United States
Department
of Agriculture

Forest Service

**Pacific
Northwest
Region**

1995

Eagle Creek Watershed Analysis

Mt. Hood National Forest

Table of Contents

Figures

Tables

Maps

Chapter 1

Characterization of the Watershed

Chapter 1
Characterization of the Watershed

Purpose

The Eagle Creek Watershed Analysis was prepared as one step in the application of the Northwest Forest Plan and implementing the Aquatic Conservation Strategy. This document is the first watershed analysis on the Mt. Hood National Forest created in full partnership with the Bureau of Land Management (BLM). Databases and responsibilities were fully shared (Appendix C Data Dictionary). The purpose of the analysis is to:

- develop and document a scientifically-based understanding of the natural ecology, processes and interactions of the Eagle Creek area, and
- based on this understanding, make management recommendations for future actions such as restoration and transportation planning.

Watershed analysis is the landscape scale link between the broad policy direction of existing top-down decisions, and the smaller scale projects that are normally done within an environmental assessment framework. Watershed analysis is an ongoing, iterative process. This report is a dynamic document, and is intended to be revised and updated as new information becomes available.

This document follows methodologies recommended in the Federal Agency Guide for Pilot Watershed Analysis (1994), Federal Guide for Ecosystem Management (draft 1995). It also incorporates Landscape Analysis and Design (Diaz & Apostol 1992) as a tool for data synthesis and developing future trends and landscape objectives.

Watershed Setting

Location

Eagle Creek watershed lies in north central Oregon on the west slope of the Cascade Range, comprising about 57,500 acres. Eagle Creek flows into the Clackamas River 5 miles north of Estacada (Map 1-1).

Climate

The climate is temperate, with average annual precipitation ranging from 55 inches near the mouth to 100 inches in the upper reaches near Squaw Mountain. Approximately 70% of the precipitation occurs from October through March, while less than 3% occurs in July and August. Less than 35% of the watershed lies within the transient snow zone, where snow levels fluctuate during the winter.

Physiography

Elevations in the watershed range from about 300 feet at the confluence with the Clackamas River to slightly over 4200 feet in the headwaters of the Upper Eagle Mainstem and South Fork subwatersheds around Old Baldy Mountain (4209 feet) and Squaw Mountain (4771 feet). The watershed is approximately 18 miles long and 7 miles wide at its widest point. Eagle Creek flows in generally a westerly direction and has three major tributaries, South Fork, Delph Creek and North Fork (Map 1-2). Much analysis was stratified by these subwatersheds. Stream gradients generally exceed 2% except for the three miles above the confluence with the Clackamas River where depositional channels exist. Stream gradients exceed 4% in many of the tributaries that feed into the major channels in the upper half of the watershed.

Eagle Creek Mainstem has mostly cobble substrate contributing to a predominately riffle environment. The Lower Mainstem and parts of the Middle Mainstem have modest floodplain development. South Fork has cobble and boulder substrate with a narrow floodplain. The major tributaries, Bear Creek, Little Eagle Creek that flow into North Fork have predominately cobble substrate with narrow floodplains. Delph Creek has a gravel substrate with broad and narrow floodplains.

Geology/Geomorphology

The Eagle Creek Watershed varies substantially in terms of topographic relief and consequently, landslide potential. In the eastern portion of the watershed, slopes consist of lava flows and slightly indurated volcaniclastic formations, with drainages deeply incised and slope angles exceeding 70% in some areas. This landscape is predominately erosional. In contrast, the landscape of the western portion of the watershed is largely depositional. Drainages are shallow, and some meander within narrow floodplains. Slope angles are modest. The fluvial deposits that form much of this part of the watershed have been transported by both Eagle Creek and the Clackamas River.

Major instability problems are largely limited to the deeply incised drainages in the eastern portion of the watershed where slope angles exceed 50 and sometimes 70 percent.

Plants and Animals

The watershed lies predominately within the western hemlock zone with parts of the upper watershed occurring within the Pacific Silver Fir and Mountain Hemlock Zones. Dominant tree species include Douglas-Fir, western hemlock, western red cedar, pacific silver fir, noble fir, red alder and big leaf maple. Understory species include vine maple, rhododendron sword fern, salal, Alaska huckleberry, and bear grass. Several plant species of concern are thought to occur in the more unique vegetation types. Currently, 25% of the watershed is in early forest seral stage, 64% in mid, and 10% in late seral. These plant communities provide habitat for a variety of animal species including elk, black-tailed deer, red-tailed hawk, and late seral forest associated species such as the northern spotted owl.

Aquatic

The watershed supports anadromous salmonids including winter steelhead, coho salmon and spring chinook. Late-run Coho and Winter Steelhead were identified as "stocks at risk" (Nehlsen et al, 1991). In total, about 28 miles of habitat are utilized by anadromous salmonids as salmonid migration is blocked just below a falls at the Eagle Creek National Fish Hatchery (ELNFH). Fish ladders exist on two water falls below the hatchery. The hatchery, operated by the U.S. Fish and Wildlife Service (USFWS), currently produce Winter Steelhead and Early Run Coho. Historically Spring and Fall Chinook were raised and released from this facility.

Water temperatures in habitat used by anadromous fish are generally favorable. However, during hot summers with low flows, water temperatures can reach stressful levels.

Tributaries above the fish hatchery support healthy populations of resident Cutthroat trout. These trout are likely to be genetically distinct due to the presence of the three large falls causing barriers to genetic mixing of any downstream trout. Rainbow trout have been stocked in the Mainstem at Eagle Fern Park and in North Fork on BLM property to provide a recreational fishery.

Social/People

Information on American Indian use in the Eagle Creek watershed is sketchy. Areas on the Clackamas River near the mouth of Eagle Creek have been identified as important sites for salmon harvest and preservation. Huckleberry fields in the higher elevations continue to be used by Warm Springs people. Scattered lithic sites have been found in the higher elevations of Eagle Creek.

European settlement coincided with the Oregon Trail westward expansion. After Phillip Foster opened his nearby farm to greet travelers and sell goods in 1848, settlers also traveled east into the Eagle Creek watershed. Between the 1850's and 1900 nine separate settlements, each with their own school house, developed in the Eagle Creek lowlands. The Eagle Creek post office was established in 1852, and plateaus in the lower one half of the watershed have been cleared and farmed.

Ownership

Forest Service and BLM manage 37% of the watershed (Table 1 and Map 1-3).

A recent land exchange has taken place between Clackamas County and the Forest Service during this analysis. The north half of section 18, T3S, R6E is county property (320 acres) and is no longer National Forest land. Our analysis will not reflect this change.

Table 1. Owners Within the Watershed

Owner	Acres	Percent of Total
BLM	4,004	7%
Clackamas County	181	0.3%
Forest Service	17,272	30%
US Fish and Wildlife Service	119	0.2%
Longview Fiber	13,698	23.8%
Other Private	22,236	38.7%
Total	57,510	100%

Management Direction

The Mt. Hood National Forest Land and Resource Management Plan (Forest Plan) of 1991, amended by the President's NW Forest Plan of 1994, will provide management direction for lands within the National Forest System. For BLM lands, the amended Resource Management Plans/Final Environmental Impact Statement (RMPs/FEISs) will dictate management direction within the Eagle Creek Watershed. The NW Forest Plan Record of Decision (ROD) has specific direction about amending existing land management plans for both National Forests and BLM (e.g. 12). In summary, the president's plan will only replace existing plan standards and guidelines that are in conflict with, or are less restrictive than those directed by the ROD.

Below is a summary of land management allocations within the Eagle Creek watershed:

Table 2. Summary of Land Management Allocations

President's Plan	Acres	Mt. Hood Forest Plan	Acres
Matrix	10,321	B6 -Special Emphasis Watershed	6,529
LSR	1,619	C1 - Timber Emphasis	2,063
Connectivity/Diversity (BLM)	580	A2 - Wilderness	8,769
Riparian Reserves	5,000	A4 - Special Interest Area	42
		B3 - Roaded Recreation	9
		Eligible, Wild & Scenic	2,656
Total	17,520		20,068

Note: *B7 - general riparian is an unmapped land allocation, and will be superseded by the riparian reserve directions from the president's plan. Many allocations overlap.*

Eagle Creek watershed is listed as a Tier 2 watershed under the president's plan, designating where high water quality is important.

Trail 502 (Mt. Baldy trail) and 781 (Douglas ridge trail) are Level 1 Sensitivity trails under Mt. Hood Forest plan. These trails are expected to meet the highest Visual Quality Objectives (VQO) for scenic quality.

Matrix and C1 allocations are timber emphasis allocations, however B6- special emphasis watershed, riparian reserves, trail foreground viewsheds, and LSR allocations are all main drivers in this analysis and would set timber harvest as a secondary benefit or extended rotations.

Refer to the respective BLM and Forest Service plans for more details on directions for each land allocation.

PULSE

During the winter of 1994, the Mt. Hood National Forest undertook what has been termed the forest-wide "PULSE" effort. Participants mobilized from all over the Forest to assemble, analyze, and synthesize information. The purpose was to develop larger-scale (Forest level) information and analyses in preparation for beginning watershed analysis. PULSE provided information about the context, both ecological and human, of watersheds within the overall Forest. It provided information about larger-scale processes, patterns, and uses so that watershed analysis could be shaped by larger-scale issues. The Eagle watershed analysis team reviewed the products of the PULSE effort. Listed below are the topics that showed insight into the relationship between Eagle and the Clackamas River basin.

