creel census, population estimates. Summarize current sportfishing regulations and where/ to what extent incidental take may occur.

PRODUCT:

- Overlay of campgrounds, river-access, stocking area/quantity to compare indigenous species distribution. Highlight high impact areas.

Issue:

Factors suppressing bull trout populations in the upper McKenzie River sub-basin are passage barriers, overharvest, hybridization/competition with brook trout and habitat degradation.

a. What factors increase the risk of bull trout population(s) extinction in the Upper McKenzie?

Table 1-20

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Population(s) estimates ODFW	F003			Paper
Level II surveys ODFW, USFS	F001			Paper

Description of General Analytical Process:

1. Describe habitat condition and population size.
2. Describe habitat connectivity within watershed.
3. Apply estimated population to Rieman/McIntyre model, to determine pop. viability/risk of extinction.

PRODUCT:

- Risk estimate, based upon population size, trends, suppressing factors and literature survey.

b. Are areas essential to bull trout life history requirements adequately protected from the effects of human disturbance?

Table 1-21

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Level II surveys ODFW, USFS	F001			
Stream temps	H001			
Aerial photo	A002			
P. Minear study	F006			
Biological probes	F005			
Spanning surveys	F003			

Description of General Analytical Process:

1. Range map comparison to habitat condition, including riparian condition (McKenzie mainstem, and spawning tributaries).
2. Examine: stream temps, riparian composition and age, in-stream wood, spawning and rearing habitat condition, prey composition.
3. Answer the question: Are riparian reserves adequate to protect bull trout habitat? (include historic range).

Issue:

Simplification of channels, habitat degradation and passage barriers may have resulted in loss of spring chinook spawning and rearing habitat in the Upper McKenzie River Subbasin.

- a. Are areas essential to spring chinook life history requirements adequately protected from the effects of human disturbance?

Table 1-22

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Level II surveys and Redd surveys	F001 F003		Aerial and ground	
P. Minear study	F006			
Stream temps	H001			
Biological probes	F005			

Description of General Analytical Process:

1. Range map/habitat condition (including riparian condition).
2. Examine elements required for chinook production: water temps, in-stream wood, habitat condition, riparian composition. Identify habitat outside historic range of variability. Answer the question: Are riparian reserves adequate to protect chinook habitat?
3. Include hydro analysis - are peak flows beyond historic range?

- b. Have utility mitigation efforts adequately supplemented loss of habitat since dam construction?

Table 1-23

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Redd surveys	F003			
Leaburg counts	F003			
Carmen counts/EWEB	F003			

Description of General Analytical Process:

1. Examine historical production.
2. Compare mitigation production to natural production.

- a. What is the economic contribution of fisheries to the Upper McKenzie Subbasin?

Table 1-24

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
ODFW Creel census	F003			
Stocking reports ODFW	F003			
ODFW Salmon/steelhead tag returns	F003			

Description of General Analytical Process:

1. Determine effort/stocked fish and total spent/unit effort.
2. Determine effort/Chinook and average yearly catch.
3. Determine total spent/unit effort.

Issue:

Existing riparian habitat may not be adequate to support species utilizing it.

- a. What was the historic composition of the riparian vegetation? How does that compare to current conditions?
- b. What is the historic role of disturbance in the riparian areas? How does the historic disturbance compare to the current conditions?
- c. Will the interim riparian reserves and matrix standards and guidelines adequately provide all 5 functions outlined in the ROD?

Table 1-25

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Historic vegetation and fire maps	No	District wide	Use maps produced in question 1.	
Literature on fires and other disturbance	Yes	Regional	Literature Search	

Description of General Analytical Process:

- Compare current vegetation condition in the riparian areas from the VEGIS database to the historic condition as indicated by REAP and the historic state fire and vegetation maps. For wilderness area, use the data collected by Jane Kertis and the prescribed natural fire group.

PRODUCTS:

- Narrative comparing current and historical conditions.
- d. What criteria would lead to interim riparian reserve adjustments, and where are some of the areas that fit these criteria?
- e. What are the appropriate riparian reserve boundaries for this landscape?

Table 1-26

DATA NEEDED	EXIST
LMP Layer	Yes
Veg Layer	Yes
SHAB Layer	Yes
Stream Layer	Yes

Description of General Analytical Process:

- IDT review layers and discuss biological implications of alternatives.

Issue:

Grazing of pack animals in wilderness areas may be impacting riparian areas to an extent outside of wilderness objectives.

- a. Where and what kind of disturbance has occurred?
- b. Where are areas with the highest potential for degradation in the future?

Table 1-27

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Wilderness campsites used by stock rate high, med, low	Yes		Hard copy from Troy's data	
Location of water closest to those sites	Yes		Stream layer on GIS	

Description of General Analytical Process:

- Take wilderness permit data for last four seasons, break out those identified as stock users, note trailhead entrance points. Through consultation with Steve O., Phil, Stacey, and through LAC inventories, identify low, moderate, and heavy stock use campsites. Overlay a water/stream layer, and through inference determine riparian areas that are at a low/medium/high risk for grazing impacts. Recommend an appropriate sampling procedure for future field verification and restoration projects.

Issue:

Grazing of Forest Service pack animals at Fish Lake and cattle at Lava Lake is occurring. This activity, combined with manipulation of the stream channel and riparian vegetation may be degrading stream channel conditions and fish habitat; may be degrading wetlands; and may be altering the vegetation composition of the area.

- What are the natural functions and processes occurring within these areas?
- In Terms of the ROD's 5 objectives for riparian reserves, what is the current biological condition of these areas?
- What roles do these areas play in a larger landscape?
- What effects have grazing and channel manipulation had on stream channel condition, function and aquatic habitat in these areas?

Table 1-28

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Fish Lake Analysis	Yes	Fish Lake		Paper
Lava Lake EA	Yes	Lava Lake		Paper

TERRESTRIAL DOMAIN

Issue:

Insects and diseases are affecting forest health and resilience in many of the stands within the analysis area. Of particular interest are the spruce budworm infestation, the Douglas-fir bark beetles, the root rots, and the dwarf mistletoe.

- a. What is the extent and severity of insect and disease effects?
- b. How do current conditions compare with historic conditions?
- c. Do the current conditions present a significant risk of large-scale fires?

Table 2-1

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Maps of recent insect and disease infestations	Yes	District Wide	GIS	GIS - Paper
Information on historic insect and disease infestations	No	District Wide	Interpolate from literature and historic vegetation maps	Paper
Relative Risk of Large Stand Replacing Fire	No	Regional	Literature search, including Swanson and Morrison (Deer Creek) Fuel Models	Paper

Description of General Analytical Process:

1. Vegetative condition is directly related to insect and disease levels. Use historic vegetation condition to infer insect and disease levels. Compare current insect and disease conditions to inferred historic levels.
2. Use fuel models to compare current risk of large scale fires with historic records of such fires to determine a relative difference.

PRODUCTS:

- Narrative describing role of insects and diseases in historic and current context
- Narrative describing historic and current risks of large scale fires.

Issue:

Management activities within these forests, including timber harvest, road building, and fire exclusion, may have altered species' composition and created patterns and conditions that are outside of the historic range. This could impact the biological diversity of the watershed.

a. How does the current condition of vegetation compare with the historic range? How do these changes affect land management objectives, ecosystem function, and structure?

b. Are there individual plants and plant communities that are decreasing or increasing due to past management activities? What wildlife are associated with these plant communities?

Table 2-2

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Guild Habitat maps Basin & Watershed	Yes	1" = 1 mile		
Guild maps for 1900 landscape	No			

Description of General Analytical Process:

1. Determine acres of habitat by Guild for watershed and basin; and calculate % contribution of watershed to basin.
2. Evaluate distribution of habitat for corridors, barriers, etc.
3. Compare historic landscape to existing.

Table 2-3

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Map of 1900 landscape	Yes			
Map of 1994 landscape	Yes			
REAP report	Yes			
WHR database	Yes			

Description of General Analytical Process:

1. Compare 2 landscapes and structures that develop under natural versus "managed" disturbances. Identify trends in habitat structures and link species to the structures using WHR database.

Table 2-4

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Ecoplot database	Yes V010	UPMA		Paradox D.B.

Description of General Analytical Process:

1. Use existing info to assess if any plant sp/plant community is increasing or decreasing in UPMA.

c. What was the role of human-set fire in altering the vegetation patterns in the prehistoric past? Is there any evidence for this in the archaeological record?

Table 2-5

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Historic Vegetation maps and fire history maps	Some	District wide	Historic State forest stand and fire maps	Paper
Current vegetation	Yes	District Stands	GIS, Vegis database	Paper
Role of Prehistoric Fires	Yes	Regional	Literature search	
Information on vegetation of wilderness areas	Yes	Forest	Jane Kertis database and Pacific Natural Fire	GIS

Description of General Analytical Process:

1. Compare current vegetation condition from the VEGIS database to the historic condition as indicated by REAP and the historic state fire and vegetation maps. For wilderness area, use the data collected by Jane Kertis and the prescribed natural fire group.

PRODUCTS:

- Map of historic structural stages
- Map of current structural stages.
- Narrative describing aboriginal use of fire in the watershed.

Issue:

Levels of large woody debris and snags in managed stands, campgrounds, roadsides, etc. may be below historic levels for these systems. This could impact a variety of species that depend on these elements for habitat.

- a. What is the natural range of variability for LWD on this landscape?
- b. Have management activities altered the landscape condition significantly outside the historic range for snags and LWD?

Table 2-6

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Current snag and LWD levels and distribution	Yes	District wide	GIS	Table
Historic snag and LWD levels and distribution	No	Regional	Extrapolation of existing natural stand	Table

Description of General Analytical Process:

1. Examine existing undeveloped forest stands in each broad plant series to determine historic levels of snags and LWD. Consider fire patterns into extrapolation of historic snag and LWD. Based on current fire patterns and assumptions of management practices, determine existing levels of snags and LWD for the watershed.

PRODUCTS:

- Narrative and table comparing current and historic levels of snags and large woody debris.

Issue:

The public expects a variety of commodity outputs from this area, however, meeting those expectations may conflict with other objectives or may not be sustainable.

- a. What are the suitable and available areas in the watershed?
- b. Where are the potential areas for harvest of special forest products in the watershed?

Table 2-7

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Ecoplot database	Yes V010	UPMA		Paradox database

Description of General Analytical Process:

1. Look at ecoplot database to assess high concentration of SFP species.
2. Look at past SFP harvest areas.
3. Talk to district personnel who may have knowledge of areas of high concentration of SFP plants.

PRODUCT:

- Narrative and list of locations, possibly a map w/locations.

Table 2-8

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Suitable and available acres in the watershed	Yes	District wide	GIS - "What's available Map"	GIS - Paper
Areas open for special forest products	Yes	District wide	GIS - map of areas suitable for collection of various special products	GIS

Description of General Analytical Process:

1. Acres suitable and available for various types of commodity production will be displayed in a tabular format.

Issue:

Future land management strategies focused on the maintenance or development of late-successional forest species may result in diminished availability of habitat for early seral species.

- a. What is the historic and projected future availability of early, mid and late seral habitat over time in this watershed?
- b. How will the availability and distribution of these habitat types affect species associated with them over time?
(see 2-2 through 2-5)

Issue:

The road management strategy for the watershed may be affecting the quality of wildlife habitat and hunting opportunities.

- a. What are the current road densities within the watershed? How do they currently impact wildlife habitat and hunting opportunities?

Table 2-9

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Road density Data	Yes			
EHAB	Yes			
Wildlife habitat/species locations	Yes			

Description of General Analytical Process:

1. Run HEIWEST for HE values.
2. Compare with forest plan objectives.
3. Overlay roads and wildlife habitat areas and look for impacts.

Table 2-10

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Map of areas with open roads	Yes			
Map of areas within open 1 mile of open roads	No			

Description of General Analytical Process:

1. Identify zones of hunting opportunities: ie. areas within .5 mile ,etc. of open roads. Evaluate acres and elk use.

Issue:

Some current recreation uses conflict with other uses or management goals. Areas such as Sawyer's Cave provide both recreation opportunities and critical wildlife habitat.

- a. Where are recreation use areas conflicting with T, E and S species and species of concern?

Table 2-11

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Map of TES species	Yes	1" = 1 mile		
Map of Rec. areas	Yes			

Description of General Analytical Process:

1. Overlay maps of TES and recreation use and identify over-laps.
2. Determine if type of use is in conflict with species' sensitivity to disturbance.

Issue:

Diversity (i.e. horizontal structure, species mix, stocking levels) in past harvest areas may be providing low quality habitat for species that rely on early seral stages.

- a. What is the current diversity level within managed plantations? How does this compare with historic early seral stage habitat?

Issue:

The Northwest Forest Plan calls for the survey and management of numerous species of wildlife, fungi, lichens, bryophytes and vascular plants (ROD Table C-3). The location of many of these species is unknown. The Standards and Guidelines in the Northwest Forest Plan may not adequately protect these local endemic and rare species when applied at a site-specific level.

- a. What C-3 species may potentially occur in the watershed based on their range and habitat requirements?
- b. What Table c-3 wildlife and plant species know to occur in the watershed?

Table 2-12

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Wildlife sitting/s mapped	In progress	1" = 1 mile		
Range maps of C-3 species	Yes			
Great Gray owl sites	Yes	1" = 1 mile		
Seral stage map	Yes	1" = 1 mile		
Meadow map	Yes	1" = 1 mile		

Description of General Analytical Process:

1. Review documented locations and existing range maps.
2. Review habitats within .25 miles of GGO nest sites and distance to nearest meadows.
 - c. Do the NFP standards and guidelines adequately protect existing habitat or provide long-term habitat for species targeted within the Plan?
 - d. What is required for the maintenance of these species or their habitat?

Table 2-13

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Current Veg.	Yes	1" = mile		

Description of General Analytical Process:

1. Use model of projected landscape under NWFP and known locations and analyze:
 - Great Grey - % of openings vs. closed canopy/OG over time.
 - 3-toed - snag levels.
 - Tree Vole - % of OG, dispersal corridors in OG condition.

Table 2-14

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Appendix J2/ Table C-3 spp. database	Yes	UPMA		Paradox database
FSEIS ROD WNF Plan	Yes	UPMA		paper
Map of potential habitat for these spp.	No	UPMA	GIS Veg layer, riparian layer, and SHAB layer	GIS

Description of General Analytical Process:

1. Check existing info for spp. presence in UPMA. and habitat requirements.
2. List documented sightings in UPMA.
3. List species that may potential occur in the UPMA.
4. List mgmt strategies and S&Gs required for Table C-3 species.

PRODUCT:

- Narrative, report and map or potential habitat for species.

Issue:

Because a portion of this watershed lies along the crest of the Cascades, it functions as an ecotone between east and west side ecosystems. Standards and Guidelines within the Northwest Forest Plan that pertain specifically to westside systems may not be appropriate for this area.

- a. What areas within the watershed function as an ecotone?
- b. What eastside S&G's within the NWF Plan are more applicable to this area?

Table 2-15

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Veg series map	Yes			

Description of General Analytical Process:

1. Review series near crest for disturbance histories and applicability of eastside S & G's.

Issue:

The watershed must continue to contribute to the recovery of several threatened and endangered species, and also maintain or increase the populations of rare or sensitive species.

- a. What TES species are known to occur or potentially occur within this watershed?
- b. What is the condition of their populations and habitat?

Table 2-16

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Documented sighting reports of sensitive plants	Yes V020	UPMA		paper and GIS point layer
Non-forested habitats	Have some info and currently collecting V012	UPMA	Aerial photos	GIS

Description of General Analytical Process:

1. Assess habitat quality and viability of species. Assess the potential habitat for sensitive plants in UPMA.

PRODUCT:

- List of documented species in UPMA. and quality of their habitat. List of sensitive spp. that may potentially be found in the watershed. List habitat types for future surveys.

- c. What is the status of the TE species recovery, and how must this landscape contribute?

Table 2-17

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
TE species map	Yes			
50-11-40& Take & CHU analysis	Yes			
LSR analysis LSR's map	Yes			
Habitat around lakes	Yes			
Cliff Habitat	Yes			

Description of General Analytical Process:

1. Map of capable, current and potential owl habitat. Compare with 11-40 rule.
2. Analyze land allocations dispersal habitat exists in.
 - Analyze acres of OHAB within 1.2 miles of sites.
 - Analyze acres of owl habitat in LSR's.
 - Map late successional habitat around lakes and reservoirs.
 - Map cliff habitat.

Issue:

Road right of ways may not be meeting all legal or environmental obligations (i.e. maintenance and "take" issues).

- a. Does potential exist for conflicts between access administration and taking of threatened or endangered species?
- b. Does potential exist for conflicts between access administration and maintenance?

Table 2-18

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Map of road right of ways	NO	1" mile	See Pat Hutchins	Hard copy

Description of General Analytical Process:

1. Route map of existing right-of-ways to team to see if conflicts exist.
2. Write a narrative.

Table 2-19

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Map of private timber inholdings	Yes	1"		
Map of F.S. roads that may access these properties	Yes	1"		
Data on owls in take situation	Yes	1"		
Location of peregrine sites	Yes	1"		

Description of General Analytical Process:

1. Overlay maps above to see what private inholdings are in the vicinity of peregrine and owl sites.
2. Review road access to identify Forest Service roads that could be used to haul timber from private lands.

Issue:

The majority of sensitive and rare plant species that are known or suspected to occur in the watershed occupy non-forested areas (special habitats). These areas, though protected by S&G's, are generally unmapped and unsurveyed. It is unknown what their current contribution to biodiversity on the landscape is or what threats may need to be recognized.

- a. Where and what kind of special habitats are present within the watershed?
- b. Are there special habitats within the watershed that have limited distribution across the watershed/Forest/ or Region?
- c. What threatens the continued stability or functioning of these special habitats?
- d. What wildlife and botanical species of interest are associated with these areas?

Table 2-20

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
SHAB identified and typed	Some V012	UPMA	Aerial photos	photos
Field verification of selected SHABs	Some V012	UPMA	Past field inventories, and current field reconnaissance.	paper
Past and current mgmt activities near SHABs	Some	UPMA	Harvest areas identified District personal.	GIS, paper, per. com.

Description of General Analytical Process:

1. Aerial photo interpretation for SHABs. Digitize into GIS. Assess stability of SHABs across the watershed. Assess mgmt activities around SHABs.

PRODUCT:

- Narrative and GIS map.

Table 2-21

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Special habitat map	Yes		Use SRI, special features, and manuscripting	
Franklin and Dyrness reports	Yes			
Forest analysis	Yes			
WHR database	Yes			

Description of General Analytical Process:

1. Research on distribution.
2. Research on threats.
3. Query WHR for species associated.

Issue:

Important geological resources may be at risk from management activities and knowledge of their locations may be lost.

a. Are there areas of unique geologic research value (fossils or formations) that could be damaged or destroyed by management activities?

Table 2-22

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Location areas of fossils, or geologically unique areas of research or interpretive value	Yes No		Literature search of UofO, DOGAMI, and personal interviews with geology/geography dept. staff at UofO/OSU/District.	

Description of General Analytical Process:

1. Determine if areas exist in the watershed that should be protected under American Antiquities Act, or areas that contain geologic formations of unique research and interpretive value.
 - Literature search and personal interviews with UofO, OSU, and State Department of Geology staff.
 - Produce map of any previously unknown areas.

Issue:

Transmission line corridors may be impacting riparian areas, water quality, wildlife habitat, recreation developments, and heritage resources.

a. Have the transmission line corridors facilitated the invasion and establishment of noxious weeds?

Table 2-23

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Presence of noxious weeds in line corridors.	Some	Transmission lines in UPMC	Aerial photo interpretation.	Photos
Past TES surveys	Some V020	UPMA		Paper
Past records	Yes	UPMA	Check with Pat Hutchins for original records.	Paper
EWEB info, past work in corridors.	Yes	UPMA		

Description of General Analytical Process:

1. Cross reference early aerial photos with latest aerial photos for presence of noxious weeds/ground disturbance.
2. Read through original papers of project. Read past BE's for documentation of noxious weeds.

b. Where has riparian/upland vegetation, water quality, and stream channel processes been modified by maintenance of vegetation within transmission line corridors?

c. What is the effect of transmission line corridors on wildlife species?

Table 2-24

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Map of corridor	Yes	1"		
Map of TES and other special habitats	Yes	1"		

Description of General Analytical Process:

1. Overlay and review impacts.

Issue:

Trailbridge Reservoir flats and Carmen Reservoir, which resulted from the construction of the Carmen/Smith project, are experiencing soil compaction, noxious weed invasion and establishment, and the loss of native vegetation.

- a. What are the current vegetative and soil conditions of these areas?
- b. What actions compatible with the recreation goals for the area are needed to correct or improve these areas?

Table 2-25

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Reports and personal communications	Yes	Trailbridge and Carmen areas		Paper per. com.

Description of General Analytical Process:

1. Assess current conditions of areas. Identify potential activities that may be implemented to improve the current conditions.

PRODUCT:

- Narrative.

SOCIAL AND ECONOMIC DOMAIN

Issue:

There may be conflicts between economic growth and resource conditions. Demands influencing campgrounds, wildlife (hunting and viewing), fishing regulations may change visitor use.

- a. What actions in the future may change the tourism generated economic benefits to the local economy?

Table 3-1

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Existing Visitors Profile	Yes		Reports on Scenic Byway, State Scorp.	
Amount of Existing Use	Yes		RRIS for past 5 years.	

Description of General Analytical Process:

1. Sources include- A Report prepared by Dean Rynyan Associates conducted for the McKenzie Pass/Santiam Pass National Scenic Byway Interpretive Plan, entitled "Interpretive Audience Analysis, The Central Cascades, Oregon. The report consists of a visitor profile and visitor demographics, and focus on the visitors who would be going to recreation destinations within this watershed analysis area. Another report is "Initial Social Assessment of Proximate Communities for the Central Cascades Adaptive Management Area (1/95) by Bruce Shindler, et al, Oregon State University. SCORP report for Oregon will also provide some demand trends for different recreation activities. A draft report on the issue of privatization of future recreation developments on National Forests will also be reviewed for information. Marketing of National Forests by State Tourism Boards.