Table 3. Relationship Between Eagle and Clackamas River Basin

Eagle Watershed		
Topic	**Eagle Creek Watershed**	**Clackamas River Basin**
Late Seral	Below Forest average	More late seral, still slightly below
Existing Conditions Compared to Range of Natural Variability	Slightly outside	Slightly outside
Stand Size Variability	8-21" fairly uniform, upper Watershed Lower watershed young, more patchy	Patchy
Late Seral in Riparian	Moderate	High
Fish Stock Diversity	Lower on National Forest, high on lower reaches	High
Wildlife species diversity by EAU	Third highest on Forest	Third highest
Elk and deer movement routes	Follow Eagle Creek, North Fork Eagle Creek, Trout Creek	
1994 Aerial Insect Infestation	Low infestation rates	Upper Clackamas high
Off-site Plantations	Patch in North Fork	No others
Windthrow	Small area	Unknown
Fire Regime	8	6-9, predominantly 8's

Stratification

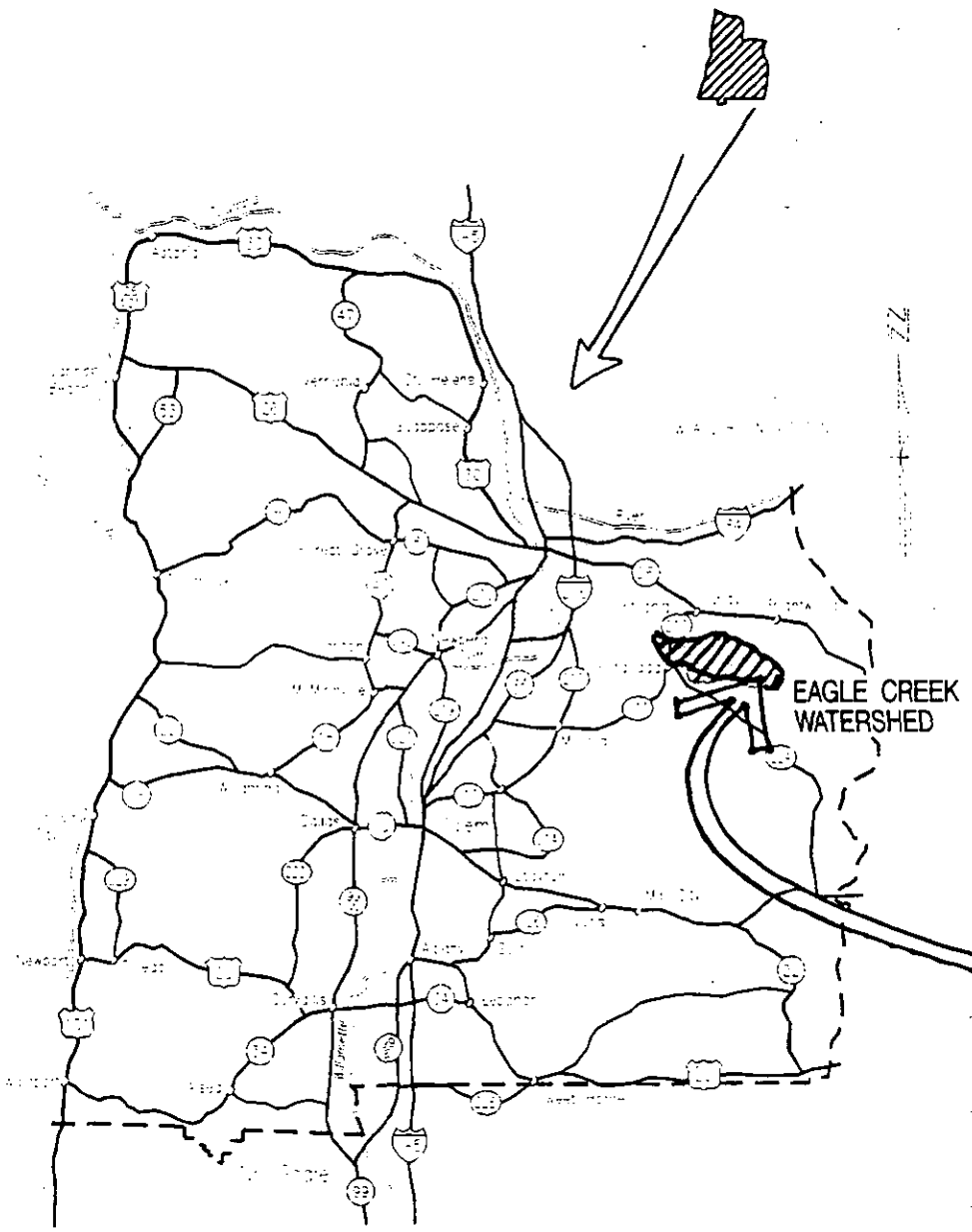
For ease of analysis the Eagle Creek Watershed was stratified three different ways. Depending on the need or question being asked determined which stratification was used.

The first stratification split all Federal lands separately from all private lands. The second stratification followed the major subwatersheds:

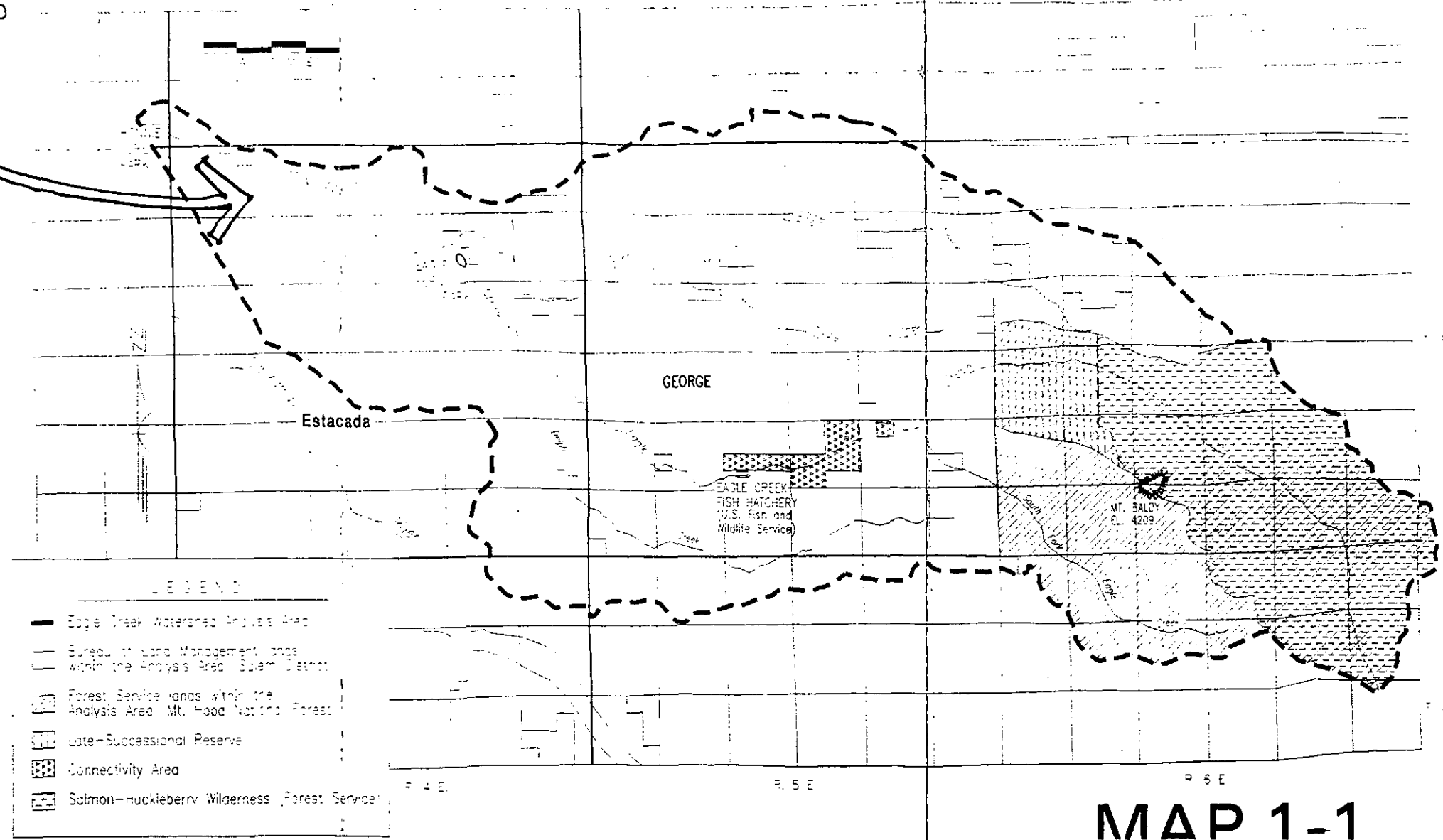
- lower, middle and upper mainstem,
- North Fork,
- South Fork, and
- Delph Creek (Map 1-2).

The third stratification was splitting the watershed into thirds with a combination of physiography and land use. The "lower third" of the watershed is dominated by rural development and the most gentle topography. The "middle third" is dominated by plateaus and canyons, and is primarily Longview Fiber industrial forest land. The "upper third" has the steepest slopes of the watershed and is primarily Federal forest lands.