Issue:

Significant recreational use of the Upper McKenzie may be focused on use of fishery resources. Conflicts over the use of this resource may occur in the future as use increases.

- a. What is the economic and sociological contribution of fisheries in the Upper McKenzie sub-basin?

Issue:

In some locations, conflicts exist among some recreationist who are participating in various legitimate recreational activities on the forest.

- a. Where do conflicts currently occur between recreationists?

Table 3-2

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Opinions of Recreation managers	No		Discuss among Trails/Wilderness/Developed Sites/Winter Sports etc.	Narrative.

Description of General Analytical Process:

1. Discussion of water skiers and fishing at Big Lake; use of campgrounds by large groups who actually need a group reservation area; campgrounds having reservation vs. users who want spontaneity; large groups who want to hike and party sizes in wilderness; snow play vs. x-country vs. snowmobile; horse users looking for day rides having primarily wilderness trails available where conflicts with hikers can occur. Draw some conclusions, where possible, about what these conflicts mean for existing and future capacities for various recreation opportunities.

Issue:

Parts of this watershed area are used by ATV's (all terrain vehicles), which can impact vegetation, soils and botanical/wildlife resources.

- a. Where within the watershed is ATV use prevalent? and where and how is the use impacting other resources?

Table 3-3

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Map of ATV Travel Areas	Yes	1" Mill?	Larry Wilson	Hard Copy
Numbers, Types, of ATV's	No		Jim Denney's 94 Season information on ATV Encounters.	Narrative.

Description of General Analytical Process:

Document the 1994 season field contacts by Jim Denney with ATV riders in the Big Lake Burn Area. Summarize the numbers of riders encountered and label routes by types of riders and low, medium, high use. Use Larry Wilson's map of the burn and show his estimates of erosion damage by different routes. Have this information reviewed by specialists for resource damage potentials and recommendations.

Issue:

Enforcement of heritage resource preservation and artifact protection laws is a problem. Few forest visitors are aware that even the waste material (i.e., flakes) of obsidian tool protection is protected by law from illegal collecting.

- a. To what extent are prehistoric heritage resources being damaged by illegal collecting?

Table 3-4

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Info on Forest Visitor behavior	No		Questionnaire survey (?)	
Info on Arch. site changes	P001	Good	Review original site forms, updates, and monitoring forms	Paper - reports
Evidence for theft	No		Stratified sample survey of known sites	
LEO records	Yes	Unk	Interview LEO	

Description of General Analytical Process:

1. Draft a mailing questionnaire, send to user groups; interpret results.
2. Review site files, compile listing on site condition changes.
3. Summarize data and findings to answer questions.
4. Interview LEO's.

Issue:

Administration, grazing, and recreation uses at Fish Lake may be impacting heritage resources.

- a. To what extent is use of Fish Lake impacting heritage resources?

Table 3-5

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Info on admin use changes to buildings	No	Individual buildings	Interview with Jim Denney; field observer	
Data regarding arch. site changes in lakebed	P001/ No	Some good info; needs update (lakebed)	Interview with Jime Denney; field inspection of SWR.	Paper - Reports

Description of Analytical Process:

1. Interview Fish Lake guard regarding data needed above, conduct field survey when snow clears.
2. Summarize results and info in site files and Oracle data base.

Issue:

Recreational use is resulting in damage to severe historic structures.

- a. What historical structures/areas occur within the watershed?

Table 3-6

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Comprehensive listing of list, structures	P001; Oracle data base	Quads; point specific, too.	File review; base map review.	Paper - Reports
Comprehensive listing of areas	P001/ No		Back ground research; file review.	Uport/ map overlay

Description of General Analytical Process:

1. Review base maps, plot sites/structures/areas on GIS; output map and prepare listing; overlay on basemap of watershed.
- b. What damage is occurring to the structures?

Table 3-7

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Damage assessment	P001/ No	Building specific	Interviews; field surveys.	Paper - reports

Description of Analytical Process:

1. Interview those "in the know" - field surveys of buildings when access clears.
2. Summary report to answer questions.
3. Reviews of HR building files.
4. Arrange for damage assessments.

- c. Where are unacceptable levels of damage occurring?

Table 3-8

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Definition of what is acceptable	Sec'y of interior standards	National standards	Research regs, interview Forest Arch.	Summary report
Application of standards to damage assessments	No	Buildings specific	Compare with damage assessments.	Summary report

Description of General Analytical Process:

1. Office review of regulations, consultation with Forest Archeologist.

Issue:

Impacts to the scenic quality of natural features may be occurring from degradation caused by rock sources, insect and disease mortality, and harvest units.

- a. What existing conditions are inconsistent with the Scenic Byway, Wild and Scenic River, and Forest Plan?

Table 3-9

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
LMP layer on GIS	Yes	1" mile	Done - except for updates to 12A, Developed Sites.	
Review Forest Plans, Scenic Byway, W & S River	Yes		Read Plans	Narrative

Description of General Analytical Process:

1. Use the ROS/VQO/VEGIS analysis in Recreation Question 1, use description as a starting point, from the Scenic Byway Appendix. Contact Bob Loncore for specialist's input and description.

Issue:

Prescribed Natural Fire (natural or management ignited) is within designated Class 1 airsheds which may be limited by air and good visibility, and the ecological need for using PNF as an ecosystem management tool, may conflict.

- a. What was the historical air quality 1850-1900?

Table 3-10

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Estimate of PM-10 and acres burned	Yes	Region west Oregon	Review existing work	Table Text

Description of General Analytical Process:

1. Research and Document existing work as a reference to this WA.
- b. What is the current NAAQS and benchmark for our areas?

Table 3-11

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Standards	Yes	Wild/non-wild	Read and Cite	Text
Curent Aug. status of summer airshed	Yes	Region	Read and Cite Smoke mgmt reports	Text Table

Description of General Analytical Process:

1. Research and document smoke management reports for past few years.

Issue:

Allocations of funds have been too limited to accomplish all land adjustments of those lands may be a benefit to resources on those and surrounding parcels.

a. Which parcels of land are available? and what are the resource benefits of Government ownership of each?

b. What are the priorities for acquisitions based on resource benefits?

Table 3-12

DATA NEEDED	EXIST?	RESOLUTION	COLLECTION METHODS	MEDIA
Discuss Land Potentials.			Pat and Phil	Narra- tive
Draw out map of potentials.	No	1" mile		Hard Copy

Description of General Analytical Process:

1. Route private land with forest zoning to team, see if any adjacent private lands appeal important for National Forest Management goals?.

APPENDIX D
PUBLIC INVOLVEMENT

PUBLIC INVOLVEMENT

An effort to contact interested publics and organizations occurred through several processes over the course of the analytical process:

1. The Watershed Analysis Team conducted a public meeting on Feb. 28, 1995 to discuss the watershed with interested publics.
2. A draft of the significant issues was published in the McKenzie Ranger District Quarterly Newsletter in March, 1995.
3. A draft of the significant issues was mailed to publics and organizations on the McKenzie and Sweethome Ranger District's mailing lists. Comments received were reviewed by the WA team.
4. Each team member contacted a variety of publics and counterparts in other agencies to obtain available information.
5. The draft significant issues were given to the McKenzie Watershed Council for review and comment.

APPENDIX E
ADDITIONAL DATA

SILVICULTURE APPENDIX

OVERVIEW OF DEVELOPMENT PATTERNS

(Adapted from Oliver and Larsen 1990).

Stand development after a stand-replacing disturbance—

Stages of development:

Stand Initiation Stage:

Growing space is reoccupied following a stand-replacing disturbance, such as fire.

Stem Exclusion Stage:

Occurrence of new tree stems is excluded by limits on light or moisture. The canopy is closed and crowns recede.

Understory Re-initiation Stage:

Second cohort established under older overstory. Mortality in the overstory creates growing space for new trees in the understory.

Old-growth Stage:

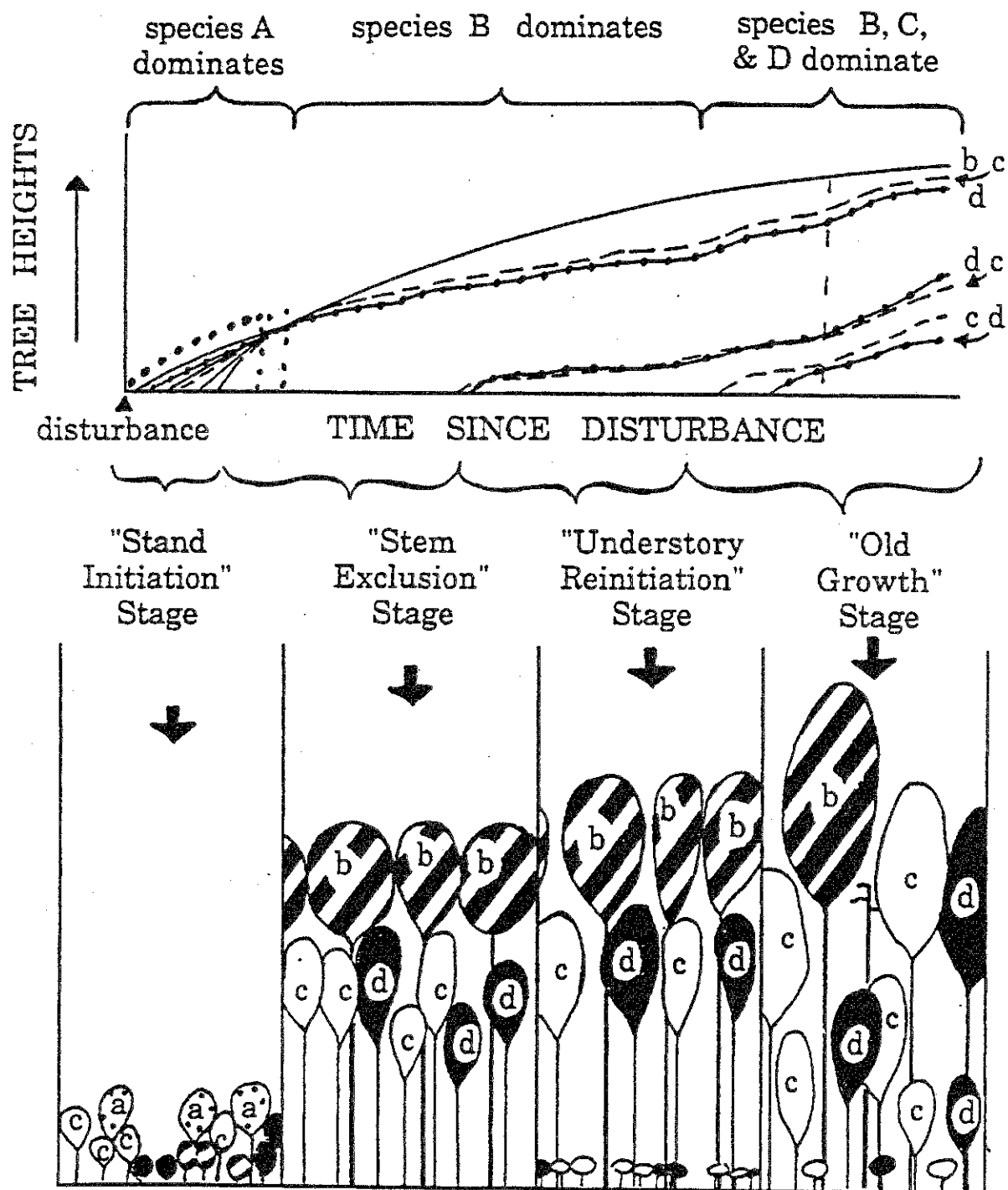
Multi-cohort, multi-strata stands with large, old trees.

Stand Development after minor disturbances—

Uneven-Age, All-aged, Multi-cohort:

These stands develop after disturbances that leave much of the original stand intact. Minor disturbances can include fire, logging, windthrow, insects and diseases. Single trees or cohorts become established in the created openings. The number of ages can be affected by the degree and frequency of the disturbance.

Development Patterns



ACRES SUITABLE AND AVAILABLE IN THE WATERSHED

The total Upper McKenzie Watershed contains about 230,924 acres. After subtracting areas set-aside by Congress, areas set-aside by the Willamette Forest Plan, and areas set-aside by the President's Forest Plan (including riparian reserves), the watershed contains about 85,453 acres suitable and available for timber management. This amount is about 37% of the watershed.

Stand development descriptions used throughout the Upper McKenzie Watershed analysis.

TREE SIZE DESCRIPTION	STAGES OF DEVELOPMENT (C.Oliver 1990)	WILDLIFE HABITAT DESCRIPTION	DBH	SERIAL STAGE	SIZE CLASS	PSME SITE IV	ABGR SITE III	TSHE SITE II	TSHE SITE III	ABAM SITE IV	ABAM SITE V	TSME SITE IV
SEEDLING	Stand Initiation	Grass/forb/shrub	>6" TALL	EARLY	1	E	E	E	E	E	E	E
SEEDLING AND SAPLING	"	Open Sapling-pole	1" - 5"	EARLY	1.5	E	E	E	E	E	E	E
SAPLINGS	"	"	1" - 5"	EARLY	2	M	E	E	E	E	E	E
SAPLINGS AND POLES	Stem Exclusion	"	1" - 5"	EARLY	2.5	M	M	M	M	M	M	M
POLES	"	Closed Sapling Pole	5" - 9"	MID	3	M	M	M	M	M	M	M
POLES AND SMALL TREES	"	Open Small Conifer	5" - 9"	MID	3.5	M	M	M	M	M	M	M
SMALL TREES	"	Closed Small Conifer	9" - 21"	MID	4	M	M	M	M	M	L	M
SMALL & MEDIUM TREES	Understory Reinitiation	"	9" - 21"	MID	4.5	L	M	M	M	L	L	L
MEDIUM TREES	"	Large Conifer	21" - 32"	LATE	5	L	L	L	L	L	L	L
MEDIUM AND LARGE TREES	"	"	21" - 32"	LATE	5.5	L	L	L	L	L	L	L
LARGE TREES	Old Growth	Old Growth	32" - 48"	LATE	6	L	L	L	L	L	L	L
LARGE AND GIANT TREES	Old Growth	"	32" - 48"	LATE	6.5	L	L	L	L	L	L	L
GIANT TREES	Old Growth	"	> 48"	LATE	7	L	L	L	L	L	L	L
PSME: Douglas Fir ABGR: Grand Fir TSHE: Western Hemlock ABAM: Pacific Silver Fir TSME: Mt. Hemlock												

BOTANY APPENDIX

Modifying Riparian Reserves:

The draft Terrestrial Ecology Addendum (1995) contains a list of survey and manage species and other riparian zone plants that must be considered prior to modifying riparian reserve boundaries. Species range and habitat was analyzed, species not suspected to occur in the watershed were deleted. Only vascular plants were deleted from list.

Survey and Manage Species:

Bryophytes:

Kurzia makinoana

Marsupella emarginata var. *aquatica*

Scouleria marginata

Tritomaria exsectiformis

Lichens:

Cetrelia cetroids

Collema nigrescens

Dermatocarpon luridum

Hydrothyria venosa

Leptogium burnetiae var. *hirsutum*

Leptogium cyanescens

Leptogium rivale

Leptogium saturninum

Leptogium teretiusculum

Platismatia lacunosa

Ramalina thrausta

Usnea longissima

Fungi:

Galerina sphagnicola

Helvella compressa

Helvella crassitunicata

Helvetia elastica

Helvetia maculata

Polyozellus multiplex

Phlogiotis helvelloides

Rickenella setipes

Vascular Plants:

Botrychium minganense

Coptis trifolia

Corydalis aguae-gelidae

Habenaria orbiculata

Non Survey and Manage Species:**Vascular Plants:**

Adiantum pedatum
Aralia californica
Asarum caudatum
Dryopteris austriaca
Gymnocarpium dryopteris
Habenaria saccata
Lysichiton americanum
Menziesia ferruginea
Mitella breweri
Mitella caulescens
Mitella ovalis
Mitella pentandra
Poa laxiflora
Scoliopus hallii
Streptopus amplexifolius
Streptopus roseus
Taxus brevifolia
Thuja plicata
Tiarella unifoliata
Vaccinium membranaceum
Viola glabella

Survey and Manage Plant Species Found in the Watershed

Species	Category	Survey Strategy	Location
<i>Cantharellus cibarius</i>	Chantrelle	3,4	
<i>Gautieria magnicellaris</i>	Rare False Truffle	1,3	Mt Washington Wilderness.
<i>Rhizopogon atroviolaceus</i>	False Truffle	3	Santiam Pass, Airstrip burn.
<i>Rhizopogon inquinatus</i>	Rare False Truffle	1,3	Tombstone Pass.
<i>Thaxterogaster pingue</i>	False Truffle	3	Lost Lake, Scott Lake, Tombstone Prairie.
<i>Plectania melastoma</i>	Uncommon Cup Fungi	3	Deer Creek.
<i>Lobaria oregana</i>	Nitrogen-fixing Lichen	4	Mature and old-growth forests below 3000'.
<i>Lobaria scrobiculata</i>	Nitrogen-fixing Lichen	4	Mature and old-growth forests below 3000'.
<i>Nephroma occultum</i>	Rare Nitrogen-fixing Lichen	1,3	Fish Lake Creek.
<i>Nephroma resupintum</i>	Nitrogen-fixing Lichen	4	Near Fish Lake Creek, upstream from Clear Lake.
<i>Pseudocyphellaria rainierensis</i>	Rare Nitrogen-fixing Lichen	1,2,3	Koosah Falls
<i>Tholuma dissimilis</i>	Rare Leafy (arboreal) Lichen	1,3	Iron Mtn.
<i>Allotropa Virgata</i>	Vascular plant	1,2	MK-1010,6555,6584,6592,6593,6594,6604,6607,6612,6669,6673,6723,8317,8327,8331,8332.
<i>Botrychium montanum</i>	Vascular plant	1,2	Browder & Pyramid Creek.

Noxious Weeds Found in the Watershed

Common Name	Scientific Name	Distribution	Biological Control
Spotted knapweed	<i>Centaurea maculosa</i>	Patchy	Yes
Canada Thistle	<i>Cirsium arvense</i>	Widespread	Yes
Bull Thistle	<i>Cirsium vulgare</i>	Widespread	Yes
Scotch-broom	<i>Cytisus scoparius</i>	Widespread	Yes
St. John's-wort Wa	<i>Hypericum Perforatum</i>	Widespread	Yes
Tansy ragwort	<i>Scencio jacobaea</i>	Patchy	Yes

Non-Native Plants Found in the Watershed *

Common Name	Scientific Name	Distribution	Biological Control
Bentgrass	<i>Agrostis alba</i>	Isolated	
Bitter wintercress	<i>Barbarea vulgaris</i>	Isolated	
Field mustard	<i>Brassica campestris</i>	Isolated	
Oxeye daisy	<i>Chrysanthemum leucanthemum</i>	Isolated	
Orchard grass	<i>Dactylis glomerata</i>	Patchy	
Queen Anne's-lace	<i>Daucus carota</i>	Patchy	
Teasal	<i>Dipsacus fullonum</i>	Isolated	
Wall lettuce	<i>Lactuca muralis</i>	Patchy	
Yellow toadflax	<i>Linaria vulgaris</i>	Isolated	
Annual rye	<i>Lolium perenne</i>	Patchy	
Bird's foot trefoil	<i>Lotus corniculatus</i>	Patchy	
Common forget-me-not	<i>Myosotis scorpioides</i>	Isolated	
Reed Canarygrass	<i>Phalaris arundinacea</i>	Isolated	
Common Timothy	<i>Pheum pratense</i>	Patchy	
Common Plantain	<i>Plantago lanceolata</i>	Widespread	
Kentucky bluegrass	<i>Poa pratensis</i>	Patchy	
Sealheal	<i>Prunella vulgaris</i> var. <i>vulgaris</i>	Widespread	
Himalaya blackberry	<i>Rubus discolor</i>	Patchy	
Evergreen Blackberry	<i>Rubus laciniatus</i>	Patchy	
Red Sorrel	<i>Rumex acetosella</i>	Widespread	
Dandelion	<i>Taraxacum officinale</i>	Patchy	
Red clover	<i>Trifolium pratense</i>	Patchy	
White clover	<i>Trifolium repens</i>	Patchy	
Common mullen	<i>Verbascum thapsus</i>	Isolated	
* Excluding Wilderness Areas.			

***Allotropa vigata** locations in the Upper McKenzie Watershed.**

Landblock	Ecoplot	Plant Association	% of Coverage	Township	Range	Section	Elevation	RD
2A	6604	TSHE/ RHMA- BENE	1.00	15.00	6.00	4	2500	MK
2A	6723	TSHE/ RHMA- BENE	1.00	15.00	6.00	9	2540	MK
2B	6612	TSHE/ RHMA- BENE	1.00	14.00	6.00	35	2540	MK
3	6673	ABGR/ ARUV	1.00	13.00	7.00	15	3800	MK
3	8327	ABGR/ ARUV	1.00	13.00	7.00	15	3800	MK
4	8331	ABGR/ ARUV	1.00	13.00	7.00	32	3120	MK
4	6669	ABGR/ ARUV	1.00	14.00	7.00	9	3250	MK
4	1010	TSHE/ BENE	1.00	14.00	7.00	17	3100	MK
5	8332	TSHE/ RHMA- BENE	1.00	15.00	6.00	36	2900	MK
5	6584+	TSHE/ RHMA- GASH	1.00	15.00	7.00	17	2860	MK
5	6592	TSHE/ BENE	1.00	16.00	6.00	2	2000	MK
5	6593+	TSHE/ RHMA- GASH	1.00	16.00	6.00	2	2150	MK
5	6594+	TSHE/ RHMA- GASH	1.00	16.00	6.00	2	2180	MK
5	6555	TSHE/ RHMA/ LIBO2	1.00	15.00	6.00	36	3200	MK
6	8317	PSME- TSHE/ BENE	1.00	16.00	6.00	11	1600	MK
6	6607	TSHE/RHM A- GASH	1.00	16.00	6.00	15	2160	MK
* FEIS ROD Survey strategy 1: manage known sites, 1995. + Uncommon plant association in the watershed.								