Eagle Creek Watershed Location Map



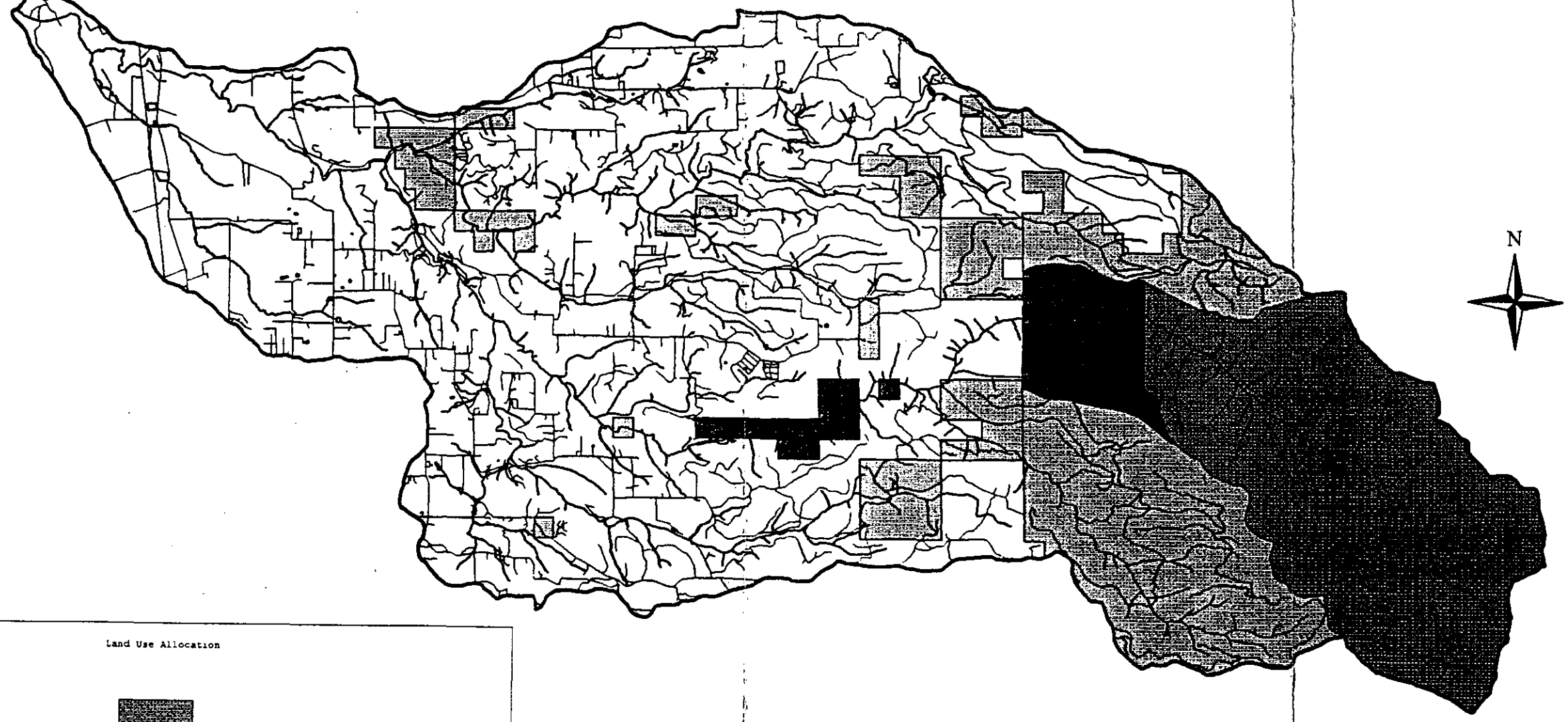
EAGLE CREEK WATERSHED ANALYSIS AREA

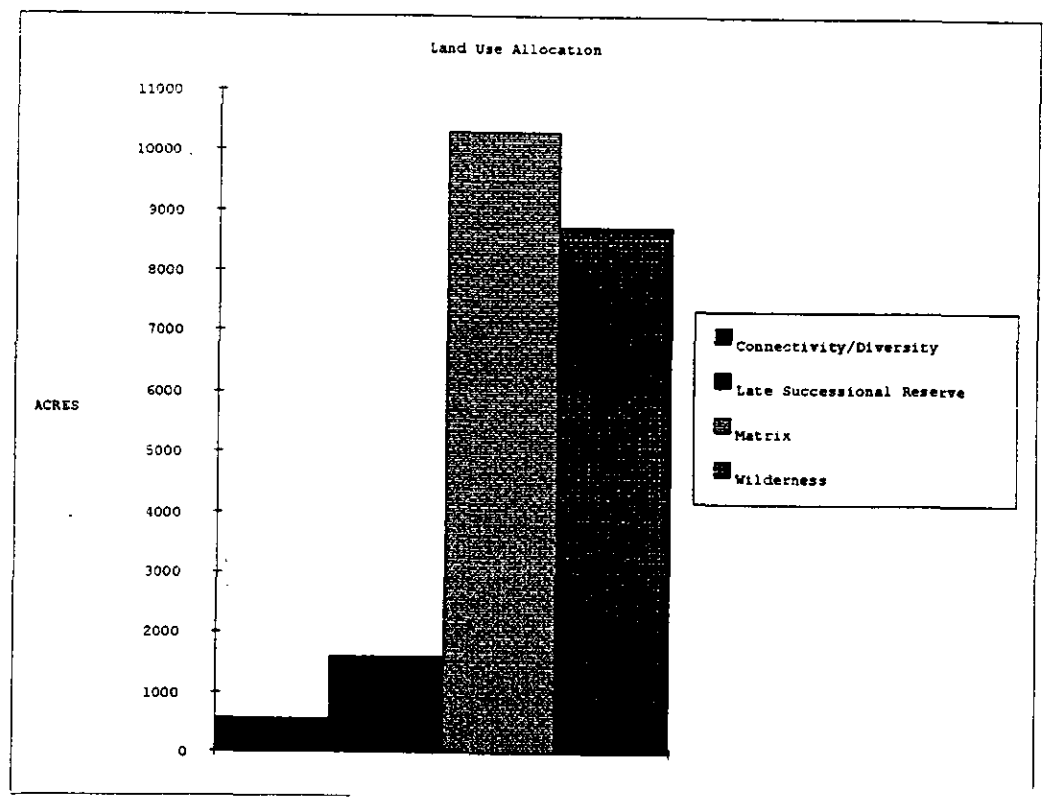


MAP 1-1

Eagle Creek Watershed

Federal Land Use Allocations





Watershed Boundary

Roads

Streams

Connectivity

Late Successional Reserve

Matrix

Wilderness

N

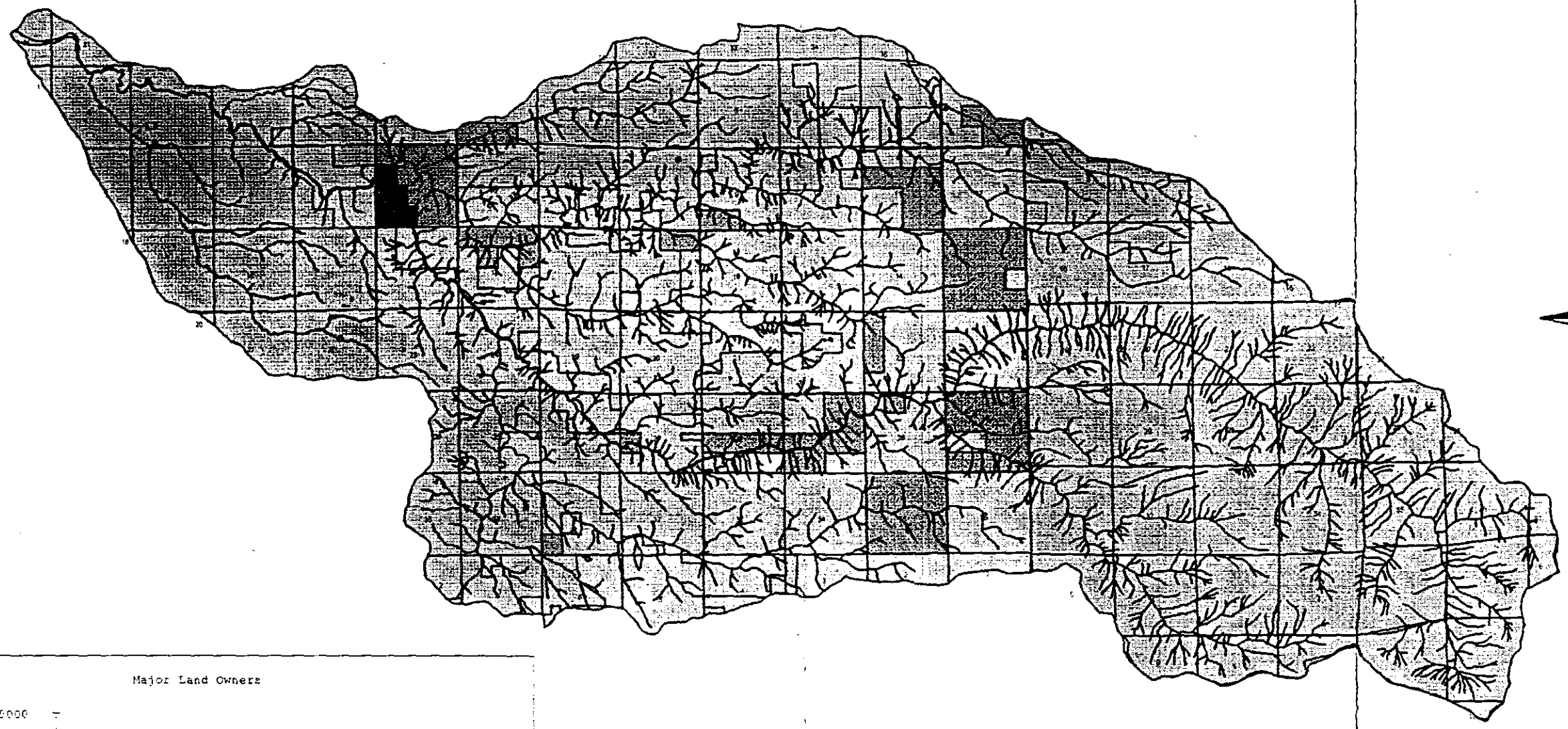
Scale 1:100,000

1 0 1 2 Miles

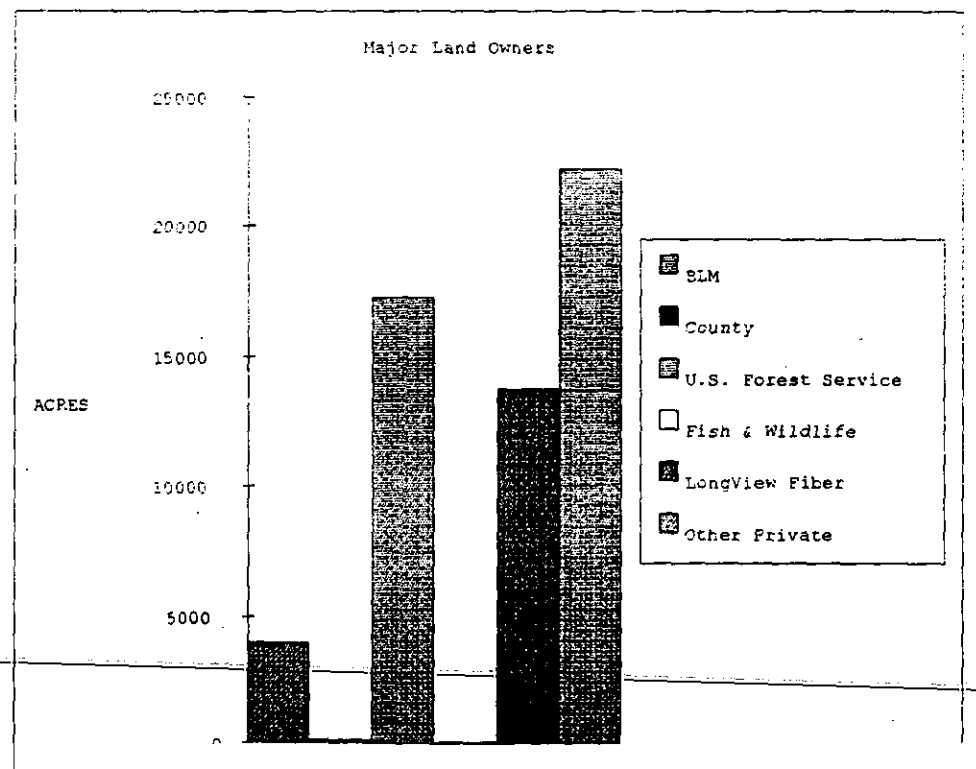
MAP 1-2

Eagle Creek Watershed

Major Land Ownership



N



- Public Land Survey
- Streams
- BLM
- County
- U.S. Forest Service
- Fish & Wildlife
- LongView Fiber
- Other Private Landowners

Scale 1:100,000

1 0 1 2 3 4 Miles

MAP 1-3

Chapter 2

Issues and Key Questions

Chapter 2
Issues and Key Questions

Public Participation

Public participation occurred in several ways. A public meeting was held specifically to introduce draft issues and key questions and solicit response from the public. In addition, several hundred letters with the issues and key questions were mailed to residents of Eagle Creek watershed and other known Clackamas River activists. Two other public meetings were held during the formation of issues for Eagle Creek watershed analysis, and public comment was also solicited during those meetings.

In general, comments from the public were in three areas:

- concerns over increased development and urbanization of the lower watershed,
- maintenance of high quality water and habitat for resident cutthroat trout, and
- protection of remaining old growth and late seral habitats in the Eagle Creek watershed.

Comments generated from public participation were incorporated into development of issues and key questions. Comments also helped focus the analysis.

Issues and Key Questions

Terrestrial

- ❑ What are the processes affecting vegetation and landscape patterns, both natural and human caused? What are the current conditions of the landscape and stand vegetation, and how does this affect species composition and diversity?
- ❑ What is the role of the watershed in conservation of old growth associated species (i.e. the spotted owl) and non-old growth associated species (including plants)?
- ❑ What landscape patterns would attain or affect ecological objectives and social expectations?
- ❑ Where are the opportunities for commercial timber harvest?

Aquatic and Riparian

- ❑ What are the processes affecting riparian and stream conditions, both natural and human caused? What changes have affected riparian and aquatic dependent organisms, and recreational opportunities?
- ❑ What is the role of Eagle watershed in conservation of aquatic and riparian dependent species?

Social

- ❑ What is the role of the watershed in providing recreation opportunities?
- ❑ What type of access and transportation is needed?

Chapter 3

Reference and Current Conditions

Chapter 3
Reference and Current Conditions

Terrestrial

The terrestrial system includes landscape ,vegetation and wildlife components. Landscape looks at the vegetation types and patterns with geologic features to explain expected variability. The various types of vegetation and their seral stages of early, mid and late describe the structure of the forest. Early seral does not includes large commercial agriculture, and late seral includes old-growth. Finally wildlife species and their use of habitat can document the dynamics to the system.

Historic Vegetation/Fire History

Pattern