Rare Forested Plant Associations in the Upper McKenzie Watershed.

Plant Association	Ecoplot	Landform Block
PSME/HODI-WHMO	6143	1 & 2B
PSME/HODI/GRASS	6602	2A
PSME-TSHE/BENE	Browder Ridge	2B
ABGR/BENE	Browder Ridge	2B
ABAM/RHAL/XETE	563	4
ABGR/CHUM	8328	4
PSME/HODI-WHMO	8338	5
PSME/SYMO	11164 & 11165	5
PSME/SYMO	11179	5
PSME/SYMO	6570 & 6624	5
PSME/SYMO	6581	5
SHAB MGMT GUIDE 1993: Rare: ≤ 5 sites on district;		

Unique Forested Plant Associations in the Upper McKenzie Watershed

Plant Association	RD Rating	Landform Block	Number of ecoplots
ABAM/RHMA-BENE	MK - C	2A	1 ecoplot
ABAM/RHMA-BENE	SH - U-C	2B	1 ecoplot
ABAM/RHMA-VAAL/COCA	SH - C	2B	2 ecoplots
ABAM/RHMA/XETE	MK - C	2B	1 ecoplot
ABAM/RHMA/XETE	SH - C	2B	4 ecoplots
ABAM/VAAL/COCA	SH - C	2B	2 ecoplots
ABCO	MK	4	2 ecoplots
TSHE/BENE/OXOR	MK - C	1	3 ecoplots
TSHE/LIBO2	MK - C	2A, 4 & 5	4 ecoplots
TSHE/RHMA-GASH	MK - C	5	5 ecoplots
TSHE/RHMA-VAAL/COCA	MK - C	5	1 ecoplot
TSHE/RHMA/XETE	MK - C	5	3 ecoplots
TSME/LUZULA	MK -U-C	5	1 ecoplot
Based on 305 ecoplots in watershed with forested plant associations. McKenzie Rd. 268 ecoplots & Sweet Home Rd. 37 ecoplots. SHAB MGMT GUIDE 1992: Rare: ≤ 5 sites on district; Uncommon: 6-11 sites on district; Common: > 11 sites on district.			

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Bryophytes

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Antitrichia curtipendula</i>	2	LS/OG	RZ, M/W	HW/C	low
<i>Bartramioopsis lescunii</i>	4	LS/OG	LDD		
<i>Douinia ovata</i>	3	LS/OG	RZ, M/W, RO		low to mid
<i>Encalypta brevicollis</i> var. <i>crumiana</i>	4	LS/OG	M/W, RO		
<i>Herbertus aduncus</i>	3	LS/OG	M/W, RO		low to high
<i>Kurzia makinoana</i>	3	LS/OG	RZ, LDD, M/W		low
<i>Marsupella emarginata</i> var. <i>aquatica</i>	3		RZ		mid to high
<i>Plagioclila satoi</i>	3	LS/OG	LDD, RO		low
<i>Ptilidium californicum</i>	1	LS/OG	LDD, M/W	ABCO	high
<i>Scouleria marginata</i>	3		RZ		
<i>Tetraphis geniculata</i>	3	LS/OG	LDD, M/W		low to mid
<i>Thamnobryum neckeroides</i>	5		M/W, RO		mid to high
<i>Tritomaria exsectiformis</i>	3	LS/OG	RZ, RO		low to high
<i>Tritomaria quinqueidentata</i>	3	LS/OG	RO		

Fungi - Mycorrhizal

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Albatrellus avellaneus</i>	3	LS/OG			
<i>Albatrellus ellisii</i>	3	LS/OG			
<i>Albatrellus flettii</i>	3	LS/OG			
<i>Alpova alexsmithii</i>	3	LS/OG		Abies spp., TSME	mid to high
<i>Alpova</i> sp. nov. # Trappe 9730	1	LS/OG		PSME	mid
<i>Arcangeliella crassa</i>	3	LS/OG	LDD	Abies spp., TSME	mid to high
<i>Boletus haematinus</i>	3			Abies spp.	high
<i>Boletus pulcherrimus</i>	3	LS/OG			low to mid
<i>Cantharellus cibarius</i>	1	LS/OG, 2G	LDD		
<i>Cantharellus formosus</i>	3	LS/OG	LDD		
<i>Cantharellus subalbidus</i>	3	LS/OG, 2G	LDD		
<i>Cantharellus tubaeformis</i>	3	LS/OG	LDD		
<i>Catathelasma ventricosa</i>	4	LS/OG			low to mid

Rating: 1=Species present; 2=Species highly probable; 3=Species suspected; 4=Insufficient data on habitat and/or range to determine status; 5=Species not listed in Table C-3; listed in Appendix J2.

Seral Stage: LS/OG=late successional/oldgrowth; 2G=2nd growth.

Habitat: RZ=riparian zones; LDD=litter, down & duff; M/W=mesic/wet; D=dry; RO=rock outcrops, cliffs.

Trees: ABAM=Abies amabilis-Pacific silver fir; ABCO=Abies concolor-White fir; ABGR=Abies grandis-Grand fir; ABLA=Abies lasiocarpa-Subalpine fir;

ABPR=Abies procera-Noble fir; HW/C=hardwoods & conifers; PICO=Pinus contorta-Lodgepole pine; PIMO=Pinus monticola-Western white pine;

PSME=Pseudotsuga menziesii-Douglas-fir; THPL=Thuja plicata-Western redcedar; TSHE=Tsuga heterophylla-Western hemlock;

TSME=Tsuga mertensiana-Mountain hemlock.

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Fungi - Mycorrhizal

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Choiromyces alveolatus</i>	3	LS/OG	LDD	Abies spp., TSME	mid to high
<i>Choiromyces venosus</i>	3	LS/OG		HW/C, PSME	
<i>Chroogomphus loculatus</i>	3	LS/OG			mid
<i>Cortinarius azureus</i>	3	LS/OG			low to high
<i>Cortinarius boulderensis</i>	3	LS/OG			low to high
<i>Cortinarius canabarpa</i>	4	LS/OG	LDD		
<i>Cortinarius cyanites</i>	3	LS/OG			low to high
<i>Cortinarius magnivelatus</i>	3	LS/OG			low to high
<i>Cortinarius olympianus</i>	3	LS/OG			low to high
<i>Cortinarius rainierensis</i>	4	LS/OG	LDD		
<i>Cortinarius spilomius</i>	3	LS/OG			low to high
<i>Cortinarius tabularis</i>	3	LS/OG			low to high
<i>Cortinarius valgus</i>	3	LS/OG			low to high
<i>Cortinarius variipes</i>	4	LS/OG	LDD		
<i>Dermocybe humboldtensis</i>	4	LS/OG			low
<i>Destuntzia fusca</i>	3	LS/OG		HW/C, Abies spp., PSME, TSHE	low
<i>Elaphomyces subviscidus</i>	3	LS/OG		Pinus spp.	mid
<i>Gastroboletus imbebellus</i>	3	LS/OG		Pinus spp.	mid to high
<i>Gastroboletus ruber</i>	3	LS/OG	LDD	TSME	mid to high
<i>Gastroboletus subalpinus</i>	3	LS/OG	LDD	PICO	high
<i>Gautieria magnicellaris</i>	1	LS/OG		Abies spp., TSME	high
<i>Glomus radiatum</i>	3	LS/OG	M/W		
<i>Gomphus bonarii</i>	3	LS/OG			
<i>Gomphus clavatus</i>	3	LS/OG			
<i>Gomphus floccosus</i>	3	LS/OG			
<i>Gomphus kauffmanii</i>	3	LS/OG			
<i>Gymnomyces</i> sp. nov. # Trappe 1690, 1706, 1710	1	LS/OG		ABAM, ABGR, ABPR, TSME	mid
<i>Hebeloma olympiana</i>	3	LS/OG			low to high
<i>Hydnum repandum</i>	3	LS/OG, 2G			
<i>Hydnum umbilicatum</i>	3	LS/OG, 2G			
<i>Hygrophorus caeruleus</i>	3	LS/OG			low to high

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Fungi - Mycorrhizal

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Ramaria concolor</i> f. <i>tsugina</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria coulterae</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria cyaneigranosa</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria fasciculata</i> var. <i>sparsiramosa</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria gelatiniaurentia</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria gracilis</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria hilaris</i> var. <i>olympiana</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria largentii</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria lorithamnus</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria maculatipes</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria rainierensis</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria rubella</i> var. <i>blanda</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria rubribrunnescens</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria rubrievanescens</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria rubripermanens</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria spinulosa</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria stuntzii</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria suecica</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria thiersii</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria verlotensis</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Rhizopogon abietis</i>	3	LS/OG		Abies spp., PIMO	high
<i>Rhizopogon atroviolaceus</i>	1	LS/OG		Abies spp., PIMO	high
<i>Rhizopogon brunneiniger</i>	3	LS/OG		Abies spp., PSME, TSHE	low to high
<i>Rhizopogon evadens</i> var. <i>subalpinus</i>	3	LS/OG		Abies spp., TSME	high
<i>Rhizopogon exiguus</i>	3	LS/OG		PSME, TSHE	low
<i>Rhizopogon flavofibrillosus</i>	3	LS/OG			mid to high
<i>Rhizopogon inquinatus</i>	3	LS/OG, 2G	LDD	PSME	
<i>Rhizopogon truncatus</i>	3	LS/OG		Abies spp., PIMO	high
<i>Russula mustelina</i>	3	LS/OG			low to mid
<i>Sarcodon fuscoindicum</i>	3	LS/OG, 2G		Abies spp., PSME, TSHE, Pinus spp.	
<i>Sarcodon imbricatus</i>	3	LS/OG, 2G		Abies spp., PSME, TSHE, Pinus spp.	

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Fungi - Mycorrhizal

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Hygrophorus karstenii</i>	3	LS/OG			low to high
<i>Hygrophorus vernalis</i>	3	LS/OG			low to high
<i>Leucogaster citrinus</i>	3	LS/OG	LDD	HW/C, PSME, TSHE	low to high
<i>Leucogaster microsporus</i>	3	LS/OG	LDD	PSME	mid
<i>Martellia idahoensis</i>	3	LS/OG		Abies spp.	mid to high
<i>Martellia monticola</i>	3	LS/OG	LDD	Abies spp., TSME	mid to high
<i>Nivatogastrium nubigenum</i>	3	LS/OG	LDD, D		mid to high
<i>Phaeocollybia attenuata</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia californica</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia carmanahensis</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia dissiliens</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia fallax</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia gregaria</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia kauffmanii</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia olivacea</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia oregonensis</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia piceae</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia pseudofestiva</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia scatesiae</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia sipei</i>	3	LS/OG	M/W		low to high
<i>Phaeocollybia spadicea</i>	3	LS/OG	M/W		low to high
<i>Phellodon atratum</i>	3	LS/OG, 2G		Abies spp., PSME, TSHE, Pinus spp.	
<i>Polyozellus multiplex</i>	3		RZ, M/W	Abies spp., Pinus spp.	mid to high
<i>Ramaria abietina</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria amyloidea</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria araiospora</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria aurantiiscescens</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria botryis</i> var. <i>aurantiiramosa</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria celerivirescens</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria claviramulata</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	
<i>Ramaria concolor</i> f. <i>marri</i>	3	LS/OG	LDD	Abies spp., PSME, TSHE, Pinus spp.	

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Fungi - Mycorrhizal

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Sedecula pulvinata</i>	4	LS/OG	LDD	ABLA, TSME	mid to high
<i>Thaxterogaster pingue</i>	1		LDD	Abies spp.	mid to high
<i>Tricholoma venenatum</i>	4	LS/OG	LDD		low to mid

Fungi - Saprobes

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Aleuria rhenana</i>	5	LS/OG	LDD		
<i>Aleurodiscus farlowii</i>	3	LS/OG	LDD		
<i>Asterophora lycoperdoides</i>	3	LS/OG	LDD		
<i>Asterophora parasitica</i>	3	LS/OG	LDD		
<i>Baeospora myriadophylla</i>	3	LS/OG	LDD		low to mid
<i>Bondarzewia montana</i>	3	LS/OG	LDD	Abies spp.	high
<i>Bryoglossum gracile</i>	5		M/W		high
<i>Chrysomphalina grossula</i>	3	LS/OG	LDD		low to mid
<i>Clavariadelphus borealis</i>	4	LS/OG	LDD, M/W	HW/C	
<i>Clavariadelphus ligula</i>	4	LS/OG	LDD, M/W	HW/C	
<i>Clavariadelphus lovejoyae</i>	4	LS/OG	LDD, M/W	HW/C	
<i>Clavariadelphus pistillaris</i>	4	LS/OG	LDD, M/W	HW/C	
<i>Clavariadelphus sechalinensis</i>	4	LS/OG	LDD, M/W	HW/C	
<i>Clavariadelphus subfastigiatus</i>	4	LS/OG	LDD, M/W	HW/C	
<i>Clavariadelphus truncatus</i>	4	LS/OG	LDD, M/W	HW/C	
<i>Clavicornia avellanea</i>	3	LS/OG	LDD, M/W		low to mid
<i>Clavulina cinerea</i>	3	LS/OG, 2G	LDD	HW/C	
<i>Clavulina cristata</i>	3	LS/OG, 2G	LDD	HW/C	
<i>Clavulina ornatipes</i>	3	LS/OG, 2G	LDD		
<i>Clitocybe senilis</i>	3	LS/OG	LDD, M/W		low to mid
<i>Clitocybe subditopoda</i>	3	LS/OG	LDD, M/W		low to mid
<i>Collybia bakerensis</i>	3	LS/OG	LDD		low to mid
<i>Cordyceps capitata</i>	3	LS/OG	LDD		
<i>Cordyceps ophioglossoides</i>	3	LS/OG	LDD		

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Fungi - Saprobes

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Cudonia circinans</i>	5	LS/OG	LDD		
<i>Cudonia monticola</i>	3	LS/OG	LDD		
<i>Cyphellostereum laeve</i>	3	LS/OG	M/W		
<i>Dichostereum granulosum</i>	3	LS/OG	LDD		
<i>Fayodia gracilipes</i> (rainierensis)	3	LS/OG	LDD		low to mid
<i>Galerina atkinsoniana</i>	3	LS/OG	M/W		
<i>Galerina cerina</i>	3	LS/OG	M/W		
<i>Galerina heterocystis</i>	3	LS/OG	M/W		
<i>Galerina sphagnicola</i>	3	LS/OG	RZ, M/W		
<i>Galerina vailliaeformis</i>	3	LS/OG	M/W		
<i>Gelatindiscus flavidus</i>	3	LS/OG			
<i>Grandinia microsporella</i>	5	LS/OG	LDD		
<i>Gymnopilus punctifolius</i>	3	LS/OG	LDD		low to mid
<i>Gyromitra californica</i>	3		RZ, LDD		
<i>Gyromitra esculenta</i>	3	2G	LDD	HW/C	
<i>Gyromitra infula</i>	3		LDD	HW/C	
<i>Gyromitra melaleucoides</i>	3		LDD		
<i>Gyromitra montana</i> (syn. <i>G. gigas</i>)	3		LDD		
<i>Helvella compressa</i>	3	LS/OG	RZ, M/W	HW/C	low to mid
<i>Helvella crassitunicata</i>	3	LS/OG	RZ, M/W		low to mid
<i>Helvella elastica</i>	3	LS/OG	RZ, M/W	HW/C	low to mid
<i>Helvella maculata</i>	3	LS/OG	RZ, M/W		low to mid
<i>Hypomyces luteovirens</i>	3	LS/OG	LDD		
<i>Marasmius applanatipes</i>	3	LS/OG	LDD		low to mid
<i>Mycena hudsoniana</i>	3	LS/OG	RZ, LDD	HW/C	low to mid
<i>Mycena lilacifolia</i>	3	LS/OG	RZ, LDD	HW/C	low to mid
<i>Mycena marginella</i>	3	LS/OG	RZ, LDD	HW/C	low to mid
<i>Mycena monticola</i>	3	LS/OG	RZ, LDD	HW/C	low to mid
<i>Mycena overholtsii</i>	3	LS/OG	RZ, LDD	HW/C	low to mid
<i>Mycena quinaultensis</i>	3	LS/OG	RZ, LDD	HW/C	low to mid
<i>Mycena tenax</i>	3	LS/OG	RZ, LDD	HW/C	low to mid

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Fungi - Saprobes

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Mythicomycetes corneipes</i>	3	LS/OG	LDD		low to mid
<i>Neourmula pouchetii</i>	3	LS/OG	LDD	TSHE, THPL	
<i>Otidea leporina</i>	3	LS/OG	LDD, M/W	HW/C	low to mid
<i>Otidea onotica</i>	3	LS/OG	LDD, M/W	HW/C	low to mid
<i>Otidea smithii</i>	3	LS/OG	LDD, M/W		low to mid
<i>Oxyporus nobilissimus</i>	3	LS/OG	LDD	ABPR	
<i>Phlebia diffusa</i>	5	LS/OG	LDD		
<i>Phlogotitis helevloides</i>	3	LS/OG	RZ, LDD		low to mid
<i>Pholiota albivelata</i>	3	LS/OG	RZ, LDD	HW/C	
<i>Phytoconis ericetorum</i>	3	LS/OG	LDD		
<i>Pithya vulgaris</i>	3			Abies spp.	high
<i>Plectania latahensis</i>	3	LS/OG	LDD		high
<i>Plectania melastoma</i>	1	LS/OG	LDD	HW/C	
<i>Plectania milleri</i>	3		LDD		high
<i>Podostroma alutaceum</i>	3	LS/OG	LDD		
<i>Polyporoletus sublividus</i>	5	LS/OG	LDD		
<i>Postia rennyii</i>	5	LS/OG	LDD		
<i>Rickenella setipes</i>	3	LS/OG	RZ, M/W		
<i>Sarcosphaera eximia</i>	3		D		
<i>Scytinostroma cf. galatinum</i>	5	LS/OG	LDD		
<i>Sparassis crispa</i>	3	LS/OG		PSME	low to mid
<i>Spathularia flavida</i>	3	LS/OG	LDD		low to mid
<i>Stagnicola perplexa</i>	3	LS/OG	LDD		

Lichen

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Calicium abietinum</i>	3	LS/OG		HW/C	
<i>Calicium adaequatum</i>	3	LS/OG		HW/C	
<i>Calicium adspersum</i>	3	LS/OG		HW/C	
<i>Calicium glauccellum</i>	3	LS/OG		HW/C	

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Lichen

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Calicium viride</i>	3	LS/OG		HW/C	
<i>Cetrelia cetrarioides</i>	3		RZ	HW/C	
<i>Chaenotheca brunneola</i>	3	LS/OG		HW/C	
<i>Chaenotheca chrysocephala</i>	3	LS/OG		HW/C	
<i>Chaenotheca ferruginea</i>	3	LS/OG		HW/C	
<i>Chaenotheca furfuracea</i>	3	LS/OG		HW/C	
<i>Chaenotheca subroscida</i>	3	LS/OG		HW/C	
<i>Chaenothecopsis pusilla</i>	3	LS/OG		HW/C	
<i>Cladonia norvegica</i>	3	LS/OG			
<i>Collema nigrescens</i>	3		RZ	HW/C	
<i>Cyphelium inquinans</i>	3	LS/OG		HW/C	
<i>Dendroscopaulon intricatum</i>	3	LS/OG	RZ, M/W	HW/C	low to mid
<i>Dermatocarpon luridum</i>	3	LS/OG	RZ		low to mid
<i>Heterodermia sitchensis</i>	4	LS/OG, 2G			
<i>Hydrothyria venosa</i>	3	LS/OG	RZ		low to mid
<i>Hygornia vittata</i>	4	LS/OG, 2G			
<i>Hypotrachyna revoluta</i>	3	LS/OG			high
<i>Leptogium burnetiae</i> var. <i>hirsutum</i>	3		RZ	HW/C	
<i>Leptogium cyanescens</i>	3		RZ	HW/C	
<i>Leptogium rivale</i>	3	LS/OG	RZ, RO		low to mid
<i>Leptogium satatinum</i>	3		RZ, RO	HW/C	low to high
<i>Leptogium teretiusculum</i>	3		RZ	HW/C	low to mid
<i>Lobaria hallii</i>	3		RZ, M/W	HW/C	low to mid
<i>Lobaria linita</i>	2	LS/OG	RO		mid to high
<i>Lobaria oregana</i>	1	LS/OG	M/W		low to mid
<i>Lobaria pulmonaria</i>	1	LS/OG	M/W, RO	HW/C	low to mid
<i>Lobaria scrobiculata</i>	1	LS/OG	M/W, RO		low
<i>Microcalicium arenarium</i>	3	LS/OG		HW/C	
<i>Mycocalicium subtile</i>	3	LS/OG		HW/C	
<i>Nephroma bellum</i>	3	LS/OG	M/W, RO		low
<i>Nephroma helveticum</i>	2	LS/OG	M/W, RO		low

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Lichen

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Nephroma isidiosum</i>	4	LS/OG, 2G	RO		mid
<i>Nephroma occultum</i>	1	LS/OG			low to mid
<i>Nephroma parile</i>	3	LS/OG	M/W, RO	HW/C	low
<i>Nephroma resupinatum</i>	1	LS/OG	M/W	HW/C	low
<i>Pannaria leucostictoides</i>	3	LS/OG	M/W		low
<i>Pannaria mediterranea</i>	3	LS/OG	M/W, RO		low
<i>Pannaria rubiginosa</i>	3	LS/OG			low to mid
<i>Pannaria saubinetii</i>	3	LS/OG	M/W, RO	HW/C	low to high
<i>Peltigera collina</i>	3	LS/OG	M/W, RO		low
<i>Peltigera neckeri</i>	3	LS/OG	LDD, M/W, RO		low
<i>Peltigera pacifica</i>	3	LS/OG	LDD, M/W		low
<i>Pilophorus nigricaulis</i>	3	LS/OG	RO		
<i>Pseudocyphellaria anomala</i>	2	LS/OG	M/W	HW/C	low
<i>Pseudocyphellaria anthraxis</i>	2	LS/OG	M/W		low
<i>Pseudocyphellaria crocata</i>	2	LS/OG	M/W		low
<i>Pseudocyphellaria rainierensis</i>	1	LS/OG			low to mid
<i>Ramalina thrausta</i>	3		RZ	HW/C	
<i>Stenocybe clavata</i>	3	LS/OG		HW/C	
<i>Stenocybe major</i>	3	LS/OG		HW/C	
<i>Sticta beauvoisii</i>	2	LS/OG	M/W		low
<i>Sticta fuliginosa</i>	2	LS/OG	M/W, RO	HW/C	low
<i>Sticta limbata</i>	2	LS/OG	M/W	HW/C	low
<i>Tholurna dissimilis</i>	1	LS/OG		Abies spp., PSME, TSME	high
<i>Usnea longissima</i>	2		RZ	HW/C	low to mid

Vascular Plants

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Allotropa virgata</i>	1	LS/OG	LDD, D	ABAM, ABGR, PSME, TSHE, PICO	low to high
<i>Arceuthobium tsugense</i>	2	LS/OG		TSHE	mid to high
<i>Botrychium minganense</i>	2	LS/OG	RZ, M/W	THPL	mid

Appendix Table C-3 Survey & Manage Species: Bryophytes, Fungi, Lichen, Vascular Plants

Vascular Plants

<u>Species</u>	<u>Rating</u>	<u>Seral Stage</u>	<u>Habitat</u>	<u>Trees/Genus/Species</u>	<u>Elevation</u>
<i>Botrychium montanum</i>	1	LS/OG	LDD, M/W	THPL	mid
<i>Coptis trifolia</i>	3	LS/OG	RZ, LDD, M/W	Abies spp., PSME, TSHE, THPL, PIMO	low to mid
<i>Corydalis aquae-gelidae</i>	3		RZ		low to mid
<i>Cypripedium montanum</i> (west Cascades)	3	2G	M/W	HW/C	low to mid
<i>Habenaria orbiculata</i>	3	LS/OG	RZ, LDD, M/W	ABCO, TSHE	mid to high

Rating: 1=Species present; 2=Species highly probable; 3=Species suspected; 4=Insufficient data on habitat and/or range to determine status; 5=Species not listed in Table C-3; listed in Appendix J2.

Seral Stage: LS/OG=late successional/oldgrowth; 2G=2nd growth.

Habitat: RZ=riparian zones; LDD=litter, down & duff; M/W=mesic/wet; D=dry; RO=rock outcrops, cliffs.

Trees: ABAM=Abies amabilis-Pacific silver fir; ABCO=Abies concolor-White fir; ABGR=Abies grandis-Grand fir; ABLA=Abies lasiocarpa-Subalpine fir; ABPR=Abies procera-Noble fir; HW/C=hardwoods & conifers; PICO=Pinus contorta-Lodgepole pine; PIMO=Pinus monticola-Western white pine; PSME=Pseudotsuga menziesii=Douglas-fir; THPL=Thuja plicata-Western redcedar; TSHE=Tsuga heterophylla-Western hemlock; TSME=Tsuga mertensiana-Mountain hemlock.

Special Forest Products Potential Harvest Areas in the Upper McKenzie Watershed

<u>Species</u>	<u>% Coverage</u>	<u>Plot</u>	<u>Township</u>	<u>Range</u>	<u>Section</u>
Beargrass	80.00	1225	13.00	7.00	24
Beargrass	40.00	520	13.00	7.00	28
Beargrass	65.00	1226	13.00	7.50	24
Beargrass	50.00	531	14.00	6.00	27
Beargrass	75.00	500	14.00	6.00	28
Beargrass	80.00	1224	14.00	7.00	14
Beargrass	50.00	9020	14.00	7.00	20
Beargrass	65.00	1223	14.00	7.50	11
Beargrass	50.00	1004	14.00	7.50	16
Beargrass	70.00	245	16.00	7.00	2
Beargrass	90.00	316	16.00	7.00	3
Beargrass	90.00	320	16.00	7.00	7
Beargrass	90.00	446	16.00	7.00	11
Beargrass	60.00	1036	16.00	7.00	12
Beargrass	50.00	517	16.00	7.00	12
Oregon grape	45.00	6621	14.00	6.00	36
Oregon grape	40.00	6667	14.00	7.00	31
Oregon grape	40.00	6668	14.00	7.00	31
Oregon grape	50.00	6710	15.00	6.00	1
Oregon grape	50.00	1024	15.00	6.00	16
Oregon grape	40.00	6554	15.00	6.00	25
Oregon grape	60.00	6551	15.00	6.00	26
Oregon grape	45.00	6642	15.00	6.00	36
Oregon grape	55.00	6590	15.00	7.00	6
Oregon grape	50.00	318	15.00	7.00	9
Oregon grape	75.00	6587	15.00	7.00	9
Oregon grape	45.00	6586	15.00	7.00	15
Oregon grape	40.00	1015	15.00	7.00	16
Oregon grape	50.00	6585	15.00	7.00	20
Oregon grape	40.00	1020	15.00	7.00	29
Oregon grape	65.00	6577	16.00	5.00	11
Oregon grape	60.00	248	16.00	5.00	14
Oregon grape	40.00	6131	16.00	5.00	15
Oregon grape	60.00	8314	16.00	5.00	15
Oregon grape	65.00	6144	16.00	6.00	11
Oregon grape	65.00	6641	16.00	6.00	11
Oregon grape	80.00	6569	16.00	6.00	12
Oregon grape	70.00	6608	16.00	6.00	14
Oregon grape	40.00	6142	16.00	6.00	17
Oregon grape	55.00	6591	16.00	6.00	35
Oregon grape	60.00	6716	16.00	7.00	5
Oregon grape	50.00	6627	16.00	7.00	7
Oregon grape	40.00	6713	16.00	7.00	7
Oregon grape	70.00	6611	16.00	7.00	14
Oregon grape	80.00	230	16.00	7.00	17
Oregon grape	50.00	1034	16.00	7.00	23

Special Forest Products Potential Harvest Areas in the Upper McKenzie Watershed

<u>Species</u>	<u>% Coverage</u>	<u>Plot</u>	<u>Township</u>	<u>Range</u>	<u>Section</u>
Prince's pine	25.00	6672	13.00	7.00	15
Prince's pine	20.00	8329	13.00	7.00	22
Prince's pine	45.00	6644	13.00	7.00	23
Prince's pine	40.00	1001	13.00	7.00	24
Prince's pine	30.00	522	13.00	7.00	34
Prince's pine	20.00	524	14.00	6.00	28
Prince's pine	20.00	6613	14.00	6.00	36
Prince's pine	20.00	6621	14.00	6.00	36
Prince's pine	25.00	529	14.00	7.00	7
Prince's pine	25.00	6589	14.00	7.00	29
Prince's pine	25.00	321	14.00	7.00	33
Prince's pine	45.00	6615	15.00	6.00	1
Prince's pine	25.00	6616	15.00	6.00	1
Prince's pine	40.00	447	15.00	7.00	3
Prince's pine	25.00	6588	15.00	7.00	8
Prince's pine	20.00	1236	15.00	7.00	9
Prince's pine	20.00	1235	15.00	7.00	15
Prince's pine	25.00	241	15.00	7.00	15
Prince's pine	25.00	240	15.00	7.00	21
Prince's pine	35.00	317	15.00	7.00	22
Prince's pine	40.00	1012	15.00	7.00	32
Prince's pine	20.00	1043	15.00	7.00	34
Prince's pine	20.00	1018	16.00	7.00	4
Prince's pine	30.00	8326	16.00	7.00	14
Salal	40.00	6706	15.00	6.00	11
Salal	80.00	6598	15.00	6.00	23
Salal	50.00	6553	15.00	6.00	24
Salal	40.00	6642	15.00	6.00	36
Salal	45.00	6584	15.00	7.00	17
Salal	90.00	6575	16.00	5.00	10
Salal	80.00	6578	16.00	5.00	11
Salal	90.00	6580	16.00	5.00	12
Salal	40.00	248	16.00	5.00	14
Salal	55.00	6568	16.00	6.00	11
Salal	80.00	232	16.00	6.00	12
Salal	75.00	6134	16.00	6.00	14
Salal	55.00	8316	16.00	6.00	14
Salal	85.00	6541	16.00	6.00	16
Salal	60.00	8312	16.00	6.00	16
Salal	70.00	6640	16.00	6.00	21
Salal	55.00	6542	16.00	6.00	22
Salal	70.00	6591	16.00	6.00	35
Salal	60.00	6610	16.00	7.00	19

GEOLOGY APPENDIX

AREAS OF SPECIAL GEOLOGIC INTEREST

US 126/OR 242 Intersection

Approximately three miles east of the community of McKenzie Bridge US 126 intersects Oregon 242. This intersection is near the approximate boundary of the Western and High Cascade physiographic provinces. It is also near the point at which the McKenzie River changes course direction from north-south to east-west (breaching the western escarpment of the High Cascade Graben), and at the confluence of Lost Creek and the McKenzie River.

The road cuts at this intersection were excavated through a terminal moraine placed there by a late Wisconsin glacier that moved down Lost Creek to confluence with the ice mass in the main McKenzie valley. Rounded and subrounded boulders of andesite and rhyolitic obsidian from the Middle Sister can be observed in this moraine deposit.

Lost Creek Glacial Trough

Lost Creek is so named because it and several of its tributaries disappear beneath the underlying basalt lava flows from Simms Butte and Collier cone and continue by migrating through the old stream gravel buried beneath.

During the Pleistocene, glacial ice originating near the North and Middle Sisters moved down the valley in at least three episodes (Thayer 1939). The steep walls, composed of up to 1500 feet of early High Cascade basalt flows, and the U-shaped cross section of the Lost Creek trough where it has not been affected by recent volcanism, are both characteristic of glacial valleys.

Sometime after the last glaciation 12,000 years ago, and before the Mt. Mazama eruption about 7,000 years ago, a volcanic eruption at Simms Butte produced flows of basalt lava down the Lost Creek trough in thin sheets to within a quarter of a mile of Limberlost Campground (Flaherty 1981). A later eruption at Collier Cone, estimated to be between 500 and 2,500 years old (Taylor 1980), sent another lobe of lava into the Lost Creek trough. Flows from this cone, located at the base of North Sister, extended down the valley to approximately one-half mile beyond Lower Proxy Falls, partially covering the Simms Butte flows (Lund 1977).

Lakes

The processes that formed the lakes in the watershed include glacial scour, morainal deposits and lava damming. Linton, and Spring Lakes are both impounded by the Collier Cone lava flows. Neither have surface outlets. They drain into the underlying porous lava.

Scott, Heart, and Hand Lake are associated with glacial scour and lava damming. Hand lake is dammed by lava from Twin Craters.

Trail Bridge, Smith and Carmen are three hydroelectric generating reservoirs. Clear Lake and Fish Lake were formed by lava dams during the latest eruptions of Nash and Sand Mountain Craters. Clear Lake is 1.5 miles long and more than 120 feet deep. It was formed about 3,000 years ago by a Sand Mountain volcanic eruption and lava flow that dammed the

McKenzie River (Bensen 1965). Rising waters inundated a standing forest which is still rooted on the lake bottom. The lake floor is light colored due to the accumulation of diatomaceous mud. Diatoms are silica-secreting fresh water plants. The lake is recharged mainly by large springs along the north and east shores which have their origin in the High Cascade plateau to the east. The porous, recent lava flows cover the previous glacial deposits and form a conduit for ground water movement. Water is also supplied from Ikenick Creek, which flows northeast into the north end of the lake.

Hackleman Creek was dammed by a lava flow from Sand Mountain approximately 3,800 years ago to form Fish Lake (Taylor 1968). The eastern shore of Fish Lake consists of younger basalt flows from Nash Crater. Fish Lake is normally dry during the summer due to the decreased rainfall, high porosity of the lake bottom (a major "sink-hole" exists in the lake bed, which is probably a collapsed lava tube), and a small recharge basin.

Lava Lake is located west of Little Nash Crater and was formed similarly and contemporaneously to Fish Lake and Clear Lake by a basalt flow from Nash Crater 3,800 years ago which dammed Park creek (Taylor 1968).

Lost Lake was formed, like Lava Lake, by lava flows associated with a north-south alignment of four basaltic cinder cones (Lost Lake group). The flow formed a ridge that dammed Lost Creek approximately 2,000 years ago (Taylor 1968). Big Lake is situated one mile south of Hoodoo and Hayrick Buttes and occupies a glacially scoured valley. The result of these vesicular (porous) and blocky recent High Cascade lava flows that covered previously formed drainage channels is an upper McKenzie basin that is predominantly drained underground and discharged at the surface as large springs such as Big Spring, on the east side of Clear Lake, Great Spring on the north end, and Ice Cap Spring near Koosah Falls.

Hot Springs, the result of deep magma chambers heating underground water and forcing it to the surface along fault lines, occur at Belknap and Deer Creek along a north-south trend following the inferred location of the Western Cascade escarpment. The Belknap Hot Springs discharge water with a temperature of 188 degrees Fahrenheit (Bowen et.al. 1978).

Water Falls

Linton Creek pours over a series of Husband volcanic lava flows which produced Linton Falls, the largest and most spectacular water fall in the Three Sisters Area. It empties into Linton Lake.

Proxy Falls is located approximately 1.5 miles west of Linton Falls. There are two main falls, Upper and Lower Proxy Falls. The two main falls are different, both in form and in origin. Water for Upper Proxy Falls originates in a large group of small springs that emerge from inner beds between lava flows about 600 feet above the valley floor. At the bottom of the falls, the water flows into a nearly circular basin from which there is no outlet. Without noticeable eddy motion or an apparent opening in the bottom of the basin, the water percolates into the lava flow and enters the subsurface drainage system (Lund 1977).

Two thick flows of basaltic andesite lava (which dammed Clear Lake) from the Sand Mountain chain of cinder cones, moved into the McKenzie River canyon 3,000 years ago. The terminus of the first flow is marked by Koosah Falls. Sahalie Falls is located atop the

terminus of the second flow 0.4 miles upstream. A series of springs can be seen across the canyon at the base of Koosah Falls, which demonstrates the subsurface drainage network of the area. As a result of the energy of the water pouring over the falls, calving of the underlying blocks of weaker rock occurs in a cycle of headward erosion, which has carved out an amphitheater into the lava margin. Tamolitch Falls, 2 miles downstream from Koosah Falls, was formed similarly by a volcanic eruption and lava flow from Belknap Crater 10 miles to the east, approximately 1,500 years ago (Taylor 1967).

Volcanic Cones and associated Lava Flows

The Inaccessible Cone, Scott Mountain, and Two Butte alignment began eruptions about 3,800 years ago on the glaciated High Cascades andesite platform. The Two Butte cinder cone is in close proximity to Hwy. 242 approximately one mile northwest of Alder Springs campground. It contains a short flow of basalt which descends the steep glaciated side of the valley for only a short distance. Scott Mtn. is a glaciated High Cascade shield volcano composed of gray, fine grained basalt capped by a small, much eroded cinder cone.

The eruptions from Simms Butte and Collier Cone occurred about 7,000 and 2,500 to 500 years ago, respectively, and flowed down Lost Creek Valley.

Yapoah Cone, Condon Butte, and Four-in-One Cone all erupted approximately 2,600 years ago and are part of a north-south alignment of 19 vents. The Yapoah flows poured nearly 5 miles down the eastern slope of the Cascades following the valley of a small stream. Oregon 242 follows its southern edge east of the pass, down into regions of older rocks.

Belknap, Little Belknap, South Belknap, and Twin Craters, are a focal point of nested summit cones with a long and complex episode of Holocene (recent) basalt and basaltic andesite volcanism. The broad shield of the Belknap complex is 5 miles in diameter with an estimated thickness of 1,700 feet and is 1.3 cubic miles in volume. Basaltic andesite issued from vents at the north and south bases of the cone approximately 1,500 years ago, with the exception of Little Belknap which erupted earlier at 2,900 y bp. Lava poured 12 miles to the west and ash was ejected from the northernmost of the two summit craters. The main bulk of the Belknap ash, which has been traced over an area exceeding 100 square miles, was ejected earlier from a larger south crater. Still earlier lavas were basaltic and moved eastward 7 miles from their vents.

The Dee Wright Observatory is located at the summit of Hwy. 242 at the McKenzie Pass. The building is constructed on a lava flow which erupted from Yapoah Cone 3 miles southeast of the highway 2,600 to 2,900 years ago and overlaps an earlier flow from the Little Belknap Crater. The observatory offers a panoramic vista of the McKenzie Lava Field and the volcanic cones which produced it.

The North Sister (elev. 10,085 feet) is a glacially dissected remnant of a large summit cone which was built upon a broad shield volcano of early High Cascade andesite. The composite cone is composed of thin flows and a central plug of uniform basaltic andesite.

The Middle Sister (elev. 10,045 feet) and South Sister (elev. 10,358) were active during the Pleistocene, and therefore were not as extensively eroded. They do not rest on shield volcanoes and are not homogeneous in composition. They contain over 26 different types of

igneous rock including rhyolites, andesites, basalts, obsidian, and tuffs. Eruptions of silicic lavas have occurred on the flanks of South Sister as recently as 2,300 to 1,900 years bp.

The **Sand Mountain Alignment** is a north-south aligned group of volcanic vents which are located from Little Nash Crater in the north to the central and south group of the Sand Mountain cones near Inaccessible Cone in the south. This alignment crosses into the Mt. Washington Wilderness, reaching a point on an imaginary east-west line that extends westward from Mt. Washington to Hwy. 126 near Beaver Marsh south of Koosah Falls. This chain of volcanoes within the area comprise a total of 22 cones with 41 distinct vents.

The lava from the Sand Mountain Alignment generally flowed westward down the slope from Nash Crater and Sand Mountain, as well as the central and south group, with an accompanying discharge of ash and cinders. These eruptions are estimated to have occurred between 3500-3800 years ago. The last massive eruption of lava came from the South Group, Nash Crater, and Little Nash Crater to constitute the earlier Clear Lake Flow, Lava Lake and Fish Lake Flows. The last Clear Lake Flow of the massive lava eruption stage which dammed the McKenzie River occurred about 3,000 years ago from the south vent of Sand Mountain (Taylor 1980).

A replica of the original Sand Mountain Lookout at the summit of Sand Mountain (elev. 5,400 feet) has recently been constructed on the site of the original lookout which was destroyed by fire several years ago. This vantage point offers one of the best views of the upper McKenzie basin to the south and west.

Taylor, (1980) describes The Trailbridge Ignimbrite as a distinctive Western Cascade basaltic andesite ignimbrite located in the road cut adjacent to the Trailbridge Reservoir information display and parking area. [Note: an ignimbrite is a very hot pyroclastic flow that moves in part as a mobile gas-charged lava-foam or froth with nonstratified components and various rock inclusions. Thick, porous crust develops and serves to insulate a hot, liquid interior through which inclusions settle and from which gas escapes and an intense welding process takes place.]

The outcrop is approximately 40 feet thick, cut by at least five faults, and is a very distinctive marker horizon that has been traced, without notable changes in feature, for 7 miles north and south along the Western Cascade foothills. One remarkable feature of this rock unit is the uncommon lithologies of the inclusions, which include gabbroic and dioritic porphyries. A bulk sample of the dense interior has been dated at 5 my.

Approximately 1/4 mile north of this site, on the east side of the road, across from the powerhouse, the highway cut exposes several springs emerging from an aquifer on High Cascade pillow basalt.

Mt. Washington (elev. 7,794 feet) presently is what remains of a large, symmetrical Plio-Pleistocene andesite composite cone built on top of a previously erupted shield volcano of basalt and basaltic andesite. Erosion by streams and by glaciers which etched cirques back into the peak have destroyed the superstructure of the volcano and exposed the feeding plug of intrusive rock.

Sawyer's Ice Cave is lava tube formed in a flow from Crater located approximately 2 miles northeast of Fish Lake. A lava tube is formed by a slightly viscous flow that cools quickly on the outer surface, yet allows the molten lava to continue flowing, which eventually drains and leaves a hollow tube or tunnel. When the tube collapses, an entrance is formed by which access can be made. Sawyers Ice Cave has a continuous cold breeze moving through it due to the difference in air pressure from the outside and inside of the tunnel. Other areas of lava tube formation can be found east of Fish Lake in the lava field of Nash Crater.

Three Fingered Jack (elev. 7,841) to the north, like Mt. Washington and North Sister, is a heavily glaciated basaltic andesite composite cone and is estimated to be have begun erupting between 700,000 and 200,000 years ago (Davie 1980).

Maxwell Butte (elev. 6,229) is located three miles southwest of Three Fingered Jack and is considered to be a broad basaltic andesite volcano which erupted between 80,000 and 40,000 years ago. Wisconsin glaciers scoured the upper flanks but did not extend to the west base of the mountain (Davie 1980).

The Lost Lake Group of cinder cones erupted approximately 2,000 years ago and dammed lost creek to form Lost Lake. The cone north of the highway at Lost Lake directly west of the entrance to the campground is 1,000 feet wide and contains a crater 300 feet deep (Priest 1983).