It is difficult to assess the pattern of past fire events in the Eagle Creek watershed due to the amount of settlement within the watershed. Settlement first began in the watershed in the 1860's. At that time much of the watershed was forested, with more open conditions on the plateaus.

Over the next hundred years settlement progressed east up the watershed. Land was cleared and burned for agriculture. The lower third of the watershed is now primarily agricultural and rural development.

The mid portion of the watershed is primarily forested with about half the area's forests originating between 1900 and 1950, and the other half since 1950 (Map 3-1). Much of the industrial forest land originated since 1950. The remaining forest originated between 1900 and 1949, the result of a combination of logging and burned areas. Many of the burned areas are probably the result of fires that were set to clear areas in the lower portion of the watershed.

The upper third of the watershed has had less effect of human settlement and management. Most of the vegetation in the upper portion of the watershed originated between 1850 and 1899, indicating a large stand replacement fire or multiple stand replacement fires during this time period. Webber (1992) estimates a mean fire occurrence of less than fifty years between major fires in this portion of the watershed.

Remnant older stands are found scattered throughout the upper portion of the watershed and are frequently associated with riparian areas and wetlands. Other riparian areas, primarily intermittent streams and in the upper reaches of the watershed, were completely burned over except for some scattered individual trees.

Suppression

Fire suppression on Forest Service lands within the watershed began in the late 19th century. Historic fire records for the period between 1940 and 1970 indicate relatively few ignitions, and no large fires in the area. Three lightning caused fire starts occurred in the 1940's, two starts in the 1950's (one lightning and one person caused), and no documented ignitions occurred in the 1960's. All of these fires were less than 1/4 acre in size. In the last three decades only one fire start occurred on Forest Service lands within the watershed.

Fire Regimes

The Mt. Hood National Forest has been divided into eleven fire ecology/ fire regime groups based on vegetation, fire frequency, and fire behavior (Evers et al., 1994). The Eagle Creek watershed contains two of these fire ecology groups, Groups 7 and 8. Stand replacement crown fires are the presettlement and current fire behavior for both of these groups.

Fire Group 8 is the dominant fire regimes within the Eagle Creek watershed, covering most of the drainage. This fire group is termed the "warm, moist western hemlock and Pacific silver fir" group and has an average fire frequency of 50-300+ years.

Fire Group 7 is found in the higher elevations along the eastern and southeastern edge of the watershed. This is termed the "cool associations" group and is often subject to frost. This group has an average fire frequency of 100-300 years. These areas are found primarily in the mountain hemlock zone, although some also occur in the Pacific silver fir zone.

Figure 1. Current condition compared to historic range of amount of early seral vegetation. Values shown are percentage of the total area within each forest series.

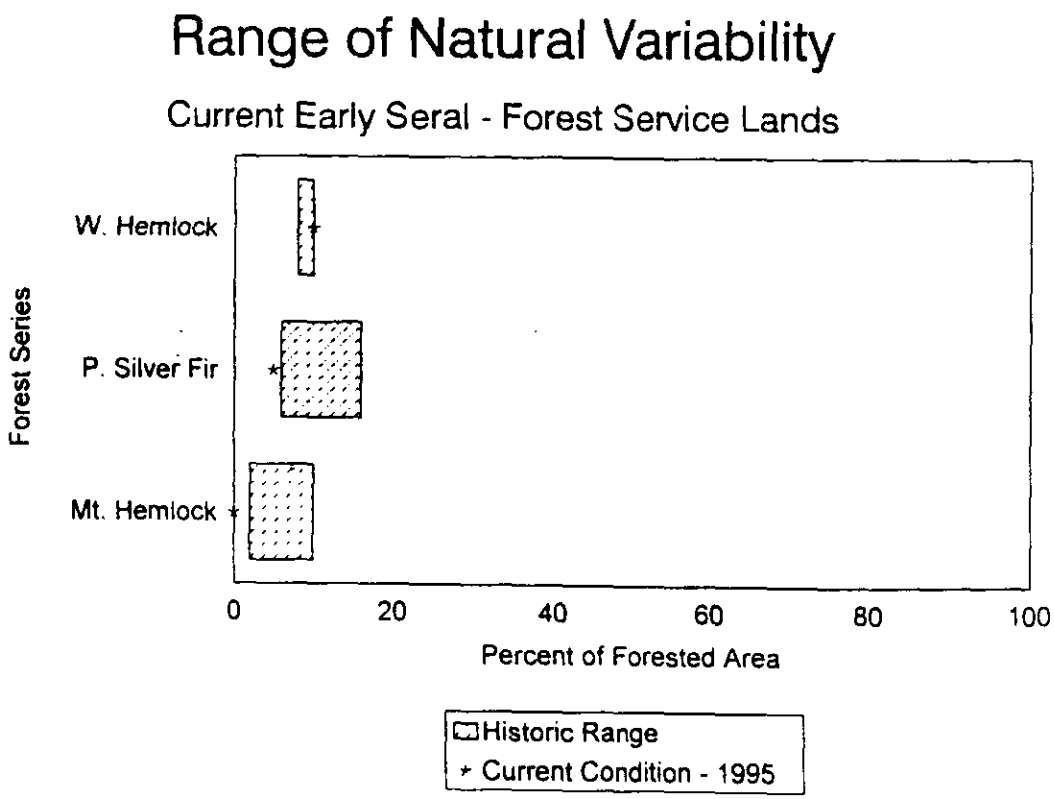
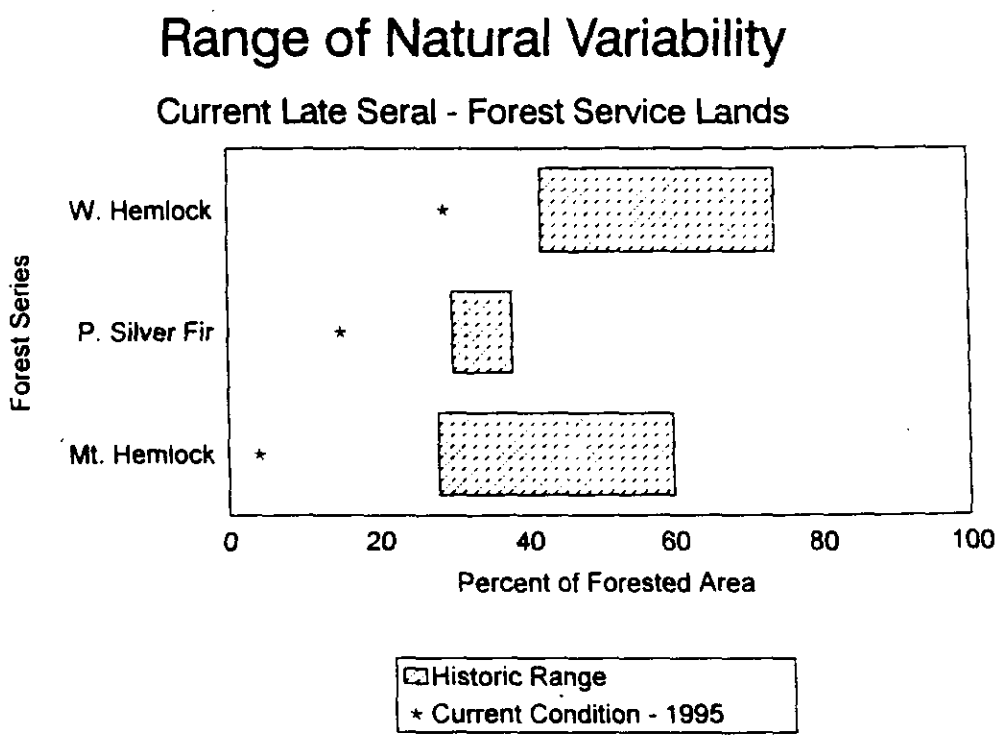