Hoodoo Butte is a recent basaltic cinder cone with a summit crater that was shielded from Pleistocene glaciation by Hayrick Butte. The Butte stood as an elongate andesite dome in the path of the advancing ice.

Hogg Rock is a platy volcanic dome of very fine-grained andesite which was completely over ridden by glacial ice. Hogg rock was named for T. Egenton Hogg, who in 1888 built the grade for the Corvallis and Eastern Railroad intended to connect Newport and Boise (Taylor 1967).

Hayrick Butte is a mesa-like mass of basaltic andesite which also was overridden by the Pleistocene ice sheet (Wilson et.al. 1981).

Little Nash Crater erupted between 3,500 and 3,800 years ago and is now quarried for the red cinders that are used on the highway in the winter. The quarried areas are littered with discarded volcanic bomb fragments up to 4 feet in diameter.

Some of the prominent Western Cascade and Early High Cascade ridge-capping Basalt peaks in the western portion of the Watershed include Crescent, Echo, Squaw, Iron, Wildcat, and Carpenter Mountains, The Three Pyramids, Lookout, Browder, Bunchgrass and Smith Ridges, and Frissel Point.

LISA ANALYSIS

The 1973 S.R.I. database for soil engineering properties was used for assigning ranges for physical variables such as soil depth, soil classification and shear strength. Slope angles were varied as intersections occurred between the S.R.I. layer, and a Slope layer which was created by bracketing slope angles into polygons < 20%, 20-50, 50-70, and >70%. These ranges of values were then entered into LISA which develops cumulative and probability distribution functions for each variable used in the infinite slope equation to calculate a factor of safety. The equation is iterated 1,000 times using a Monte Carlo simulation subroutine to randomly select variables with the ranges and distribution functions defined to solve the equation. A factor of safety frequency histogram is produced along with a Probability of Failure. This can be interpreted as a percent of area within a polygon susceptible to failure, or the relative frequency of events.

ROAD RELATED FAILURES



GEOLOGY

APPENDIX

LEVEL I STABILITY ANALYSIS RESULTS

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 3 NATURAL SLOPE

User name	MIKE LONG
Time of simulation	06-20-1995 11:43:04
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	975807309
Probability of failure	.245

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 1.00	Apex: 3.00	Max.: 4.00
Ground slope	(%)	Triangular	Min.: 60.00	Apex: 80.00	Max.: 110.00
Tree surcharge	(psf)	Uniform	Min.: 3.00	Max.: 6.00	
Root cohesion	(psf)	Histogram 5 classes			
	Class	Minimum	Maximum	Percent	
	1	0.00	20.00	30.00	
	2	20.00	40.00	30.00	
	3	40.00	60.00	20.00	
	4	60.00	80.00	10.00	
	5	80.00	100.00	10.00	
Friction angle	(deg)	Uniform	Min.: 32.00	Max.: 38.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 50.00	
Dry unit weight	(pcf)	Normal	Mean: 120.00	Std.: 1.50	
Moisture content	(%)	Uniform	Min.: 10.00	Max.: 25.00	
Specific gravity		Constant	Value: 2.65		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.10	Max.: 0.30

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.03	3.98	2.67	0.63
Ground slope	(%)	61.96	109.15	83.29	9.84
Tree surcharge	(psf)	3.00	6.00	4.52	0.86
Root cohesion	(psf)	0.05	99.53	38.19	26.36
Friction angle	(deg)	32.00	37.99	34.98	1.75
Soil cohesion	(psf)	0.01	49.98	25.75	14.33
Dry unit weight	(pcf)	115.36	124.64	119.98	1.51
Moist unit weight	(pcf)	128.85	140.00	136.38	1.79
Saturated unit wt.	(pcf)	134.23	140.00	137.10	0.94
Moisture content	(%)	10.00	24.99	17.44	4.31
Groundwater ratio (Dw/D)		0.00	0.30	0.13	0.06
Factor of safety		0.64	2.37	1.19	0.26

Histogram of natural slope factor of safety

Range	# Values	
0.64 - 0.80	32	=====
0.80 - 0.95	149	=====
0.95 - 1.11	251	=====
1.11 - 1.27	232	=====
1.27 - 1.43	176	=====
1.43 - 1.58	93	=====
1.58 - 1.74	39	=====
1.74 - 1.90	15	=====
1.90 - 2.06	6	=====
2.06 - 2.21	1	=====
2.21 - 2.37	6	=====

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.64
Sample mean	:	1.19	Sample maximum	:	2.37
Sample median	:	1.15			
Sample standard deviation:		0.26			
P[FS <= 1]	:	0.245			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 3 WILDFIRE

User name	MIKE LONG
Time of simulation	06-20-1995 11:45:40
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	820389509
Probability of failure	.634

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 1.00	Apex: 3.00	Max.: 4.00
Ground slope	(%)	Triangular	Min.: 60.00	Apex: 80.00	Max.: 110.00
Tree surcharge	(psf)	Constant	Value: 0.00		
Root cohesion	(psf)	Constant	Value: 0.00		
Friction angle	(deg)	Uniform	Min.: 32.00	Max.: 38.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 50.00	
Dry unit weight	(pcf)	Normal	Mean: 120.00	Std.: 1.50	
Moisture content	(%)	Uniform	Min.: 10.00	Max.: 25.00	
Specific gravity		Constant	Value: 2.65		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.10	Max.: 0.30

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.04	3.94	2.64	0.62
Ground slope	(%)	60.91	108.69	83.62	10.48
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.00	0.00	0.00	0.00
Friction angle	(deg)	32.00	38.00	34.92	1.72
Soil cohesion	(psf)	0.06	49.98	25.68	14.18
Dry unit weight	(pcf)	115.36	124.64	119.93	1.47
Moist unit weight	(pcf)	128.99	140.00	136.35	1.73
Saturated unit wt.	(pcf)	134.23	140.00	137.07	0.91
Moisture content	(%)	10.00	24.98	17.56	4.29
Groundwater ratio (Dw/D)		0.00	0.29	0.13	0.06
Factor of safety		0.59	1.68	0.95	0.16

Histogram of natural slope factor of safety

Range	# Values	
0.59 - 0.69	25	=====
0.69 - 0.79	115	=====
0.79 - 0.89	244	=====
0.89 - 0.99	227	=====
0.99 - 1.09	188	=====
1.09 - 1.18	122	=====
1.18 - 1.28	45	=====
1.28 - 1.38	25	=====
1.38 - 1.48	6	=====
1.48 - 1.58	1	=====
1.58 - 1.68	2	=====

Histogram Statistics

Number of iterations	: 1000	Sample minimum	: 0.59
Sample mean	: 0.95	Sample maximum	: 1.68
Sample median	: 0.94		
Sample standard deviation:	0.16		
P[FS <= 1]	: 0.634		

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 233/235 NATURAL SLOPE

User name MIKE LONG
Time of simulation 06-20-1995 09:00:30
Map unit LBL.MPU
Number of iterations 1000
Random number seed 270694732
Probability of failure .032

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	6.00	Apex:	10.00	Max.:	20.00
Ground slope	(%)	Triangular	Min.:	30.00	Apex:	45.00	Max.:	60.00
Tree surcharge	(psf)	Uniform	Min.:	6.00	Max.:	12.00		
Root cohesion	(psf)	Histogram 7 classes						
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	5.00				
	2	20.00	40.00	20.00				
	3	40.00	60.00	20.00				
	4	60.00	80.00	20.00				
	5	80.00	100.00	20.00				
	6	100.00	120.00	10.00				
	7	120.00	140.00	5.00				
Friction angle	(deg)	Uniform	Min.:	25.00	Max.:	30.00		
Soil cohesion	(psf)	Uniform	Min.:	50.00	Max.:	250.00		
Dry unit weight	(pcf)	Normal	Mean:	85.00	Std.:	1.50		
Moisture content	(%)	Uniform	Min.:	15.00	Max.:	30.00		
Specific gravity		Constant	Value:	2.4				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.10	Apex:	0.30	Max.:	0.50

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	6.14	19.78	11.96	2.91
Ground slope	(%)	30.57	59.63	44.91	6.19
Tree surcharge	(psf)	6.00	12.00	9.10	1.71
Root cohesion	(psf)	0.06	139.47	65.63	31.71
Friction angle	(deg)	25.00	30.00	27.45	1.41
Soil cohesion	(psf)	50.13	249.80	148.91	57.93
Dry unit weight	(pcf)	80.36	89.64	84.94	1.45
Moist unit weight	(pcf)	93.30	113.86	103.89	4.11
Saturated unit wt.	(pcf)	109.28	114.69	111.95	0.85
Moisture content	(%)	15.01	30.00	22.30	4.28
Groundwater ratio (Dw/D)		0.10	0.49	0.30	0.08
Factor of safety		0.81	2.42	1.46	0.29

Histogram of natural slope factor of safety

Range	# Values	
0.81 - 0.96	18	===
0.96 - 1.11	69	=====
1.11 - 1.25	154	=====
1.25 - 1.40	224	=====
1.40 - 1.54	182	=====
1.54 - 1.69	151	=====
1.69 - 1.83	89	=====
1.83 - 1.98	58	=====
1.98 - 2.13	29	=====
2.13 - 2.27	14	==
2.27 - 2.42	12	==

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.81
Sample mean	:	1.46	Sample maximum	:	2.42
Sample median	:	1.42			
Sample standard deviation:		0.29			
P[FS <= 1]	:	0.032			

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 233/235 50% CUT

User name MIKE LONG
Time of simulation 06-20-1995 09:05:56
Map unit LB1.MPU
Number of iterations 1000
Random number seed 80772995
Probability of failure .102

INPUT DATA
=====

NATURAL DATA
=====

Soil depth	(ft)	Triangular	Min.: 6.00	Apex: 10.00	Max.: 20.00
Ground slope	(%)	Triangular	Min.: 30.00	Apex: 45.00	Max.: 60.00
Tree surcharge	(psf)	Uniform	Min.: 3.00	Max.: 6.00	
Root cohesion	(psf)	Histogram 7 classes			
	Class	Minimum	Maximum	Percent	
	1	0.00	20.00	5.00	
	2	20.00	30.00	20.00	
	3	30.00	40.00	20.00	
	4	40.00	50.00	20.00	
	5	50.00	60.00	20.00	
	6	60.00	70.00	10.00	
	7	70.00	80.00	5.00	
Friction angle	(deg)	Uniform	Min.: 25.00	Max.: 30.00	
Soil cohesion	(psf)	Uniform	Min.: 50.00	Max.: 250.00	
Dry unit weight	(pcf)	Normal	Mean: 85.00	Std.: 1.50	
Moisture content	(%)	Uniform	Min.: 15.00	Max.: 30.00	
Specific gravity		Constant	Value: 2.4		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.20	Apex: 0.50	Max.: 0.70

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	6.21	19.71	11.86	2.91
Ground slope	(%)	30.83	59.92	44.81	6.16
Tree surcharge	(psf)	3.00	5.99	4.45	0.84
Root cohesion	(psf)	0.05	79.69	42.57	16.51
Friction angle	(deg)	25.00	30.00	27.60	1.47
Soil cohesion	(psf)	50.87	249.87	151.44	56.66
Dry unit weight	(pcf)	80.36	89.64	85.10	1.55
Moist unit weight	(pcf)	93.55	114.69	104.33	3.99
Saturated unit wt.	(pcf)	109.28	114.69	112.04	0.90
Moisture content	(%)	15.01	30.00	22.61	4.29
Groundwater ratio (Dw/D)		0.21	0.69	0.47	0.10
Factor of safety		0.74	2.24	1.31	0.27

Histogram of natural slope factor of safety

Range	# Values	
0.74 - 0.87	29	=====
0.87 - 1.01	87	=====
1.01 - 1.15	173	=====
1.15 - 1.28	218	=====
1.28 - 1.42	192	=====
1.42 - 1.55	120	=====
1.55 - 1.69	91	=====
1.69 - 1.83	50	=====
1.83 - 1.96	21	=====
1.96 - 2.10	12	=====
2.10 - 2.24	7	=====

Histogram Statistics

Number of iterations	: 1000	Sample minimum	: 0.74
Sample mean	: 1.31	Sample maximum	: 2.24
Sample median	: 1.28		
Sample standard deviation:	0.27		
P[FS <= 1]	: 0.102		

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 233/235 CLEARCUT

User name	MIKE LONG
Time of simulation	06-20-1995 09:22:04
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	80772995
Probability of failure	.214

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	6.00	Apex:	10.00	Max.:	20.00
Ground slope	(%)	Triangular	Min.:	30.00	Apex:	45.00	Max.:	60.00
Tree surcharge	(psf)	Constant	Value:	0.00				
Root cohesion	(psf)	Histogram	4 classes					
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	25.00				
	2	20.00	40.00	45.00				
	3	40.00	60.00	25.00				
	4	60.00	80.00	5.00				
Friction angle	(deg)	Uniform	Min.:	25.00	Max.:	30.00		
Soil cohesion	(psf)	Uniform	Min.:	50.00	Max.:	250.00		
Dry unit weight	(pcf)	Normal	Mean:	85.00	Std.:	1.50		
Moisture content	(%)	Uniform	Min.:	15.00	Max.:	30.00		
Specific gravity		Constant	Value:	2.4				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.30	Apex:	0.60	Max.:	0.80

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	6.21	19.71	11.86	2.91
Ground slope	(%)	30.83	59.92	44.81	6.16
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.03	79.38	31.69	17.61
Friction angle	(deg)	25.00	30.00	27.60	1.47
Soil cohesion	(psf)	50.87	249.87	151.44	56.66
Dry unit weight	(pcf)	80.36	89.64	85.10	1.55
Moist unit weight	(pcf)	93.55	114.69	104.33	3.99
Saturated unit wt.	(pcf)	109.28	114.69	112.04	0.90
Moisture content	(%)	15.01	30.00	22.61	4.29
Groundwater ratio (Dw/D)		0.31	0.79	0.57	0.10
Factor of safety		0.67	2.12	1.21	0.25

Histogram of natural slope factor of safety

Range	# Values	
0.67 - 0.80	28	=====
0.80 - 0.94	99	=====
0.94 - 1.07	176	=====
1.07 - 1.20	222	=====
1.20 - 1.33	179	=====
1.33 - 1.46	125	=====
1.46 - 1.59	89	=====
1.59 - 1.72	44	=====
1.72 - 1.85	21	=====
1.85 - 1.98	11	=====
1.98 - 2.12	6	=====

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.67
Sample mean	:	1.21	Sample maximum	:	2.12
Sample median	:	1.19			
Sample standard deviation:		0.25			
P[FS <= 1]	:	0.214			

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 233/235 WILDFIRE

User name	MIKE LONG
Time of simulation	06-20-1995 09:16:37
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	80772995
Probability of failure	.338

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 6.00	Apex: 10.00	Max.: 20.00
Ground slope	(%)	Triangular	Min.: 30.00	Apex: 45.00	Max.: 60.00
Tree surcharge	(psf)	Constant	Value: 0.00		
Root cohesion	(psf)	Constant	Value: 0.00		
Friction angle	(deg)	Uniform	Min.: 25.00	Max.: 30.00	
Soil cohesion	(psf)	Uniform	Min.: 50.00	Max.: 250.00	
Dry unit weight	(pcf)	Normal	Mean: 85.00	Std.: 1.50	
Moisture content	(%)	Uniform	Min.: 15.00	Max.: 30.00	
Specific gravity		Constant	Value: 2.4		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.30	Apex: 0.60	Max.: 0.90

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	6.21	19.71	11.86	2.91
Ground slope	(%)	30.83	59.92	44.81	6.16
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.00	0.00	0.00	0.00
Friction angle	(deg)	25.00	30.00	27.60	1.47
Soil cohesion	(psf)	50.87	249.87	151.44	56.66
Dry unit weight	(pcf)	80.36	89.64	85.10	1.55
Moist unit weight	(pcf)	93.55	114.69	104.33	3.99
Saturated unit wt.	(pcf)	109.28	114.69	112.04	0.90
Moisture content	(%)	15.01	30.00	22.61	4.29
Groundwater ratio (Dw/D)		0.31	0.89	0.60	0.12
Factor of safety		0.59	1.94	1.12	0.24

Histogram of natural slope factor of safety

Range	# Values	
0.59 - 0.71	18	===
0.71 - 0.84	94	=====
0.84 - 0.96	151	=====
0.96 - 1.08	217	=====
1.08 - 1.20	195	=====
1.20 - 1.33	124	=====
1.33 - 1.45	106	=====
1.45 - 1.57	50	=====
1.57 - 1.69	24	=====
1.69 - 1.81	10	==
1.81 - 1.94	11	==

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.59
Sample mean	:	1.12	Sample maximum	:	1.94
Sample median	:	1.10			
Sample standard deviation:		0.24			
P[FS <= 1]	:	0.338			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 71 NATURAL SLOPE

User name MIKE LONG
Time of simulation 06-20-1995 12:11:10
Map unit LB1.MPU
Number of iterations 1000
Random number seed 269346594
Probability of failure .057

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 1.00	Apex: 2.00	Max.: 3.00
Ground slope	(%)	Triangular	Min.: 70.00	Apex: 80.00	Max.: 110.00
Tree surcharge	(psf)	Uniform	Min.: 6.00	Max.: 12.00	
Root cohesion	(psf)	Histogram 7 classes			
	Class	Minimum	Maximum	Percent	
	1	0.00	20.00	5.00	
	2	20.00	40.00	20.00	
	3	40.00	60.00	20.00	
	4	60.00	80.00	20.00	
	5	80.00	100.00	20.00	
	6	100.00	120.00	10.00	
	7	120.00	140.00	5.00	
Friction angle	(deg)	Uniform	Min.: 32.00	Max.: 38.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 50.00	
Dry unit weight	(pcf)	Normal	Mean: 120.00	Std.: 1.50	
Moisture content	(%)	Uniform	Min.: 10.00	Max.: 25.00	
Specific gravity		Constant	Value: 2.65		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.20	Max.: 0.30

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.04	2.92	1.99	0.41
Ground slope	(%)	71.19	108.73	86.47	8.38
Tree surcharge	(psf)	6.01	11.99	9.00	1.73
Root cohesion	(psf)	0.36	139.81	66.16	31.83
Friction angle	(deg)	32.01	37.99	35.01	1.73
Soil cohesion	(psf)	0.01	49.89	24.95	14.66
Dry unit weight	(pcf)	115.48	124.64	120.03	1.46
Moist unit weight	(pcf)	127.06	140.00	136.38	1.85
Saturated unit wt.	(pcf)	134.30	140.00	137.14	0.91
Moisture content	(%)	10.01	25.00	17.48	4.32
Groundwater ratio (Dw/D)		0.01	0.29	0.17	0.06
Factor of safety		0.63	2.80	1.47	0.34

Histogram of natural slope factor of safety

Range	# Values	
0.63 - 0.83	4	=
0.83 - 1.03	64	=====
1.03 - 1.22	192	=====
1.22 - 1.42	239	=====
1.42 - 1.62	196	=====
1.62 - 1.82	147	=====
1.82 - 2.01	88	=====
2.01 - 2.21	44	=====
2.21 - 2.41	14	==
2.41 - 2.61	6	=
2.61 - 2.80	6	=

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.63
Sample mean	:	1.47	Sample maximum	:	2.80
Sample median	:	1.42			
Sample standard deviation:		0.34			
P[FS <= 1]	:	0.057			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 71 50% CUT

User name MIKE LONG
Time of simulation 06-20-1995 12:12:51
Map unit LB1.MPU
Number of iterations 1000
Random number seed 177750647
Probability of failure .143

INPUT DATA

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	1.00	Apex:	2.00	Max.:	3.00
Ground slope	(%)	Triangular	Min.:	70.00	Apex:	80.00	Max.:	110.00
Tree surcharge	(psf)	Uniform	Min.:	3.00	Max.:	6.00		
Root cohesion	(psf)	Histogram	5 classes					
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	20.00				
	2	20.00	40.00	20.00				
	3	40.00	60.00	30.00				
	4	60.00	80.00	20.00				
	5	80.00	100.00	10.00				
Friction angle	(deg)	Uniform	Min.:	32.00	Max.:	38.00		
Soil cohesion	(psf)	Uniform	Min.:	0.00	Max.:	50.00		
Dry unit weight	(pcf)	Normal	Mean:	120.00	Std.:	1.50		
Moisture content	(%)	Uniform	Min.:	10.00	Max.:	25.00		
Specific gravity		Constant	Value:	2.65				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.00	Apex:	0.20	Max.:	0.40

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.06	2.98	2.00	0.42
Ground slope	(%)	70.27	108.78	86.59	8.57
Tree surcharge	(psf)	3.00	6.00	4.49	0.88
Root cohesion	(psf)	0.21	99.91	46.07	25.26
Friction angle	(deg)	32.01	37.99	35.00	1.75
Soil cohesion	(psf)	0.06	49.97	24.53	14.45
Dry unit weight	(pcf)	115.43	124.64	119.99	1.51
Moist unit weight	(pcf)	129.74	140.00	136.34	1.81
Saturated unit wt.	(pcf)	134.27	140.00	137.11	0.94
Moisture content	(%)	10.01	24.98	17.29	4.29
Groundwater ratio (Dw/D)		0.01	0.39	0.20	0.08
Factor of safety		0.63	2.45	1.29	0.28

Histogram of natural slope factor of safety

Range	# Values	
0.63 - 0.79	13	==
0.79 - 0.96	90	=====
0.96 - 1.12	187	=====
1.12 - 1.29	246	=====
1.29 - 1.45	216	=====
1.45 - 1.62	126	=====
1.62 - 1.78	70	=====
1.78 - 1.95	30	=====
1.95 - 2.11	14	=====
2.11 - 2.28	3	=====
2.28 - 2.45	5	=====

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.63
Sample mean	:	1.29	Sample maximum	:	2.45
Sample median	:	1.27			
Sample standard deviation:		0.28			
P[FS <= 1]	:	0.143			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 71 CLEARCUT