Figure 2. Current condition compared to historic range of amount of late seral vegetation. Values shown are percentage of the total area within each forest series.



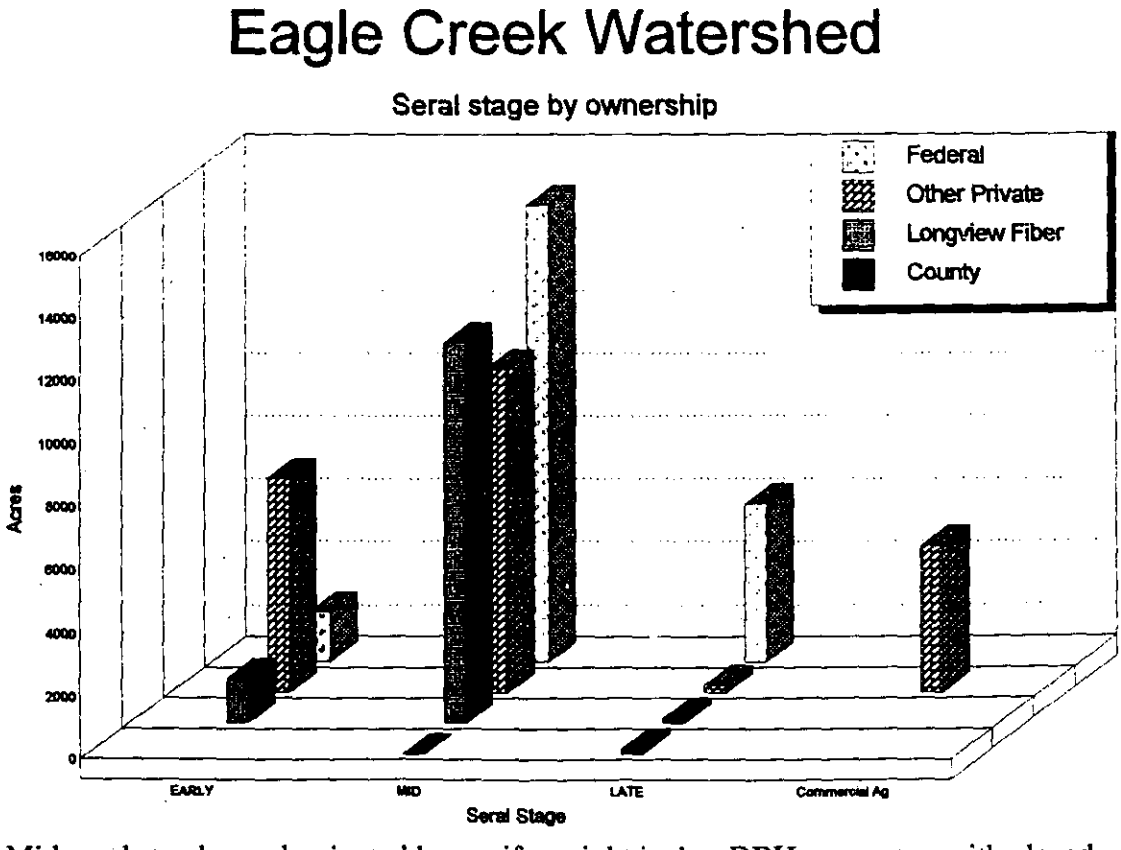
Seral Stages

Federal lands (USFS, BLM, and USFWS) make up about 21,400 acres out of a total 57,500 acres in the watershed (or 37% of the watershed). Twenty-three percent (5,000 acres) of federal lands exist in late seral condition (Map 3-3).

For this analysis, seral stage is defined according to stand structure rather than stand age. Late seral stands are forests dominated by conifers at least 21 inches in diameter at breast height (DBH). Most of these stands are older than 80 years.

Late seral conditions in the watershed account for a total of 5,500 acres (10% of watershed). About 500 acres of late seral stands lie within private property (Figure 3).

Figure 3. Seral Stage by Ownership



Mid seral stands are dominated by conifers eight inches DBH or greater, with closed canopies, or small sawtimber or poles stands with conifers between 8 to 21 inches DBH. For the watershed 3,690 acres (64%) are in mid seral condition. Many higher elevation forests are classified as mid seral stands because of size and not because of age. This is more primarily the case in the mountain hemlock where less than 10% of the trees are 18 inches DBH or greater.

Many mid seral forests within the National Forest in Eagle Creek are a result of large scale fires over about a 40 year time frame. Stand ages range from one hundred to one hundred and forty years. These stands are classed as mid seral and not as late seral because of structure (DBH 21 inches). Refer to the Historic Vegetation/Fire History section for more details about mid seral conditions.

Outside National Forest, most of the current mid seral stands resulted from harvest activity.

It is important to note the difference between how mid seral stands function in an ecosystem, now and in the future, based on land management objectives. In private lands, where intensive timber management is likely to be the primary objective, combined with short rotations (about 60 years) and high wood utilization, wildlife habitat for example, would be much different than in an area with high tree retention and longer rotations (about 100 to 250 years). Because mid seral stands originated quite differently between private and federal lands, their stand structures differ as well. Future fires on federal property are more likely to promote stand dynamics that produce stands with variably spaced trees, multiple species, remnant snags, coarse woody debris, and multiple canopies. In private property, stand structures would be simplified. In general, stands will consist of single species, uniformly spaced, with one canopy layer devoid of suitable snags and coarse woody debris.

Approximately 17% of the watershed is in early seral stage (9,730 acres). Most of these areas within federal lands have been created. Approximately 1,700 acres are from created openings, and 290 acres from natural causes. Early seral conditions outside federal lands have almost entirely been created by regeneration harvest or by agricultural and rural development.

Large agriculture lands were classified separately from early seral because large agriculture lands function and interact within the landscape much differently than early seral conditions within a forested ecosystem. These areas include about 4,600 acres in the watershed.

Old-growth stands are stands 200 years in age and older. All of the oldgrowth lie within Forest Service land (except 13 acres included in the county exchange). Oldgrowth accounts for 1,320 acres or about 2 % of the drainage. Oldgrowth is mainly found within riparian areas and are narrow in size. Much of the patches are included in the Salmon-Huckleberry wilderness or within the late successional reserve (LSR). Some also exist within matrix land. Refer to the Terrestrial Habitat section for more details about seral stages, Oldgrowth, and management land allocations.

Forest Series

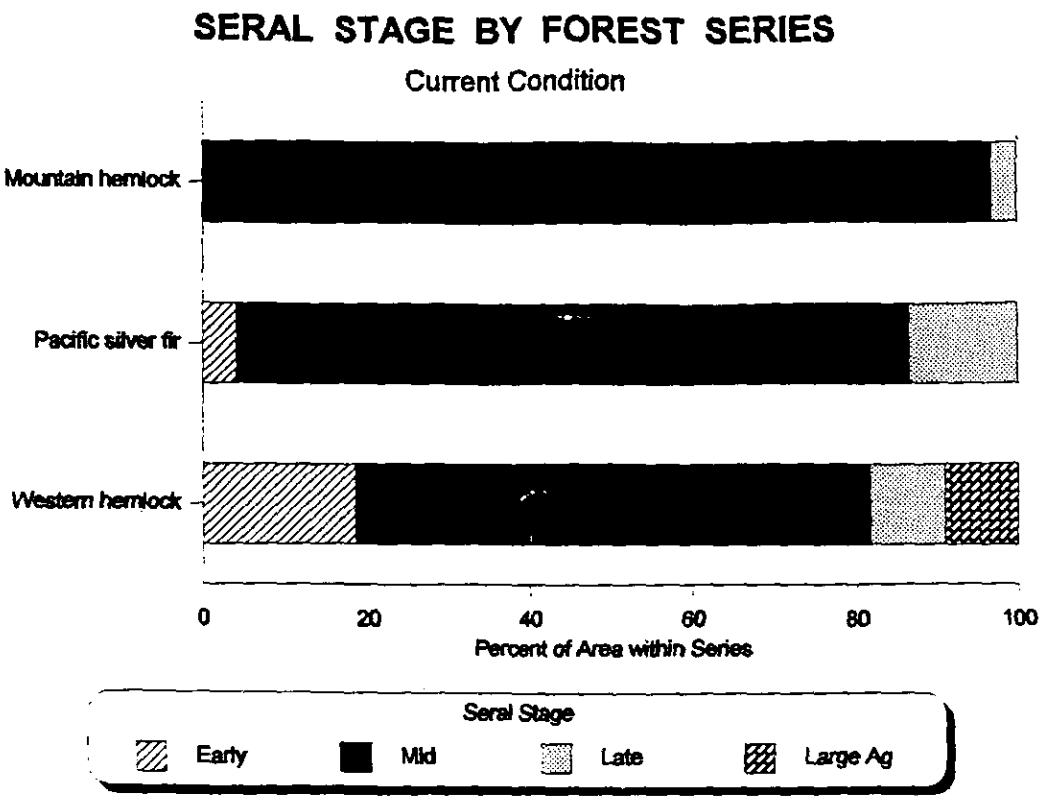
Three forest series are found within the watershed. They are:

- western hemlock,
- Pacific silver fir, and
- mountain hemlock.

A forest series (or zone) is the area where a particular tree species becomes dominant in the future climax plant community. The western hemlock series classify stands where western hemlock would most likely dominate the overstory, assuming no major disturbance such as fire takes place. For instance, forests presently containing Douglas-fir in the overstory with western hemlock in the understory, are included in the western hemlock series because Douglas-fir will not establish itself under a closed canopy, while western hemlock will dominate the stand.

The western hemlock series generally occurs at elevations below 3500 feet. Of the three series, the western hemlock series is the most productive and encompasses 90% of the watershed (Figure 4). On the average, sites in the western hemlock zone generally have deeper soils, less rock, and longer growing seasons. At the other end, the mountain hemlock zone occupies sites at higher elevations, above 4,000 feet and make up less than 1% of the watershed. Here conditions are cold, soil depths are shallow and rocky, contain low nutrient levels, and generally have short growing seasons. The Pacific silver fir zone lies between these two series in elevation and in site conditions. Pacific silver fir series accounts for 5,560 acres within the drainage or 9.5%.

Figure 4. Seral Stage by Forest Series



Insects and Disease

Because of the high incidence of disturbance from fire and harvest generating young vigorous trees, and because soil moisture is easily available, current conditions for forest health range from good to excellent. Crown foliage is full, and occurrence of disease is relatively low. Offsite trees do exist in the upper part of the North Fork subwatershed within National Forest land and will be found in the older (30-40 yr old) plantations. Offsite trees tend to be more prone to insects and disease because of their poor adaptability to the site.

Spruce budworm exists in the higher elevations at very low levels. In the westside of the Cascades, spruce budworm infestations are of short duration ranging up to 3 years. This insect is expected to have little impact in the future mainly because the location of the drainage is at the most extended end of the insect's range.

Small pockets of *Phellinus Weirii*, laminated root rot, exist as with most forested ecosystems in the western Cascades. For this watershed, no real threat exists from this root rot.

Overall, existing conditions range from good to excellent with the only **future** threat to forest health being overstocking.

Windthrow

About 20,500 acres (35% of watershed) are at risk of windthrow based on field observations, soil classification, soil moisture, topography (positioning toward prevailing winds), and edge adjacent to recent clearcutting (Map 3-3A). Half the acres are listed as high risk, and half as moderate. Field observations have shown that older stands near clearcuts located in deep wet soils, on west facing slopes, run the greatest risk of blowdown. Since these areas cover a large proportion of the watershed as to make any recommendation difficult to administer, high risk areas should be emphasized as key to future project planning.

Harvest History

Most of the regeneration harvest on Federal lands occurred in the 1940's (Table 4).

Table 4. Summary of Regeneration Harvest Within National Forest and BLM Lands Over Last 50 Years

Decade	Acres	% of Total Federal Lands
1940	1,900	9%
1950	290	1%
1960	20	0.1%
1970	210	1%
1980	630	3%
1990	600	3%
Total	3,650	17%

An addition 600 acres are accounted for high (leave tree) retention activity such as commercial thinning, partial removal, and salvage. It is difficult to determine the level of harvest activity outside federal lands with the given data. Whether existing agricultural lands are a result of forest removal can be left to speculation. However, land owned by Longview fiber (24% of drainage), we can determine that land in early and mid seral stages probably resulted from regeneration harvest. One thousand four hundred and twenty acres exist as early seral (2.5% of drainage) and 12,100 acres as mid seral (21% of drainage) within Longview Fiber property. From this we can surmise that at least a total of 17,170 (3,650 + 1,420 + 12,100) acres may have been regenerated within the drainage by both Longview Fiber and Federal lands combined (or 30% of watershed) over the last 50 years.

Wildlife

Wildlife for Federal lands on BLM and National Forest lands includes birds, mammals, reptiles, amphibians, invertebrates, fish and sensitive plants. Salem District's Resource Management Plan (RMP) lists nearly 300 wildlife species (excluding invertebrates) may occur in the watershed. National Forest documents identify over 290 species (excluding invertebrates) that potentially could occur within the watershed. Most invertebrate occurrences are only known on a much broader scale. Sustaining these wildlife populations is a management objective of the current land use plans for this area. In particular, late seral associates and aquatic species have been identified for special management in the recent Late-Successional Reserves and Riparian Reserve network in the Northwest Forest Plan. Few surveys have been conducted in this drainage to identify species occurring here. Because we are attempting to manage for ecosystems rather than single species, species are grouped into large categories called guilds that use similar habitats in similar ways. For analysis purposes these groups (guilds) show population trends, impacts or accumulative effects on habitat and can be compared to levels of natural variability of habitats. The Forest Service completed their assessment of these guilds in 1994 based on the Species Community and Conservation Assessment (SCCA) methodology, accounting for the influences that seral stage association, home range size and patch configuration (landscape pattern) are thought to exercise on the distribution of animals in the landscape. Under the SCCA, certain criteria were used to classify wildlife species into guilds (Appendix C). A description of the SCCA methodology (Mellen, et al., 1994) is in the Eagle Creek analysis file.

Past Conditions

Information of wildlife populations before the 1940s is sketchy, but occurrence can be inferred from the vegetation patterns. Mid and late seral associated species were probably more abundant particularly in the upper watershed because of the large acreages and connectivity of these older forest stands. Large ranging species had access to most of the forest types because of connectivity with other stands. Early seral associated species were less abundant because the early seral vegetation types quickly evolved into mid seral forest stands. Snags and coarse woody debris were much more plentiful in the landscape except where eliminated by extremely hot fire or repeated burning. Most special habitats changed as the surrounding vegetation changed except for caves, talus slopes, or ponds.

Species of Concern: Animals

Listings

Species of Concern for Eagle Creek are determined from two sources, sensitive species list from Mt. Hood National Forest and Special Status Species list from Salem district Resource Management Plan. Sensitive Species for the NF include those listed as Threatened or Endangered (T/E) by the U.S. Fish and Wildlife Service (USFWS) under the provisions of the Endangered Species Act (ESA) of 1973 and Sensitive species identified by the Regional Forester. Special status species for BLM include Federal T/E list species and Federal proposed threatened and endangered, Federal candidates, State listed, Bureau sensitive and Bureau Assessment species listed by the Oregon State Director of BLM (see Appendix C for definitions).

Threatened and Endangered Animals

Peregrine falcon

Peregrine falcons are listed as Endangered by the USFWS in the lower conterminous 48 states and Endangered by the State of Oregon. They are currently being considered for downlisting to Threatened by the USFWS. Peregrine falcons nest on tall cliffs near large riparian areas or wetlands. Their nest is a shallow scrape on a platform in a small cave or overhang with easy aerial access and visibility to surrounding foraging areas. In 1994 Forest Service biologists in cooperation with OSFW surveyed for potential nesting habitat. Although no sightings or eyries (active nesting sites) were found, they identified three medium potential nesting sites. BLM lands do not have any potential nesting habitat.

Bald eagle

Bald eagles are listed as Threatened by USFWS and the State of Oregon. Bald eagles are occasional winter visitors to lower Eagle Creek but are not known to nest here.

Northern spotted owl

The northern spotted owl is currently listed as Threatened by the USFWS and the State of Oregon (USDI, 1990 and ODFW, 1988). Spotted owls have been extensively studied in the Pacific Northwest and their habitat described in detail in many publications (most currently in A Conservation Strategy For The Northern Spotted Owl, Jack Ward Thomas, et al 1990). General habitat requirements and population discussion can be found in these references. Northern spotted owls nest, roost and forage mostly in mature and old-growth conifer forests.

The Designated Conservation Area OD-3, as identified in the Northern Spotted Owl Draft Recovery Plan (USDI, 1992), extends into Eagle Creek watershed and overlaps the Wilderness Area. Critical Habitat for the northern spotted owl was designated in 1992 and included 982 acres of CHU OR-10 within the Eagle Creek watershed north of the wilderness Area (Map 3-5A).

Upper Eagle Creek watershed was surveyed for spotted owls between 1991 and 1993. Four owl sites were found within the watershed and three sites just outside the watershed, that intersect the estimated 1.2 mile radius provincial home range. Because of the sensitivity of this information the sites are not identified in this document; if necessary, they may be found in the analysis file. All locations are in the upper watershed within the wilderness or LSR. In 1995 a dead spotted owl was found on the highway near Eagle Fern County Park (personal comm. —). Because there is some suitable habitat nearby they may occasionally wander down this far in the watershed, but no sites are known to occur here.