User name MIKE LONG
Time of simulation 06-20-1995 12:19:11
Map unit LB1.MPU
Number of iterations 1000
Random number seed 826680421
Probability of failure .239

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	1.00	Apex:	2.00	Max.:	3.00
Ground slope	(%)	Triangular	Min.:	70.00	Apex:	80.00	Max.:	110.00
Tree surcharge	(psf)	Constant	Value:	0.00				
Root cohesion	(psf)	Histogram	4 classes					
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	25.00				
	2	20.00	40.00	45.00				
	3	40.00	60.00	25.00				
	4	60.00	80.00	5.00				
Friction angle	(deg)	Uniform	Min.:	32.00	Max.:	38.00		
Soil cohesion	(psf)	Uniform	Min.:	0.00	Max.:	50.00		
Dry unit weight	(pcf)	Normal	Mean:	120.00	Std.:	1.50		
Moisture content	(%)	Uniform	Min.:	10.00	Max.:	25.00		
Specific gravity		Constant	Value:	2.65				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.00	Apex:	0.30	Max.:	0.40

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.03	2.96	2.00	0.40
Ground slope	(%)	70.53	109.37	87.05	8.62
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.07	79.18	31.93	17.83
Friction angle	(deg)	32.00	38.00	35.00	1.77
Soil cohesion	(psf)	0.05	49.90	25.04	14.43
Dry unit weight	(pcf)	115.36	124.64	120.00	1.54
Moist unit weight	(pcf)	129.16	140.00	136.40	1.83
Saturated unit wt.	(pcf)	134.23	140.00	137.12	0.96
Moisture content	(%)	10.03	24.99	17.34	4.21
Groundwater ratio (Dw/D)		0.00	0.40	0.23	0.08
Factor of safety		0.59	2.28	1.17	0.24

Histogram of natural slope factor of safety

Range	# Values	
0.59 - 0.74	22	===
0.74 - 0.90	79	=====
0.90 - 1.05	238	=====
1.05 - 1.21	254	=====
1.21 - 1.36	222	=====
1.36 - 1.51	101	=====
1.51 - 1.67	50	=====
1.67 - 1.82	22	===
1.82 - 1.97	8	=
1.97 - 2.13	2	
2.13 - 2.28	2	

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.59
Sample mean	:	1.17	Sample maximum	:	2.28
Sample median	:	1.14			
Sample standard deviation:		0.24			
P[FS <= 1]	:	0.239			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 71 WILDFIRE

User name	MIKE LONG
Time of simulation	06-20-1995 12:17:23
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	739197909
Probability of failure	.783

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 1.00	Apex: 2.00	Max.: 3.00
Ground slope	(%)	Triangular	Min.: 70.00	Apex: 80.00	Max.: 110.00
Tree surcharge	(psf)	Constant	Value: 0.00		
Root cohesion	(psf)	Constant	Value: 0.00		
Friction angle	(deg)	Uniform	Min.: 32.00	Max.: 38.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 50.00	
Dry unit weight	(pcf)	Normal	Mean: 120.00	Std.: 1.50	
Moisture content	(%)	Uniform	Min.: 10.00	Max.: 25.00	
Specific gravity		Constant	Value: 2.65		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.40	Max.: 0.60

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.03	2.95	1.99	0.40
Ground slope	(%)	70.78	109.53	86.79	8.55
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.00	0.00	0.00	0.00
Friction angle	(deg)	32.00	37.99	35.00	1.70
Soil cohesion	(psf)	0.07	49.94	23.97	14.25
Dry unit weight	(pcf)	115.36	124.30	120.00	1.45
Moist unit weight	(pcf)	127.90	139.79	136.43	1.76
Saturated unit wt.	(pcf)	134.23	139.79	137.12	0.90
Moisture content	(%)	10.00	25.00	17.72	4.32
Groundwater ratio (Dw/D)		0.01	0.59	0.33	0.12
Factor of safety		0.51	1.42	0.88	0.16

Histogram of natural slope factor of safety

Range	# Values	
0.51 - 0.59	14	==
0.59 - 0.67	79	=====
0.67 - 0.76	130	=====
0.76 - 0.84	202	=====
0.84 - 0.92	218	=====
0.92 - 1.01	152	=====
1.01 - 1.09	114	=====
1.09 - 1.17	54	=====
1.17 - 1.26	19	===
1.26 - 1.34	13	==
1.34 - 1.42	5	=

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.51
Sample mean	:	0.88	Sample maximum	:	1.42
Sample median	:	0.87			
Sample standard deviation:		0.16			
P[FS <= 1]	:	0.783			

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 13,61,64,610,610U,614 NATURAL SLOPE

User name	MIKE LONG
Time of simulation	06-20-1995 09:58:20
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	400890052
Probability of failure	.188

INPUT DATA

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	3.00	Apex:	4.00	Max.:	6.00
Ground slope	(%)	Triangular	Min.:	70.00	Apex:	80.00	Max.:	110.00
Tree surcharge	(psf)	Uniform	Min.:	6.00	Max.:	12.00		
Root cohesion	(psf)	Histogram	7 classes					
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	5.00				
	2	20.00	40.00	20.00				
	3	40.00	60.00	20.00				
	4	60.00	80.00	20.00				
	5	80.00	100.00	20.00				
	6	100.00	120.00	10.00				
	7	120.00	140.00	5.00				
Friction angle	(deg)	Uniform	Min.:	33.00	Max.:	38.00		
Soil cohesion	(psf)	Uniform	Min.:	0.00	Max.:	50.00		
Dry unit weight	(pcf)	Normal	Mean:	100.00	Std.:	1.50		
Moisture content	(%)	Normal	Mean:	10.00	Std.:	1.50		
Specific gravity		Constant	Value:	2.65				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.00	Apex:	0.10	Max.:	0.20

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	3.09	5.94	4.32	0.62
Ground slope	(%)	71.16	108.55	86.76	8.55
Tree surcharge	(psf)	6.00	11.99	9.02	1.74
Root cohesion	(psf)	0.07	139.14	65.78	31.92
Friction angle	(deg)	33.02	38.00	35.45	1.46
Soil cohesion	(psf)	0.02	49.96	24.65	14.76
Dry unit weight	(pcf)	95.90	104.64	99.95	1.50
Moist unit weight	(pcf)	103.77	117.08	109.95	2.18
Saturated unit wt.	(pcf)	122.11	127.55	124.63	0.93
Moisture content	(%)	5.37	14.64	10.00	1.50
Groundwater ratio (Dw/D)		0.01	0.19	0.10	0.04
Factor of safety		0.63	1.80	1.17	0.19

Histogram of natural slope factor of safety

Range	# Values	
0.63 - 0.74	6	=
0.74 - 0.85	27	=====
0.85 - 0.95	87	=====
0.95 - 1.06	170	=====
1.06 - 1.17	210	=====
1.17 - 1.27	213	=====
1.27 - 1.38	141	=====
1.38 - 1.48	96	=====
1.48 - 1.59	32	=====
1.59 - 1.70	12	==
1.70 - 1.80	6	=

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.63
Sample mean	:	1.17	Sample maximum	:	1.80
Sample median	:	1.17			
Sample standard deviation:		0.19			
P[FS <= 1]	:	0.188			

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 13,61,64,610,610U,614 50% CUT

User name	MIKE LONG
Time of simulation	06-20-1995 11:16:02
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	359534680
Probability of failure	.248

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	3.00	Apex:	4.00	Max.:	6.00
Ground slope	(%)	Triangular	Min.:	70.00	Apex:	80.00	Max.:	100.00
Tree surcharge	(psf)	Uniform	Min.:	3.00	Max.:	6.00		
Root cohesion	(psf)	Histogram	6 classes					
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	20.00				
	2	20.00	40.00	20.00				
	3	40.00	60.00	30.00				
	4	60.00	80.00	20.00				
	5	80.00	100.00	10.00				
	6	100.00	120.00	0.00				
Friction angle	(deg)	Uniform	Min.:	33.00	Max.:	38.00		
Soil cohesion	(psf)	Uniform	Min.:	0.00	Max.:	50.00		
Dry unit weight	(pcf)	Normal	Mean:	100.00	Std.:	1.50		
Moisture content	(%)	Normal	Mean:	10.00	Std.:	1.50		
Specific gravity		Constant	Value:	2.65				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.00	Apex:	0.10	Max.:	0.20

LISA Version 2.00
 SRI 13,61,64,610,610U,614 50% CUT

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	3.04	5.97	4.30	0.62
Ground slope	(%)	70.11	98.89	83.50	6.42
Tree surcharge	(psf)	3.00	6.00	4.55	0.84
Root cohesion	(psf)	0.17	99.79	46.19	25.73
Friction angle	(deg)	33.00	38.00	35.40	1.46
Soil cohesion	(psf)	0.04	49.99	24.93	14.23
Dry unit weight	(pcf)	95.36	104.64	99.90	1.53
Moist unit weight	(pcf)	103.22	117.16	109.93	2.30
Saturated unit wt.	(pcf)	121.78	127.55	124.60	0.95
Moisture content	(%)	5.57	14.64	10.04	1.52
Groundwater ratio (Dw/D)		0.00	0.19	0.10	0.04
Factor of safety		0.73	1.61	1.12	0.16

Histogram of natural slope factor of safety

Range	# Values	
0.73 - 0.81	16	===
0.81 - 0.89	59	=====
0.89 - 0.97	130	=====
0.97 - 1.05	172	=====
1.05 - 1.13	181	=====
1.13 - 1.21	172	=====
1.21 - 1.29	124	=====
1.29 - 1.37	79	=====
1.37 - 1.45	40	=====
1.45 - 1.53	19	=====
1.53 - 1.61	8	==

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.73
Sample mean	:	1.12	Sample maximum	:	1.61
Sample median	:	1.10			
Sample standard deviation:		0.16			
P[FS <= 1]	:	0.248			

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 13,61,64,610,610U,614 CLEARCUT

User name MIKE LONG
Time of simulation 06-20-1995 11:19:47
Map unit LBI.MPU
Number of iterations 1000
Random number seed 496282458
Probability of failure .5

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 3.00	Apex: 4.00	Max.: 6.00
Ground slope	(%)	Triangular	Min.: 70.00	Apex: 80.00	Max.: 100.00
Tree surcharge	(psf)	Constant	Value: 0.00		
Root cohesion	(psf)	Histogram	4 classes		
	Class	Minimum	Maximum	Percent	
	1	0.00	20.00	25.00	
	2	20.00	40.00	45.00	
	3	40.00	60.00	25.00	
	4	60.00	80.00	5.00	
Friction angle	(deg)	Uniform	Min.: 33.00	Max.: 38.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 50.00	
Dry unit weight	(pcf)	Normal	Mean: 100.00	Std.: 1.50	
Moisture content	(%)	Normal	Mean: 10.00	Std.: 1.50	
Specific gravity		Constant	Value: 2.65		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.20	Max.: 0.40

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	3.03	5.93	4.35	0.63
Ground slope	(%)	70.29	99.78	83.54	6.15
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.08	78.91	31.58	17.76
Friction angle	(deg)	33.01	38.00	35.49	1.43
Soil cohesion	(psf)	0.09	49.83	25.75	14.13
Dry unit weight	(pcf)	95.43	104.64	99.98	1.50
Moist unit weight	(pcf)	102.36	116.24	110.01	2.16
Saturated unit wt.	(pcf)	121.82	127.55	124.65	0.93
Moisture content	(%)	5.37	14.64	10.03	1.50
Groundwater ratio (Dw/D)		0.00	0.39	0.20	0.08
Factor of safety		0.68	1.43	1.01	0.13

Histogram of natural slope factor of safety

Range	# Values	
0.68 - 0.75	23	=====
0.75 - 0.81	47	=====
0.81 - 0.88	110	=====
0.88 - 0.95	164	=====
0.95 - 1.02	202	=====
1.02 - 1.09	183	=====
1.09 - 1.15	135	=====
1.15 - 1.22	82	=====
1.22 - 1.29	29	=====
1.29 - 1.36	20	=====
1.36 - 1.43	5	=====

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.68
Sample mean	:	1.01	Sample maximum	:	1.43
Sample median	:	1.00			
Sample standard deviation:		0.13			
P[FS <= 1]	:	0.500			

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 13,61,64,610,610U,614 WILDFIRE

User name	MIKE LONG
Time of simulation	06-20-1995 11:22:34
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	152340412
Probability of failure	.938

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 3.00	Apex: 4.00	Max.: 6.00
Ground slope	(%)	Triangular	Min.: 70.00	Apex: 80.00	Max.: 100.00
Tree surcharge	(psf)	Constant	Value: 0.00		
Root cohesion	(psf)	Constant	Value: 0.00		
Friction angle	(deg)	Uniform	Min.: 33.00	Max.: 38.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 50.00	
Dry unit weight	(pcf)	Normal	Mean: 100.00	Std.: 1.50	
Moisture content	(%)	Normal	Mean: 10.00	Std.: 1.50	
Specific gravity		Constant	Value: 2.65		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.30	Max.: 0.60

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	3.01	5.90	4.34	0.62
Ground slope	(%)	70.63	99.13	83.34	6.12
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.00	0.00	0.00	0.00
Friction angle	(deg)	33.01	38.00	35.42	1.50
Soil cohesion	(psf)	0.01	49.98	26.31	14.60
Dry unit weight	(pcf)	95.67	104.64	99.93	1.57
Moist unit weight	(pcf)	103.41	116.64	109.84	2.31
Saturated unit wt.	(pcf)	121.97	127.55	124.62	0.98
Moisture content	(%)	5.79	14.64	9.92	1.45
Groundwater ratio (Dw/D)		0.02	0.59	0.31	0.12
Factor of safety		0.54	1.22	0.83	0.11

Histogram of natural slope factor of safety			
Range	# Values		
0.54 - 0.60	7	=	
0.60 - 0.66	51	=====	
0.66 - 0.72	121	=====	
0.72 - 0.79	170	=====	
0.79 - 0.85	243	=====	
0.85 - 0.91	186	=====	
0.91 - 0.97	127	=====	
0.97 - 1.03	61	=====	
1.03 - 1.10	26	=====	
1.10 - 1.16	5	=	
1.16 - 1.22	3		
Histogram Statistics			

Number of iterations	:	1000	Sample minimum	:	0.54
Sample mean	:	0.83	Sample maximum	:	1.22
Sample median	:	0.82			
Sample standard deviation:		0.11			
P[FS <= 1]	:	0.938			

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 21,31,301,310U NATURAL SLOPE

User name	MIKE LONG
Time of simulation	06-20-1995 13:03:27
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	329935789
Probability of failure	.08

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	1.00	Apex:	2.00	Max.:	3.00
Ground slope	(%)	Triangular	Min.:	70.00	Apex:	80.00	Max.:	110.00
Tree surcharge	(psf)	Uniform	Min.:	6.00	Max.:	12.00		
Root cohesion	(psf)	Histogram	7 classes					
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	5.00				
	2	20.00	40.00	20.00				
	3	40.00	60.00	20.00				
	4	60.00	80.00	20.00				
	5	80.00	100.00	20.00				
	6	100.00	120.00	10.00				
	7	120.00	140.00	5.00				
Friction angle	(deg)	Uniform	Min.:	28.00	Max.:	34.00		
Soil cohesion	(psf)	Uniform	Min.:	0.00	Max.:	50.00		
Dry unit weight	(pcf)	Normal	Mean:	85.00	Std.:	1.50		
Moisture content	(%)	Normal	Mean:	10.00	Std.:	1.50		
Specific gravity		Constant	Value:	2.5				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.00	Apex:	0.30	Max.:	0.40

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.03	2.98	1.99	0.42
Ground slope	(%)	70.44	108.34	86.38	8.37
Tree surcharge	(psf)	6.00	11.98	8.93	1.75
Root cohesion	(psf)	0.03	139.52	65.74	31.97
Friction angle	(deg)	28.00	33.99	31.04	1.73
Soil cohesion	(psf)	0.02	49.96	25.82	14.49
Dry unit weight	(pcf)	80.36	89.44	85.03	1.49
Moist unit weight	(pcf)	86.69	100.32	93.53	2.08
Saturated unit wt.	(pcf)	110.62	116.06	113.42	0.89
Moisture content	(%)	5.37	14.64	9.99	1.47
Groundwater ratio (Dw/D)		0.01	0.40	0.23	0.09
Factor of safety		0.67	3.46	1.60	0.47

Histogram of natural slope factor of safety

Range	# Values	
0.67 - 0.92	52	=====
0.92 - 1.18	141	=====
1.18 - 1.43	197	=====
1.43 - 1.69	226	=====
1.69 - 1.94	174	=====
1.94 - 2.19	99	=====
2.19 - 2.45	56	=====
2.45 - 2.70	34	=====
2.70 - 2.95	11	==
2.95 - 3.21	8	=
3.21 - 3.46	2	

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.67
Sample mean	:	1.60	Sample maximum	:	3.46
Sample median	:	1.55			
Sample standard deviation:		0.47			
P[FS <= 1]	:	0.080			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 21,31,301,310U 50% CUT

User name	MIKE LONG
Time of simulation	06-20-1995 13:09:40
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	184953153
Probability of failure	.113

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	1.00	Apex:	2.00	Max.:	3.00
Ground slope	(%)	Triangular	Min.:	70.00	Apex:	80.00	Max.:	110.00
Tree surcharge	(psf)	Uniform	Min.:	3.00	Max.:	6.00		
Root cohesion	(psf)	Histogram	8 classes					
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	5.00				
	2	20.00	40.00	30.00				
	3	40.00	60.00	35.00				
	4	60.00	80.00	15.00				
	5	80.00	100.00	5.00				
	6	100.00	120.00	5.00				
	7	120.00	140.00	2.50				
	8	140.00	160.00	2.50				
Friction angle	(deg)	Uniform	Min.:	28.00	Max.:	34.00		
Soil cohesion	(psf)	Uniform	Min.:	0.00	Max.:	50.00		
Dry unit weight	(pcf)	Normal	Mean:	85.00	Std.:	1.50		
Moisture content	(%)	Normal	Mean:	10.00	Std.:	1.50		
Specific gravity		Constant	Value:	2.5				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.10	Apex:	0.20	Max.:	0.40

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.03	2.96	1.99	0.41
Ground slope	(%)	70.75	109.41	86.92	8.49
Tree surcharge	(psf)	3.00	5.99	4.49	0.88
Root cohesion	(psf)	0.42	159.48	54.96	30.46
Friction angle	(deg)	28.01	34.00	30.87	1.68
Soil cohesion	(psf)	0.01	49.97	25.54	15.03
Dry unit weight	(pcf)	80.74	89.64	84.90	1.44
Moist unit weight	(pcf)	87.65	100.15	93.38	2.02
Saturated unit wt.	(pcf)	110.84	116.18	113.34	0.86
Moisture content	(%)	5.37	14.64	9.98	1.44
Groundwater ratio (Dw/D)		0.10	0.40	0.23	0.06
Factor of safety		0.59	3.66	1.47	0.45

Histogram of natural slope factor of safety

Range	# Values	
0.59 - 0.87	40	=====
0.87 - 1.15	205	=====
1.15 - 1.43	295	=====
1.43 - 1.71	223	=====
1.71 - 1.99	109	=====
1.99 - 2.27	62	=====
2.27 - 2.54	41	=====
2.54 - 2.82	14	=====
2.82 - 3.10	4	
3.10 - 3.38	4	
3.38 - 3.66	3	

Histogram Statistics

Number of iterations	: 1000	Sample minimum	: 0.59
Sample mean	: 1.47	Sample maximum	: 3.66
Sample median	: 1.39		
Sample standard deviation:	0.45		
P[FS <= 1]	: 0.113		

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 21,31,301,310U CLEARCUT

User name	MIKE LONG
Time of simulation	06-20-1995 13:11:48
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	780601382
Probability of failure	.214

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	1.00	Apex:	2.00	Max.:	3.00
Ground slope	(%)	Triangular	Min.:	70.00	Apex:	80.00	Max.:	110.00
Tree surcharge	(psf)	Constant	Value:	0.00				
Root cohesion	(psf)	Histogram	4 classes					
	Class	Minimum	Maximum	Percent				
	1	0.00	20.00	5.00				
	2	20.00	40.00	40.00				
	3	40.00	60.00	45.00				
	4	60.00	80.00	10.00				
Friction angle	(deg)	Uniform	Min.:	28.00	Max.:	34.00		
Soil cohesion	(psf)	Uniform	Min.:	0.00	Max.:	50.00		
Dry unit weight	(pcf)	Normal	Mean:	85.00	Std.:	1.50		
Moisture content	(%)	Normal	Mean:	10.00	Std.:	1.50		
Specific gravity		Constant	Value:	2.5				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.10	Apex:	0.40	Max.:	0.60

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.04	2.97	2.03	0.41
Ground slope	(%)	70.43	108.28	86.28	8.28
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.09	79.71	41.85	15.75
Friction angle	(deg)	28.00	33.99	30.97	1.76
Soil cohesion	(psf)	0.01	49.96	24.54	14.75
Dry unit weight	(pcf)	80.36	89.52	84.97	1.52
Moist unit weight	(pcf)	88.06	101.37	93.49	2.07
Saturated unit wt.	(pcf)	110.62	116.11	113.38	0.91
Moisture content	(%)	5.37	13.89	10.04	1.49
Groundwater ratio (Dw/D)		0.10	0.60	0.37	0.10
Factor of safety		0.51	2.47	1.23	0.29

Histogram of natural slope factor of safety

Range	# Values	
0.51 - 0.69	12	==
0.69 - 0.87	76	=====
0.87 - 1.05	183	=====
1.05 - 1.23	264	=====
1.23 - 1.40	211	=====
1.40 - 1.58	143	=====
1.58 - 1.76	65	=====
1.76 - 1.94	30	=====
1.94 - 2.12	10	=
2.12 - 2.29	5	=
2.29 - 2.47	1	