The three spotted owl pair sites located in the Salmon-Huckleberry Wilderness Area provides continuous habitat protection. In 1994 the Northwest Forest Plan identified 1619 acres to be managed as a Late-Successional Reserve (LSR) adjacent to the Wilderness area which provides habitat protection for an additional known pair site. No 100 acre core areas are located within the watershed as identified in the Northwest Forest Plan. Suitable habitat is most accurately identified by structure. There are approximately 4700 acres of nesting, roosting, and foraging habitat (NRF) in the watershed (Table 5). Most of this suitable and optimum habitat is in the upper watershed within the Wilderness and LSR (Map 3-4). The three owl sites that are adjacent to the Eagle Creek watershed have little or no suitable habitat within this watershed (Appendix C). All of the forest habitat outside the Wilderness is highly fragmented.

Table 5. Northern Spotted Owl Habitat in Eagle Creek Watershed

	Suitable	Optium	Total
Spotted Owl Habitat	3,400	1,320	4,720

Federal Candidate Species

Fourteen federal candidate species may occur in Eagle Creek Watershed (Appendix C). Few surveys for candidate species have been conducted in this watershed. No candidate species have been found here. See Appendix C for wildlife species that may potentially be found in Eagle Creek Watershed.

Other Sensitive Species

Ten other species on BLM's special Status Species or FS's Sensitive Species list are thought to occur in the watershed (Appendix C). Little is known about occurrence of the species because few surveys have been conducted in Eagle Creek and only one species have been found on any of the project surveys that have been done.

Sensitive Species Known to Occur in the Watershed

Cope's giant salamander

Cope's giant salamander is a Sensitive species for NF and Assessment species for BLM. This large salamander inhabits cold clear streams and adjacent riparian areas and moist conifer forest. Very little is known about the adult phase of this species. Two sightings have been recorded in the upper watershed.

Other Species of Interest

Big Game

Big game species occurring in the watershed are Roosevelt elk, blacktailed deer, black bear and cougar. Because of their high national and local interest elk are the most visible of this group. Eagle Creek watershed is part of Oregon Department of Fish and Wildlife's (ODFW) Santiam Wildlife Management Unit (north portion) in the Northwest Region. ODFW and NF have mapped normal winter range and severe winter range for this watershed. Normal winter range is all land on south facing slopes below 2800 feet in elevation and severe winter range is lands that lie on all aspects below 2200 feet in elevation (Land and Resource Management Plan, Mt. Hood National Forest 1990). Although the elk population is undetermined in this watershed there is at least one herd of over 25 animals and several small groups that use the middle and upper drainages. Few elk are found in the lower portion of the watershed. The population is thought to be under the area's carrying capability (personal comm: Tom Thorton, ODFW's district wildlife biologist). The primary problem is near extirpation of the historic elk herds around the turn of the century and their slow recovery, and also inadequate forage at the higher elevations. This watershed has been identified as a Sensitive area by ODFW because of elk damage complaints from private landowners, particularly around the George area.

ODFW's Management Objective is to increase the elk population in this upper drainage and to resolve the elk damage complaints by increasing the forage supply at higher elevations (ODFW, 1994).

Blacktailed deer are common in the area, using most of the forested areas and the edge habitats created by the interfaces of pastures and woodlots of private properties. Black bear occur in low numbers in the forested areas. Cougar are rare visitors in the area; they are probably most often found in the wilderness because of their need for remoteness. Cougar may occur anywhere blacktailed deer are found.

Other Management Requirements

The ROD and S&G for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (USDA and USDI, 1994), contains a species list and survey strategies for management (see Appendix C). These species include arthropods, mollusks, amphibians, one bird, two mammals, and five bats. These species are generally associated with late-successional forests. Habitat may exist for some species in previously harvested old growth stands and may provide areas for recruitment of new individuals. The Regional Ecosystem Office (REO) is collating location information and survey protocols. Location information should be available in 1995; survey protocols are due out in 1996.

Species of Concern: Plants

Thirty six special status plants are listed by BLM (Appendix C) as potentially occurring in the watershed, and 18 sensitive plants by Forest Service (Appendix C). No listed Threatened or Endangered plants are thought to occur in the watershed. Only six species listed as Federal candidates are thought to occur here. Many of the plants of concern are Bureau sensitive (1) and Assessment (13), for BLM. The Mt. Hood NF has 13 plant species listed by the Regional Forester as Sensitive only.

Several project surveys were conducted in the South Fork Eagle Creek subwatershed and two species have been found:

- cold-water corydalis (Corydalis, aquae-gelidae(FC2), and
- fir club-moss (Huperzia occidentalis)

No plant species of concern have been found on BLM lands.

Species of Concern Known to Occur in the Watershed

Federal Candidate Species

Cold-water corydalis

Cold-water corydalis is a Federal Candidate 2 species. This plant is a succulent perennial that grows in wet forested habitats such as seeps, springs and still streamside waters.

Other Sensitive Species

Fir club-moss

Fir club-moss is a Bureau Assessment species and Forest Service Sensitive species. This plant is a member of the club moss family. It grows on wet rocky ledges and in acid bogs.

Other Exotic Plants Species and Noxious Weeds

Introduced plant species adversely affect native plants by competing for nutrients, water, light and growing space. Several common species occur in Eagle Creek watershed:

- St. Johnswort
- tansy ragwort
- Canada thistle
- Scotch broom

These species are found in small populations throughout the watershed primarily along roads, in timber harvest units, and near recreation areas. Currently, no areas have been identified as critical infestation.

Other Management Requirements

The ROD and S&G for management of Habitat for Late Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (USDA and USDI, 1994), contains a species list and survey strategies for management. These species include vascular plants, bryophytes, lichens, and fungi. These species are generally associated with late-successional forest. Habitat may exist for some species in previously harvested old growth stands and may provide areas for recruitment of new individuals. The Regional Ecosystem Office (REO) is collating location information and survey protocols are due out in 1996.

Terrestrial Habitat Conditions

Forest Habitats

Late Seral

Late seral forest probably occurred over much of the forest lands in the watershed historically. Today because of at least two major fires (1830 and 1850) and timber harvest only 23% of the watershed is in the late seral stage (Map 3-5). Generally these stands are about 130 years old.

Old Growth

Within the late seral stage are the remnant patches of old growth (at least 200 years old). These are patches of trees that did not burn up for several centuries and were not harvested in the last few years. Most patches are very diverse in structure and age. The stands have large old trees, large snags, many down logs, several understory layers, with a variety of species. Disease and windthrow have created small openings in the canopy which creates diversity. Only 2% (1,320 acres) of the watershed is old-growth now and is located in the upper watershed on National Forest lands (Map 3-5). Fifty percent of this old growth is also in the Wilderness and LSR (see Table 19). The largest remaining contiguous block of old growth is about 600 acres in size; most of the other remaining stands are small narrow strings in or near the main streams (Map 3-5).

Mid Seral

Mid seral is the closed canopy forest that presently has the least diversity for wildlife of any seral stages. These stands have few snags, defective trees, or large downed wood from previous fires or logging. Openings and dead or dying trees have not yet begun to form. Recent forest practices on federal land have just begun to maintain some of these long term forest features. Mid seral is the most dominate of all the stages. Presently 70% of the watershed is in this seral stage (Map 3-3).

Early Seral

Early seral forest provide a wide variety of habitats as open in an otherwise nearly closed forest canopy. Openings of forb, grass, shrubs with small trees are required for foraging and nesting by many species of wildlife. This stage include large Agriculture lands which are a very simplified early seral stage because of the intensive practices as tilling, grazing, herbicides that keep the habitat in less diverse vegetation condition most of the time compared to a natural condition. The early seral stage makes up approximately 17% of the watershed currently.

Interior Forest

Interior forest guilds are those species that require large home ranges within the late seral stage. These species use the interior forest to moderate the climate, find unique nest structures, seek protection from predators, and find abundant prey that also use the interior forest. Most notable of these species is the northern spotted owl.

Interior habitat for this analysis was defined as late seral stands that are at least 500 feet from any opening (natural or created). Five hundred feet is used as a convention; actual width a a functional edge varies due to many site specific factors. Adjacent mid-seral stands and roads were not counted as edge for this analysis. Currently 5,550 acres (10% of the Eagle Creek Watershed) of interior habitat. Most of it is found in the upper Eagle Creek and South Fork Eagle Creek Subwatersheds (Map 3-6). Over 50% of the current interior habitat is located within Wilderness, LSR, or the BLM connectivity/diversity area.

Connectivity/Diversity

Using the criteria described in Appendix A, Eagle Creek has major differences from the historic or natural condition. The landscape distribution and connectivity of late seral habitat was analyzed using the SCCA database (see analysis file). Emphasis was placed on potential habitat for the guild of wildlife species that requires late seral habitat, have a large home range, and is capable of aggregating suitable habitat patches that are dispersed in a mosaic pattern (TLML guild). Fragmentation of late seral habitat can be detrimental to this species guild which includes species such as the Northern spotted owl, pine martin and wolverine. Although species within this guild can use aggregating fragmented late seral patches within their home ranges, patches that are too isolated are not likely to be used.

Two most connected late seral areas are found in the upper Eagle Creek and south fork Eagle Creek subwatersheds (Map 3-7). Late seral blocks on BLM land were determined to be too isolated to provide primary habitat for this guild of species.

Patches coded 1-4 are all contributing to effective habitat for TLML species (with code 1 signifying the highest quality habitat in terms of patch size and connectedness; code 4 signifying the least). Patches coded 5 and 6 are late seral patches that are too isolated to provide primary habitat.

Other Unique Habitats

Snags and Coarse Woody Debris

Snags are created by disease, old age, fire, stand density, and weather. Trees or parts of trees die, allowing species to use this different habitat. Primary excavators create cavities that some 70 new species can nest or roost in. Usually the larger the snag the longer it lasts (Maser, 1985) and the more valuable it is to wildlife. Older forest usually have more snags than younger forests. The lower portion of Eagle Creek watershed has very few snags because of agricultural uses and intensive timber harvest practices. The old growth patches in the upper watershed are the only area where large snags are abundant. When the snags and live trees fall to the ground they become coarse woody debris. The larger the downed log the longer it lasts on the ground (Maser, 1985). Coarse woody debris provides travel lanes for small mammals, and foraging spaces for amphibians. Past harvest of young stands left little remaining downed wood available for wildlife. Most of the natural unmanaged stands in the upper watershed have far more downed logs than the managed stands in the lower portions of the watershed.