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.51
Sample mean	:	1.23	Sample maximum	:	2.47
Sample median	:	1.20			
Sample standard deviation:		0.29			
P[FS <= 1]	:	0.214			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 21,31,301,310U WILDFIRE

User name	MIKE LONG
Time of simulation	06-20-1995 13:04:59
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	567290604
Probability of failure	.866

INPUT DATA

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 1.00	Apex: 2.00	Max.: 3.00
Ground slope	(%)	Triangular	Min.: 70.00	Apex: 80.00	Max.: 110.00
Tree surcharge	(psf)	Constant	Value: 0.00		
Root cohesion	(psf)	Constant	Value: 0.00		
Friction angle	(deg)	Uniform	Min.: 28.00	Max.: 34.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 50.00	
Dry unit weight	(pcf)	Normal	Mean: 85.00	Std.: 1.50	
Moisture content	(%)	Normal	Mean: 10.00	Std.: 1.50	
Specific gravity		Constant	Value: 2.5		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.50	Max.: 0.80

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	1.08	2.93	2.00	0.39
Ground slope	(%)	70.13	108.71	86.45	8.42
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.00	0.00	0.00	0.00
Friction angle	(deg)	28.01	34.00	31.08	1.76
Soil cohesion	(psf)	0.03	49.95	25.00	14.62
Dry unit weight	(pcf)	80.52	89.64	85.08	1.55
Moist unit weight	(pcf)	86.68	100.13	93.59	2.12
Saturated unit wt.	(pcf)	110.71	116.18	113.45	0.93
Moisture content	(%)	5.37	14.59	10.00	1.49
Groundwater ratio (Dw/D)		0.03	0.79	0.43	0.17
Factor of safety		0.30	1.55	0.78	0.19

Histogram of natural slope factor of safety			
Range	# Values		
0.30 - 0.41	6	=	
0.41 - 0.53	69	=====	
0.53 - 0.64	182	=====	
0.64 - 0.75	205	=====	
0.75 - 0.87	213	=====	
0.87 - 0.98	171	=====	
0.98 - 1.10	100	=====	
1.10 - 1.21	36	=====	
1.21 - 1.33	12	==	
1.33 - 1.44	4	=	
1.44 - 1.55	2		
Histogram Statistics			

Number of iterations	:	1000	Sample minimum	:	0.30
Sample mean	:	0.78	Sample maximum	:	1.55
Sample median	:	0.77			
Sample standard deviation:		0.19			
P[FS <= 1]	:	0.866			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 16 NATURAL SLOPE

User name MIKE LONG
Time of simulation 06-20-1995 12:37:06
Map unit LB1.MPU
Number of iterations 1000
Random number seed 911678731
Probability of failure .16

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 3.00	Apex: 4.00	Max.: 6.00
Ground slope	(%)	Triangular	Min.: 70.00	Apex: 80.00	Max.: 110.00
Tree surcharge	(psf)	Uniform	Min.: 6.00	Max.: 12.00	
Root cohesion	(psf)	Histogram 6 classes			
	Class	Minimum	Maximum	Percent	
	1	0.00	20.00	25.00	
	2	20.00	40.00	20.00	
	3	40.00	60.00	20.00	
	4	60.00	80.00	20.00	
	5	80.00	100.00	10.00	
	6	100.00	120.00	5.00	
Friction angle	(deg)	Uniform	Min.: 28.00	Max.: 34.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 200.00	
Dry unit weight	(pcf)	Normal	Mean: 85.00	Std.: 1.50	
Moisture content	(%)	Normal	Mean: 10.00	Std.: 1.50	
Specific gravity		Constant	Value: 2.5		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.20	Max.: 0.30

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	3.06	5.96	4.32	0.62
Ground slope	(%)	70.42	108.43	86.68	8.53
Tree surcharge	(psf)	6.01	12.00	9.08	1.70
Root cohesion	(psf)	0.02	119.26	46.73	30.52
Friction angle	(deg)	28.01	34.00	31.04	1.74
Soil cohesion	(psf)	0.03	199.94	100.81	56.88
Dry unit weight	(pcf)	80.48	89.64	85.04	1.51
Moist unit weight	(pcf)	86.74	101.95	93.59	2.08
Saturated unit wt.	(pcf)	110.69	116.18	113.42	0.90
Moisture content	(%)	5.37	14.64	10.05	1.52
Groundwater ratio (Dw/D)		0.02	0.29	0.17	0.06
Factor of safety		0.57	2.48	1.36	0.35

Histogram of natural slope factor of safety

Range	# Values	
0.57 - 0.74	30	=====
0.74 - 0.92	74	=====
0.92 - 1.09	140	=====
1.09 - 1.26	168	=====
1.26 - 1.44	185	=====
1.44 - 1.61	161	=====
1.61 - 1.79	120	=====
1.79 - 1.96	76	=====
1.96 - 2.14	29	=====
2.14 - 2.31	12	=====
2.31 - 2.48	5	=====

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.57
Sample mean	:	1.36	Sample maximum	:	2.48
Sample median	:	1.35			
Sample standard deviation:		0.35			
P[FS <= 1]	:	0.160			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 16 50% CUT

User name MIKE LONG
Time of simulation 06-20-1995 12:38:40
Map unit LB1.MPU
Number of iterations 1000
Random number seed 106406092
Probability of failure .224

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 3.00	Apex: 4.00	Max.: 6.00
Ground slope	(%)	Triangular	Min.: 70.00	Apex: 80.00	Max.: 110.00
Tree surcharge	(psf)	Uniform	Min.: 3.00	Max.: 6.00	
Root cohesion	(psf)	Histogram 5 classes			
	Class	Minimum	Maximum	Percent	
	1	0.00	20.00	30.00	
	2	20.00	40.00	35.00	
	3	40.00	60.00	25.00	
	4	60.00	80.00	5.00	
	5	80.00	100.00	5.00	
Friction angle	(deg)	Uniform	Min.: 28.00	Max.: 34.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 200.00	
Dry unit weight	(pcf)	Normal	Mean: 85.00	Std.: 1.50	
Moisture content	(%)	Normal	Mean: 10.00	Std.: 1.50	
Specific gravity		Constant	Value: 2.5		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.20	Max.: 0.40

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

	MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth (ft)	3.08	5.94	4.31	0.63
Ground slope (%)	70.36	109.38	86.29	8.32
Tree surcharge (psf)	3.00	6.00	4.54	0.89
Root cohesion (psf)	0.02	99.94	33.89	22.63
Friction angle (deg)	28.02	33.97	30.92	1.70
Soil cohesion (psf)	0.76	199.96	103.76	57.32
Dry unit weight (pcf)	80.80	88.95	84.94	1.45
Moist unit weight (pcf)	87.34	101.15	93.37	2.10
Saturated unit wt. (pcf)	110.88	115.77	113.36	0.87
Moisture content (%)	5.37	14.64	9.92	1.50
Groundwater ratio (Dw/D)	0.01	0.39	0.20	0.08
Factor of safety	0.54	2.37	1.29	0.34

Histogram of natural slope factor of safety

Range	# Values	
0.54 - 0.71	24	=====
0.71 - 0.87	98	=====
0.87 - 1.04	136	=====
1.04 - 1.20	158	=====
1.20 - 1.37	180	=====
1.37 - 1.54	172	=====
1.54 - 1.70	111	=====
1.70 - 1.87	62	=====
1.87 - 2.03	40	=====
2.03 - 2.20	11	==
2.20 - 2.37	8	==

Histogram Statistics

Number of iterations	: 1000	Sample minimum	: 0.54
Sample mean	: 1.29	Sample maximum	: 2.37
Sample median	: 1.28		
Sample standard deviation:	0.34		
P[FS <= 1]	: 0.224		

Level One Stability Analysis
LISA Version 2.00

=====

ID: SRI 16 CLEARCUT

User name	MIKE LONG
Time of simulation	06-20-1995 12:40:39
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	286323130
Probability of failure	.321

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.: 3.00	Apex: 4.00	Max.: 6.00
Ground slope	(%)	Triangular	Min.: 70.00	Apex: 80.00	Max.: 110.00
Tree surcharge	(psf)	Constant	Value: 0.00		
Root cohesion	(psf)	Histogram	3 classes		
	Class	Minimum	Maximum	Percent	
	1	0.00	20.00	40.00	
	2	20.00	40.00	50.00	
	3	40.00	60.00	10.00	
Friction angle	(deg)	Uniform	Min.: 28.00	Max.: 34.00	
Soil cohesion	(psf)	Uniform	Min.: 0.00	Max.: 200.00	
Dry unit weight	(pcf)	Normal	Mean: 85.00	Std.: 1.50	
Moisture content	(%)	Normal	Mean: 10.00	Std.: 1.50	
Specific gravity		Constant	Value: 2.5		
Groundwater ratio (Dw/D)		Triangular	Min.: 0.00	Apex: 0.30	Max.: 0.50

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	3.02	5.92	4.36	0.64
Ground slope	(%)	70.61	108.64	86.59	8.39
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.08	59.84	24.22	14.16
Friction angle	(deg)	28.00	34.00	30.91	1.71
Soil cohesion	(psf)	0.09	199.95	101.36	58.42
Dry unit weight	(pcf)	80.36	89.64	84.92	1.46
Moist unit weight	(pcf)	86.38	99.68	93.41	2.03
Saturated unit wt.	(pcf)	110.62	116.18	113.35	0.88
Moisture content	(%)	5.47	14.64	10.00	1.52
Groundwater ratio (Dw/D)		0.02	0.50	0.27	0.10
Factor of safety		0.44	2.16	1.19	0.32

Histogram of natural slope factor of safety

Range	# Values	
0.44 - 0.59	12	===
0.59 - 0.75	63	=====
0.75 - 0.91	156	=====
0.91 - 1.06	154	=====
1.06 - 1.22	156	=====
1.22 - 1.38	164	=====
1.38 - 1.53	138	=====
1.53 - 1.69	89	=====
1.69 - 1.85	48	=====
1.85 - 2.00	14	===
2.00 - 2.16	6	=

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.44
Sample mean	:	1.19	Sample maximum	:	2.16
Sample median	:	1.18			
Sample standard deviation:		0.32			
P[FS <= 1]	:	0.321			

Level One Stability Analysis
LISA Version 2.00

ID: SRI 16 WILDFIRE

User name	MIKE LONG
Time of simulation	06-20-1995 12:41:54
Map unit	LB1.MPU
Number of iterations	1000
Random number seed	610829830
Probability of failure	.486

INPUT DATA
=====

NATURAL DATA

Soil depth	(ft)	Triangular	Min.:	3.00	Apex:	4.00	Max.:	6.00
Ground slope	(%)	Triangular	Min.:	70.00	Apex:	80.00	Max.:	110.00
Tree surcharge	(psf)	Constant	Value:	0.00				
Root cohesion	(psf)	Constant	Value:	0.00				
Friction angle	(deg)	Uniform	Min.:	28.00	Max.:	34.00		
Soil cohesion	(psf)	Uniform	Min.:	0.00	Max.:	200.00		
Dry unit weight	(pcf)	Normal	Mean:	85.00	Std.:	1.50		
Moisture content	(%)	Normal	Mean:	10.00	Std.:	1.50		
Specific gravity		Constant	Value:	2.5				
Groundwater ratio (Dw/D)		Triangular	Min.:	0.00	Apex:	0.40	Max.:	0.70

DESCRIPTIVE STATISTICS OF SIMULATED VALUES -- NATURAL SLOPE

		MINIMUM	MAXIMUM	MEAN	S.D.
Soil depth	(ft)	3.03	5.89	4.34	0.63
Ground slope	(%)	70.40	109.42	86.51	8.27
Tree surcharge	(psf)	0.00	0.00	0.00	0.00
Root cohesion	(psf)	0.00	0.00	0.00	0.00
Friction angle	(deg)	28.00	34.00	30.95	1.77
Soil cohesion	(psf)	0.02	199.94	101.49	57.61
Dry unit weight	(pcf)	80.36	89.64	84.97	1.53
Moist unit weight	(pcf)	87.24	99.22	93.46	2.07
Saturated unit wt.	(pcf)	110.62	116.18	113.38	0.92
Moisture content	(%)	5.50	14.64	9.99	1.48
Groundwater ratio (Dw/D)		0.01	0.69	0.36	0.14
Factor of safety		0.41	1.97	1.03	0.31

Histogram of natural slope factor of safety

Range	# Values	
0.41 - 0.55	41	=====
0.55 - 0.69	122	=====
0.69 - 0.83	142	=====
0.83 - 0.98	151	=====
0.98 - 1.12	154	=====
1.12 - 1.26	158	=====
1.26 - 1.40	106	=====
1.40 - 1.54	71	=====
1.54 - 1.68	35	=====
1.68 - 1.83	16	=====
1.83 - 1.97	4	=====

Histogram Statistics

Number of iterations	:	1000	Sample minimum	:	0.41
Sample mean	:	1.03	Sample maximum	:	1.97
Sample median	:	1.01			
Sample standard deviation:		0.31			
P[FS <= 1]	:	0.486			

FISHERIES APPENDIX

Methods for determining risk of extinction of bull trout populations and assumptions.

As described in Chapter 3, the McKenzie population, due to its isolation, is difficult to describe using current models to assess population viability (Rieman and McIntyre 1993). A description of risk based on Nehlsen et al. (1991) and further developed by Ratliff and Howell (1992) is used to describe bull trout population risk based upon the following criteria: relative abundance, habitat condition, presence of brook trout, and recovery potential (Table 1).

Table 1. Bull trout risk of extinction criteria

Category	Abundance	Habitat	Brook trout	Recovery potential
Low risk of extinction	High	Excellent	None	
Of special concern	↑	↑	↑	Very good
Moderate risk of extinction	↓	↓	↓	↓
High risk of extinction	Very low	Poor	High	Major effort required
Probably extinct	No reports since 1980			

table from Ratliff and Howell 1992.

The McKenzie population was rated by Ratliff and Howell in 1992 as at moderate risk of extinction due to the following suppressing factors:

- Abundance low - over harvest (recent game regulations permitted keeping bull trout) and low known population.
- Habitat fair - habitat degradation due to the effects of timber harvest/riparian development and fragmentation of habitat with passage barriers.
- Brook trout present in low numbers - brook trout have established themselves in the upper McKenzie presenting competition and hybridization risks.

There presently has not been a significant change in these conditions. Recent increases in adult populations observed in redd counts in the fall of 1994 are likely due to recent changes in game regulations and inventory of spawning habitat not previously surveyed. Although encouraging, such fluctuations are characteristic of a small population. Upgrading the McKenzie population status should rely on long term improvement in spawning populations and reduction of other suppressing factors. A summer 1995 project will provide passage around a barrier culvert in Olallie Creek. About one mile of historically accessible spawning and rearing habitat will be available

in Olallie Creek. Rearing habitat has been identified as a factor limiting bull trout production in the upper McKenzie River. Bull trout fry have been reintroduced into upper Olallie Creek for the past two years (1994-95) in anticipation of reestablishing access. Bull trout reintroduction is scheduled to continue through 1998.

The Trail Bridge population, artificially isolated above Trail Bridge Dam, was rated by Ratliff and Howell in 1992 as at high risk of extinction due to the following suppressing factors:

- Abundance extremely low - over harvest (recent game regulations permitted keeping bull trout) and low known population.
- Habitat fair - habitat alteration due to construction of dam/timber harvest/riparian development and fragmentation of habitat with passage barriers.
- Brook trout present in high numbers - brook trout have established themselves in the Trail Bridge pool presenting competition and hybridization risks.

Although the population remains at high risk of extinction, the outlook is hopeful. Recent treatment of a barrier to Sweetwater Creek spawning and rearing habitat in 1992 and reseeding efforts (1993-95) are expected to reestablish bull trout use of this spring-fed tributary to Trail Bridge pool. Bull trout reintroduction is scheduled to continue through 1998. Monitoring of the Trail Bridge population continues and will allow up to date population status.

Evaluation of existing and historic aquatic habitat and channel condition and assumptions.

To assess aquatic habitat condition, several methods of physical habitat inventory have been referred to in this analysis. Region 6 of the Forest Service uses a methodology, the Stream Inventory Handbook (USFS Level II Method), that has evolved since 1988 into its most recent iteration, Version 7.5, 1994. Earlier Level II surveys include the Gifford Pinchot Method (USFS G-P Method) which used similar units to measure physical habitat such as large wood and channel measurements. The Forest Service protocols measure habitat in feet. A similar, metric based protocol is used by Oregon Department of Fish and Wildlife. Large wood and channel dimensions are easily converted to the Forest Service format. Surveys conducted since 1990 are most recent in the analysis area and were used to represent current aquatic habitat condition.

Several habitat parameters have been singled out to reflect channel and aquatic habitat condition. The processes of channel morphology are significantly influenced by in-stream large wood in the Cascades, their presence deflecting flows to shape channel complexity, form pools, and provide cover and nutrients, elements important to species at risk adapted to this landscape and described in this analysis. Large pool frequency is partially a function of active channel width, channel gradient and substrate, and in the Cascades the frequency of pools often correlate to the presence or absence of large in-stream wood. The influence of land management activities is often evident in stream survey summaries as low quantities of in-stream wood, low pool frequency, and/or low pool depth.

A difference in recording large pools between the ODFW and USFS methods exists. The ODFW protocol records all pools, including pocket pool habitat in its total of pool habitat. The Forest Service method records channel spanning pool habitats (as long as they are wide) as large pools for a pool habitat total. For this reason, direct comparison of pool habitat area is not possible between the two methods.

Valley Segment Types and Geographical Information System (GIS) analysis of historic and existing seral stage are another method of assessing riparian influence and associated channel condition. Flood plain width, available shade and stream temperature, recruitment supply of future in-stream wood, and riparian seral stage were examined for historic and current condition.

Quantitative parameters representing naturally functioning channels have been developed for western Cascades streams by researchers at the Forest Service Lab, Pacific Northwest Research Station (PNW), the Regional Ecological Assessment Report (REAP) and other sources and provide insight for historic channel condition when none is available in managed landscapes. A "least managed" landscape and stream in a landform block also provides historic insight. The following table summarizes reference conditions used to evaluate existing aquatic habitat and channel condition

(Table 9). These conditions were used when information was not available to estimate historic condition.

table to be provided at a later date

Stream classifications:

Class I streams are perennial (year round flow) or intermittent (flowing part of the year) streams that meet one or more of the following criteria: 1) serve as the direct source of water for domestic use; 2) provide habitats for either spawning, rearing, or migration of large numbers of fish; and/or 3) contain sufficient flow to have a major influence on water quality of another Class I stream.

Class II streams are perennial or intermittent streams that meet one or both of the following characteristics: 1) provide habitats for either spawning, rearing, or migration for moderate though significant numbers of fish; and/or 2) contain sufficient flow to have a moderated influence on water quality of a downstream Class I or II stream. Fish are present for at least a portion of the year or the stream has the potential for establishment or re-establishment of fish populations.

Class III streams are all other perennial streams that do not meet the criteria for Class I or II streams

Class IV streams are all other intermittent or ephemeral streams that do not meet the criteria for Class I, II or III streams (USDA Forest Service, 1990).

WILDLIFE APPENDIX

SPOTTED OWLS

ACRES OF SUITABLE HABITAT FOR SPOTTED OWLS WITHIN THE UPPER MCKENZIE WATERSHED.

Site Name	Acres 1.2*	Site Name	Acres 1.2*	Site Name	Acres 1.2*
Anderson Creek	1547	Frissell Creek	1861	Norwegian Creek	2110
Belknap Springs	2044	Frissell Point	1646	Payne Spring	2058
Boulder Creek	1802	Great Spgs/Clear Lk	1285	Potato Hill	1466
Budworn Creek	1804	Hand Lake Trail	1241	Powers Creek	1176
Bunchgrass Creek	1803	Irish Camp Lake	383	Proxy Point	1492
Bunchgrass Mountain	1482	Kuitan Lake	1323	Santiam Junction	1194
Carpenter Creek	1651	Lost Branch	1696	Smith Reservoir	2014
County Creek	1670	Lost Creek	1914	South Station	1002
Carmen Reservoir	1339	Lost Lake	1143	Sweet Water Creek	1950
Deer Creek	1771	Lower Browder Creek	2281	Tamolitch Falls	1812
East Beaver Marsh	1399	L. Bunchgrass Ridge	1575	Upper Kink Creek	894
East Boulder Creek	1441	Lower Foley Ridge	1681	West County	1447
Fish Lake	1095	McKenzie Gulch	1677	West Scott	0994
Florence Creek	1092	Nash Crater	950	White Branch	1602
				Wild Cat RNA	2896

* 1.2 = mile radius from owl site center

ACRES OF SUITABLE HABITAT FOR SPOTTED OWL SITES OUTSIDE THE UPPER MCKENZIE WATERSHED THAT HAVE HOME RANGES EXTENDING INTO THE WATERSHED.

Site Name	Acres 1.2*	Site Name	Acres 1.2*	Site Name	Acres 1.2*
Cone Peak	887	Lookout Mountain	1802	South Pyramid	1932
East Mill Creek	1275	Maude Creek	1278	South Station	1002
East Wildcat Mtn	1860	N. Browder Creek	1835	Tombstone Summit	1675
Echo Cr/Lost Prairie	1537	N. Carpenter Mtn	1202	Upper Crescent Cr	1805
Indian Creek	1651	Parks Creek	1863	Upper Foley Ridge	2281
Indian Creek/Tombstone	1673	Parks Lava	1268	Upper Gate Creek	1880
Lake Creek	1497	Silver Lake	1545	Upper Separation	2139
Lava Lake	1466	Smith River	2054	Upper Smith River	1869

* 1.2 = mile radius from owl site center

SUMMARY OF THE CURRENT CONDITION OF THE SANTIAM PASS CRITICAL HABITAT UNIT 15

Capable acres are those areas that are capable of producing stands of spotted owl nesting, roosting, foraging, or dispersal habitat that are not currently in one of these habitat conditions.

CHU #	TOTAL ACRES	NRFD		CAP		NEV CAP	
		AC	%	AC	%	AC	%
15	42919	24668	57	12135	28	6116	14

KEY TO CHU TABLE:

TOTAL AC.: TOTAL ACRES OF NRFD HABITAT PLUS CAPABLE HABITAT ON FEDERAL LAND IN CHU

NRFD AC., %: TOTAL BASELINE ACRES OF NRFD HABITAT IN CHU, AND % OF TOTAL ACRES

CAP. AC., %: TOTAL BASELINE ACRES, NOT CURRENTLY NRFD HABITAT, THAT ARE CAPABLE OF PRODUCING NRFD HABITAT IN THE FUTURE, AND % OF TOTAL ACRES.

NEV CAP, AC, %: TOTAL ACRES THAT WILL NEVER BE CAPABLE OF PRODUCING NRFD HABITAT

EXISTING DATA FOR CHU 15 OWL SITES.

CHU#	STS.KN +	STS.KN -	STS.EX +	TOT
15	9	6	1	16

KEY TO TABLE CHU 15 OWL SITES:

STS.KN+: PAIRS AND RESIDENT SINGLES DETECTED WITHIN THE LAST 3 YEARS; AT OR ABOVE THE USFWS PROPOSED TAKE THRESHOLD IN THE APPROPRIATE PROVINCE.

STS.KN-: SITES DETECTED WITHIN THE LAST 3 YEARS; THAT DO NOT MEET THRESHOLD.

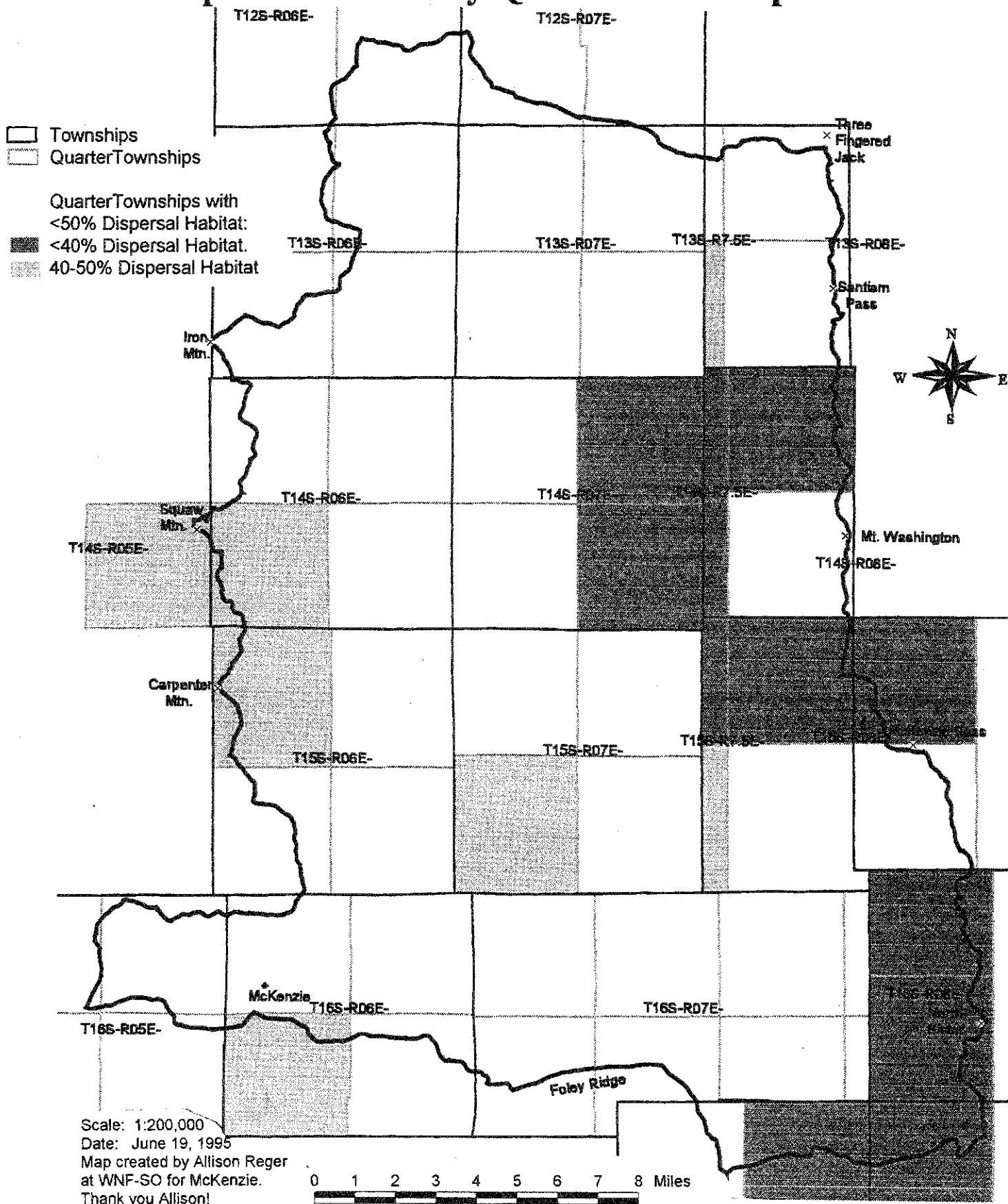
STS.EX.+ SITES EXPECTED TO BE OCCUPIED, BUT NOT ADEQUATELY SURVEYED WITHIN THE LAST 3 YEARS. MAY BE COUNTED IF HABITAT MEETS THRESHOLD.

TOT.: TOTAL OF FIRST 3 COLUMNS.

50-11-40 ANALYSIS FOR QUARTER TOWNSHIPS IN THE UPPER MCKENZIE WATERSHED

Quarter Township	LSRs and wilderness included			
	Total	Capable	Dispersal Habitat	
	Acres	Acres	Ac	%
T.12S R.6E SE	5,624	4,805	3,110	64.7%
T.12S R.6E SW	5,579	4,607	3,501	76.0%
T.12S R.7 1/2E SE	5,451	4,768	3,588	75.3%
T.12S R.7 1/2E SW	873	827	670	81.0%
T.13S R.6E NE	5,837	4,178	2,103	50.3%
T.13S R.6E NW	5,574	3,647	2,238	61.4%
T.13S R.6E SE	5,702	5,271	2,750	52.2%
T.13S R.6E SW	5,538	3,603	2,747	76.2%
T.13S R.7 1/2E NE	4,614	3,570	2,466	69.1%
T.13S R.7 1/2E NW	814	572	397	69.4%
T.13S R.7 1/2E SE	5,079	4,619	2,877	62.3%
T.13S R.7 1/2E SW	932	768	347	45.1%
T.13S R.7E NE	5,628	5,145	4,368	84.9%
T.13S R.7E NW	5,802	4,914	2,746	55.9%
T.13S R.7E SE	5,736	5,601	3,514	62.7%
T.13S R.7E SW	5,784	4,956	2,741	55.3%
T.14S R.5E SE	5,675	3,858	2,018	52.3%
T.14S R.6E NE	5,755	5,475	3,646	66.6%
T.14S R.6E NW	5,447	4,872	2,832	58.1%
T.14S R.6E SE	5,750	5,545	4,090	73.8%
T.14S R.6E SW	5,334	5,020	2,424	48.3%
T.14S R.7 1/2E NE	4,965	4,658	2,999	64.4%
T.14S R.7 1/2E NW	1,121	1,114	572	51.3%
T.14S R.7 1/2E SE	5,314	3,657	2,981	81.5%
T.14S R.7 1/2E SW	1,161	781	661	84.6%
T.14S R.7E NE	5,895	5,735	2,050	35.8%
T.14S R.7E NW	5,760	5,462	3,217	58.9%
T.14S R.7E SE	5,824	4,218	2,068	49.0%
T.14S R.7E SW	5,804	5,330	3,063	57.5%
T.15S R.6E NE	6,170	5,938	3,845	64.8%
T.15S R.6E NW	6,086	5,784	2,965	51.3%
T.15S R.6E SE	5,790	5,596	3,436	61.4%
T.15S R.6E SW	5,532	5,091	3,819	75.0%
T.15S R.7 1/2E NE	5,584	1,509	345	22.8%
T.15S R.7 1/2E NW	1,234	1,080	466	43.1%
T.15S R.7 1/2E SE	6,874	4,513	3,427	75.9%
T.15S R.7 1/2E SW	1,423	1,411	566	40.1%

Dispersal Habitat by QuarterTownship



LSRs and wilderness included				
Quarter Township	Total	Capable	Dispersal Habitat	
	Acres	Acres	Ac	%
T.15S R.7E NE	5,760	5,634	3,932	69.8%
T.15S R.7E NW	5,765	5,755	3,084	53.6%
T.15S R.7E SE	6,246	6,112	5,230	85.6%
T.15S R.7E SW	6,272	6,270	2,623	41.8%
T.15S R.8E NW	629	53	15	28.1%
T.15S R.8E SW	4,350	1,703	1,099	64.5%
T.16S R.5E NE	5,425	4,209	3,108	73.8%
T.16S R.5E NW	5,688	4,398	2,233	50.8%
T.16S R.5E SE	5,553	3,758	3,218	85.6%
T.16S R.6E NE	5,399	4,590	2,885	62.8%
T.16S R.6E NW	5,429	3,885	2,502	64.4%
T.16S R.6E SE	5,659	5,485	3,855	70.3%
T.16S R.6E SW	5,697	5,064	3,710	73.3%
T.16S R.7E NE	6,776	6,229	4,559	73.2%
T.16S R.7E NW	11,148	10,749	6,930	64.5%
T.16S R.7E SE	4,983	4,563	4,146	90.9%
T.16S R.7E SW	9,187	8,406	5,624	66.9%
T.16S R.8E NW	3,831	940	767	81.6%
T.16S R.8E SW	4,801	504	371	73.6%
T.17S R.7E NE	5,757	4,409	3,089	70.1%
T.17S R.7E NW	5,907	5,799	4,038	69.6%
T.17S R.8E NW	5,510	1,108	663	59.8%

See following map for location of quarter townships.

ANALYSIS OF LATE SUCCESSIONAL RESERVES

There are five Late Successional Reserves less than 10 miles from the Santiam Forest Health EIS project area. Their approximate distance is displayed in the following table.

DIRECTION AND DISTANCE TO LATE SUCCESSIONAL RESERVES WITHIN 10 MILES OF THE PLANNING AREA.

Direction	Distance to LSR
North	7 miles (RO214)
Northwest	0 (RO213)
West	0 (RO215)
East (2)	1 (RO244,RO245)
South	0 (RO218)

The following tables give detailed information on each LSR less than 10 miles from the project area. The data tables attempt to assess the "health" of each LSR in terms of detected spotted owl sites; owl sites within a take situation; and reproductive history.

Please realize that survey intensities have varied greatly within the LSR's. The majority of the areas have not received consistent survey coverage on a regular basis. We do not have information on percent surveyed at this time.

SUMMARY OF LSR R0213

Total Acres for LSR RO213 = 84198

Percent of NRF habitat = 62

Total existing number of sites (Pairs/Resident singles) = 48

Potential owl sites = 22*

Number of Pairs/RS in a Take Situation = 9

*based on an assumption that 80% of the LSR could be NRF habitat at any one time, and each owl pair's home range is 3000 acres.

This LSR lies to the northwest of the analysis area. Over 50% of its landbase is currently in a NRF condition. It contains 48 owl sites, which twice the calculated potential. Nine owl sites are in a "take" situation.

SUMMARY LSR R0214

Total acres = 40035

Percent of NFR = 52

Number of owl sites (Pairs/resident singles) = 25

Potential owl sites = 11*

Number of owl Pairs/Rs in a Take situation = 14

*based on an assumption that 80% of the LSR could be in an NRF condition at any one time, and each owl pair's home range is 3000 acres.

This LSR lies to the north of the analysis area on the Detroit Ranger District. Over 50% of its landbase is currently in a NRF condition. It contains 25 owl sites, which is over twice the calculated potential. However, over half of the existing sites are in a take situation.

SUMMARY OF LSR R0215

Total acres = 26514

Percent of NFR = 76

Number of owl sites (Pairs/Resident singles) = 14

Potential owl sites = 7*

Number of owl Pairs/Rs in a Take situation = 1

*based on an assumption that 80% of the LSR could be in an NRF condition at any one time, and each owl pair's home range is 3000 acres.

This LSR lies to the west of the analysis area on the Sweet Home Ranger District. Over 50% of its landbase is currently in a NRF condition. It contains 14 owl sites, which is twice the calculated potential. Only one of the existing sites is in a take situation.

SUMMARY OF LSR R0218

Total Acres = 26366

Percent of NRF habitat = 70

Total existing number of sites (Pairs/Resident singles) = 16

Potential owl sites = 7*

Number of Pairs/RS in a Take Situation = 1

* based on an assumption that 80% of the LSR could be NRF habitat at any one time, and each owl pair's home range is 3000 acres.

This LSR lies to the south of the analysis area. Over 50% of its landbase is currently in a NRF condition. It contains 16 owl sites, which is twice the calculated potential. One owl site is in a "take" situation.

SUMMARY OF LSR R0244

Total acres = 28572
Percent of NRF = 33
Number of owl sites (Pairs/resident singles) = 5
Potential Owl sites = 8*
Number of owl Pairs/RS in a Take situation = 5

*based on an assumption that 80% of the LSR could be in an NRF condition at any one time, and each owl pair's home range is 3000 acres.

This LSR lies to the east of the analysis area on the Deschutes National Forest. Less than 50% of its landbase is currently in a NRF condition as defined by west side definitions. This habitat is comprised of ponderosa pine and true firs. The LSR contains 5 owl sites, which is less than the calculated potential. All of the existing sites are in a take situation as defined by westside rules. In reality, less than 80% of the LSR may be capable of producing NRF habitat of significant quality because of the vegetation conditions.

SUMMARY OF LSR R0245

Total acres = 75762
Percent of NRF = 34
Number of owl sites (Pairs/resident singles) = 14
Potential owl sites = 20
Number of owl Pairs/RS in a Take situation = 14

*based on an assumption that 80% of the LSR could be in an NRF condition at any one time, and each owl pair's home range is 3000 acres.

This LSR lies to the east of the analysis area on the Deschutes National Forest. Less than 50% of its landbase is currently in a NRF condition as defined by west side definitions. This habitat is comprised of ponderosa pine and true firs. The LSR contains 14 owl sites, which is less than the calculated potential. All of the existing sites are in a take situation as defined by westside rules. In reality, less than 80% of the LSR may be capable of producing NRF habitat of significant quality because of the vegetation conditions.

BIG GAME ANALYSIS

HABITAT EFFECTIVENESS RATINGS FOR THE UPPER MCKENZIE WATERSHED SUBDRAINAGES

Habitat effectiveness ratings for size and spacing of forage and cover areas (HEs), forage quality (HEf), cover quality (HEc), open road density (HEr), and overall habitat effectiveness (HEsrcf). () indicates analysis on winter range portion only. (*) indicates no winter range or not enough acres of winter range to effect analysis.

HIGH EMPHASIS

HE VALUE	KINK	ANDERSON OLLALIE	NORWEGIAN TWISTY	BOULDER	SCOTT
HEs	0.70	0.71	0.83	0.68	0.87
HEc	0.40 (0.46)	0.49 (0.49)	0.46 (0.46)	0.44 (0.41)	0.45 (0.44)
HEf	0.37	0.43	0.36	0.34	0.33
HEr	0.54	0.58	0.54	0.68	0.51
HEsrcf	0.48	0.54	0.52	0.51	0.507

HE VALUE	HACKLE-MAN	GATE/IKENICK	UW McK. FRITZ BUNCH-GRASS	FLORENCE MILL	MAUDE
HEs	0.88	0.85	0.82	0.71	0.84
HEc	0.51 (0.44)	0.66 (0.64)	0.47 (0.47)	0.50 (0.49)	0.59 (*)
HEf	0.28	0.39	0.42	0.33	0.37
HEr	0.48	0.54	0.49	0.41	0.43
HEsrcf	0.49	0.586	0.53	0.468	0.53

HE VALUE	BROW-DER	N. FORK PARKS
HEs	0.85	0.91
HEc	0.63 (0.66)	0.57 (*)
HEf	0.45	0.39
HEr	0.50	0.47
HEsrcf	0.59	0.56

MODERATE EMPHASIS

HE VALUE	OLD SQUAW W. BRUSH E. BRUSH	MID DEER CARPENTER COUNTY	BUDWORM FRISSELL	UPPER NORTH SANTIAM	PARADISE BELKNAP
HEs	0.83	0.90	0.86	0.78	0.52
HEc	0.40	0.41	0.52	0.46	0.45
HEf	0.52	0.48	0.39	0.27	0.45
HEr	0.38	0.48	0.53	0.74	0.54
HEsrcf	0.51	0.51	0.55	0.52	0.488

HE VALUE	S. SIDE McKENZIE	N. SIDE HORSE	FROST	HOODOO	WHITE BRANCH
HEs	0.66	0.62	0.53	0.55	0.37
HEc	0.53	0.43	0.57	0.21	0.34
HEf	0.46	0.40	0.28	0.49	0.61
HEr	0.40	0.46	0.57	0.40	0.63
HEsrcf	0.50	0.47	0.47	0.39	0.47

LOW EMPHASIS

HE VALUE	E. SIDE UPPER McKENZIE	WASHING- TON	CRATERS
HEs	0.63	0.55	0.20
HEc	0.36	0.20	0.25
HEf	0.27	0.67	0.00
HEr	0.54	1.00	0.74
HEsrcf	0.43	0.52	0.00

HE VALUES CALCULATED WITHOUT PRIVATE ACRES (FOREST SERVICE ACRES ONLY)

HIGH EMPHASIS

HE VALUE	MAUDE	N. FORK PARKS	HACKLEMAN	FLORENCE MILL
HEs	0.80	0.90	0.87	0.65
HEc	0.69 (*)	0.61 (*)	0.52 (0.44)	0.51 (0.50)
HEf	0.39	0.43	0.28	0.38
HEr	0.45	0.52	0.48	0.43
HEsrcf	0.56	0.59	0.50	0.48

MODERATE EMPHASIS

HE VALUE	FROST
HEs	0.70
HEc	0.58
HEf	0.32
HEr	0.54
HEsrcf	0.51

SNAG ANALYSIS

SNAG REQUIREMENTS FOR MANAGING SNAG GUILD IN COMPLIANCE WITH THE 1994 ROD.

Low elevation in the UPPER MCKENZIE WATERSHED includes western hemlock and Douglas-fir series. High elevation includes Mountain hemlock, Pacific silver fir, and grand fir.

CAVITY USING SPECIES	100% LEVELS LOW ELEVATION	100% LEVELS HIGH ELEVATION
RED BREASTED SAPSUCKER	0.45	.45
DOWNY WP	0.16	NP
HAIRY WP	1.92	1.92□
RED BREASTED NUTHATCH	0.76	0.76
WHITE BREASTED NUTHATCH	NP	0.76
N. FLICKER	0.48	0.48
PILEATED WP	0.06	0.06
BLACK-CAPPED CHICKADEE	2NDARY	2NDARY
WILLIAMSON'S SAPSUCKER	NP	0.33
THREE -TOED WP	NP	0.06
BLACK BACKED WP	NP	ADDED SEPARATELY
MOUNTAIN CHICKADEE	2NDARY	2NDARY
CHESTNUT-BACKED WP	2NDARY	2NDARY
LEWIS WP	NO BREEDING RECORDS	NP
ACORN WP	NO BREEDING RECORDS	NP
WHITE-HEADED WP	NO BREEDING RECORDS	NP
TOTAL	-3.83	4.82

SNAGS TO MEET LOW ELEVATION 40% REQUIREMENT:

$$.4 \times 3.83 = -1.532$$

SNAGS TO MEET HIGH ELEVATION 40% REQUIREMENT + 100% BLACK BACKED REQUIREMENT:

$$.4 \times 4.82 = 1.928 + .12 \text{ FOR BLACK BACKED} = -2.048 - \square$$

WILDLIFE SPECIES THAT USE SNAGS FOR BREEDING IN EARLY SERAL HABITAT BY VEGETATION SERIES

VEG SERIES	# SPECIES THAT PRIMARYLY USE EARLY SERAL FOR BREEDING	# SPECIES REQUIRING SNAGS	# SPECIES REQUIRING DOWN WOODY MATERIAL
GRAND FIR	125	36	45
PACIFIC SILVER FIR	103	33	41
WESTERN HEMLOCK	114	32	45
DOUGLAS FIR	120	32	49
MT HEMLOCK	106	34	40

24% OR 78 SPECIES OF WILDLIFE ON THE WILLAMETTE NF REQUIRE SNAGS IN EARLY, MID OR LATE SERAL FORESTED HABITAT FOR BREEDING.

21% OR 68 SPECIES OF WILDLIFE ON THE WILLAMETTE NF REQUIRE DOWN WOODY MATERIAL IN EARLY, MID OR LATE SERAL FORESTED HABITAT FOR BREEDING.

PERCENT SNAG HABITAT LEVELS BY LANDFORM BLOCK

LANDFORM BLOCK	SNAG LEVEL
1	46
2A	49
2B	53
3	48
4	55
5	52
6	66

ASSUMPTIONS:

LATE SUCCESSIONAL HABITAT PROVIDING 80% LEVELS. Reduced from 100% for roadside salvage and younger stands in this class that may not have developed large snags yet.

MID SUCCESSIONAL HABITAT PROVIDING 30-40% LEVELS. Reduced from 100% for roadside salvage and younger stands that have not developed snags of larger size yet.

EARLY SUCCESSIONAL HABITAT PROVIDING 40% LEVELS ON 5-10% OF THE ACRES AND 0% ON 90-95% OF THE ACRES. Reduced since only been implementing Forest Plan standard for 40% retention for past 4 years. All early seral prior to that has no snag retention.