Special Habitats

Special habitats found in the watershed are rock outcrops, cliffs, talus slopes, meadows, some structures (bridges), ponds, riparian and wetlands. Few surveys have been conducted in the area to evaluate these features. These unique wildlife habitats provide exceptional places for many species to reproduce, forage, roost, or escape during critical periods of their life cycles. The ecotone surrounding these special habitats of diverse vegetation layers, particularly snags and remnant large old trees, are as important to the special habitat as the special habitat itself. Many of the habitats occur under overstory vegetation or are so small that they are usually not found until field surveys are conducted. Approximately 200 acres of special habitats, excluding riparian, have been mapped in this watershed (Map 3-8).

Three cliffs were located during peregrine falcon nesting surveys. The cracks and small openings in these cliffs and other smaller rock faces provide nesting and hiding sites for other small mammals and birds. Several small rock outcrops and talus slopes were identified using general photo interpretation. Many of these rock openings are surrounded by scrub alder patches. Most of these are in remote areas of the watershed. Besides providing special habitat features they provide openings in the otherwise continuous forest canopy for foraging by (bats). Three wooden bridges are found near Eagle Fern Park which could be roosting structures for bats. These bridges are on heavily traveled county roads and may not be used much for roosting sites.

Four natural meadows totaling over 70 acres occurs in the upper watershed with the largest being 40 acres in size. Many agricultural pasture meadows occur on private lands in the lower watershed. These pastures are heavily modified grasslands and often monocultures for grazing. Several small ponds with modified riparian vegetation also occur on private lands in the mid to lower portions of the watershed. Only one medium sized pond (2 acres) on public lands has been found, Baldy Pond near Mt. Baldy. Long term open waters like these ponds are important reproduction areas for several species of amphibians, and good aerial forage areas for bats because of the emergent insects from the still water. One hundred acres of wetlands have been mapped near the mouth of the drainage (USFW, 1985). These wetlands are all on private lands.

Riparian

Riparian vegetation is the most common special habitat in the watershed. More species occur in riparian habitats (Brown, et al, 1985) than other habitats. About 85% of the twenty-five thousand acres of riparian areas have been modified (Map 3-9). Most of the unmodified riparian is in the wilderness or the unmanaged portions of public lands in the mid to upper part of the watershed. The primary features missing in the modified riparian habitat are large standing trees, large downed woody debris and plant species diversity.

Aquatic Ecosystem

Introduction

Geology and Soils will be introduced in this section. Hydrologic Condition was determined by assessing changes in base and peak flows. Changes in sediment delivery to the watershed was viewed as sediment from landslides influenced or induced by management activities, roads, recent timber harvest and agricultural activity. The riparian condition was assessed by estimating reductions in large woody debris potential and changes to seral stages within the riparian area. Habitat condition was assessed as changes to pool frequency, instream wood, stream temperatures and canopy closure in the riparian area. Aquatic organisms in the watershed include indigenous fish species such as coho, spring chinook, winter steelhead, searun cutthroat and resident cutthroat and hatchery or stocked fish species such as early run coho, spring chinook, fall chinook, winter steelhead and rainbow trout. Aquatic insect populations above and below timber harvest areas were also reviewed.

Geology

The Eagle Creek Watershed varies substantially in terms of topographic relief and consequently, landslide potential. In the eastern portion of the watershed, slopes consist of lava flows and slightly indurated volcaniclastic formations, where drainages are deeply incised with slope angle exceeding 70% in some areas. This landscape is predominately erosional. In contrast, the landscape of the western portion of the watershed is largely depositional. Drainages are shallow, and some meander within narrow floodplains. Slope angles are modest. The fluvial deposits that form much of this part of the watershed have been transported by both Eagle Creek and the Clackamas River.

Eagle Creek Watershed is comprised of ten geologic units. These units were grouped into six general categories:

- weak rock,
- intermediate rock,
- resistant rock,
- unconsolidated material, and

- alluvium and quartenary landslide deposits.

Many landslides, particularly debris flows, are associated with the contact between the upper and lower members of the Sardine Formation, weak and intermediate rock categories (Appendix C). Inherent instability occurs where a more resistant rock unit overlies a less resistant rock unit. This is especially true when the lower unit is more cohesive and less permeable than the upper unit as is the case in these contact areas in the watershed. The upper unit consists of lava flows while the lower unit consists of lava flows along with weak pyroclastic rocks such as tuff breccia and lapilla tuff. These contact areas occur predominantly in the Upper Mainstem and South Fork Subwatersheds and to a lesser extent in the lower portions of Delph Creek, Middle Mainstem and North Fork Subwatersheds.

Landslide inventory of the watershed identified 11 large ancient landslides. Many of the recent debris flows appear to be associated with the 1964 100-year storm event. Forty two of the recent landslides are thought to have delivered sediment to streams. Management has influenced or initiated 14 landslides.

Soils

Soils within the upper portion of the watershed are shallow, gravelly soils formed in colluvium from pyroclastic rock. Soil complexes include felsenmeers and pyroclastic rock outcrops. Soils within the middle portion of the watershed are moderately deep, well drained soils that formed in colluvium derived from andesite and basalt mixed with volcanic ash. Soils within the lower portion of the watershed are deep, well drained soils that formed in old alluvium and in colluvium with the exception of the area in the Lower Mainstem subwatershed where the soils are deep, moderately drained soils that formed in mixed silty and clayey alluvium, or deep, somewhat poorly drained and moderately drained soils that formed in stratified glacier lacustrine deposits.

Hydrologic Condition

Limited information is available for historic and present flow conditions. Fire history suggests that increased peak flows occurred in this subwatershed following the large fires that occurred between 1900-1950 in the middle third of the watershed and between 1850-1900 in the upper third of the watershed due to the resultant lack of forest in a hydrologically recovered conditions. Large scale fires have not occurred in this watershed since the 1950's. Stand replacement crown fire was the presettlement fire behavior in this watershed. Base flows may also have changed during these periods of watershed recovery.

Base Flows

Baseflow is critical to watershed health during times of little or no precipitation, providing habitat to fish and other aquatic organisms, sustaining habitat for riparian flora and fauna, and maintaining cover forage and travel corridors for other terrestrial wildlife. Baseflows provide for beneficial downstream human uses. For the Eagle Creek Watershed, most of the water rights are used for irrigation. Water rights also exist for fire protection, domestic water supply, recreation, livestock, fisheries, wildlife, nursery and other agricultural uses. Eagle Creek base flows also contribute to the base flow of the Clackamas River. Base flow in Eagle Creek Watershed is probably similar to Fish Creek Watershed (0.2 cfs per square mile) although no specific information is available.

Decreases in base flows are a concern to the ecosystem because of:

- *reduction in effective habitat for aquatic organisms, and*
- possible degradation of water quality i.e. increased water temperatures, decreased levels of dissolved oxygen and increased algal and pathogen populations.

Decreases in base flows result in less water and degraded water quality for downstream beneficial uses.

Although limited information exists on base flows in the Eagle Creek Watershed, An assumption can be made that the Upper Mainstem subwatershed base flows have not changed due to the limited management activities that have occurred in this subwatershed. South Fork subwatershed has numerous seeps and springs feeding flows which augment base flows. Management activities have occurred in this subwatershed but probably not to an extent that would affect base flows.

Fish Hatchery Manager Doug Dysart states that the summer of 1987 was the lowest base flow condition experienced since he has been manager at the hatchery. Base flows were greater in 1992 which also was a known low flow year. This observation may indicate that base flows at the hatchery mid way down the Middle Mainstem Subbasin have not decreased.

Recent research (Hicks, et al 1991) suggests that reductions in streamflow following timber harvest may be related to the regrowth of deciduous riparian species which transpire larger quantities of water than the natural conifer vegetation. Timber harvest in the Eagle Creek watershed has resulted in less than 7% of the riparian reserve being converted to an early seral stage dominated by deciduous vegetation in most of the subwatersheds with the exception of the Lower Mainstem Subwatershed. This supports the assumption that base flows have not changed in the South Fork, Upper and Middle Mainstem Subwatersheds.

Timber harvest and agricultural activity in the Lower Mainstem subwatershed has resulted in approximately 22% of the riparian reserve being converted to an early seral stage, largely dominated by deciduous species in the Lower Mainstem Subwatershed. This may contribute to decreased baseflow in the tributaries of this subwatershed but the maintenance of baseflows in the other subwatersheds may partially mitigate the instream effects of the main channel.

Although water temperatures are high in Eagle Creek this is not considered a consequence of lowered baseflows since water temperatures in the Upper Mainstem Subwatershed are high flowing out of the wilderness area. The wilderness areas well vegetated with an overstory supplying good shade conditions and has not had management activities which could affect baseflows or water temperatures. Elevated water temperatures may be further increased due to the decreased baseflows in the Lower Mainstem along with other factors such as limited canopy closure along streams.

Peak Flows

Peak flows are critical to a watershed function as the relative frequent peak flows (2-25 year events) are the channel maintenance flows and the relative infrequent peak flows (50 and 100 year events) are floods which can change the channel and riparian vegetation. During peak flows, streambank and beds are scoured and large quantities of sediment is transported downstream. Increases in peak flows cause excessive scour and/or sediment transport and can result in risk of life and property. Peak flows were estimated using the methodology by Harris, Hubbard and Hubbard (1979) (AppendixC).

Hydrologically Recovered

Less than 35% of the total watershed area is in the transient snow zone, and only a small percentage of this area exists outside the hydrologically recovered condition. South Fork and the Upper Mainstem subwatersheds are mostly within the transient snow zone and do not have any measurable change in water available runoff as determined by the Water Available Runoff model in the Standard Methodology for Conducting Watershed Analysis Guide (1993).

Absence of vegetation buffering capacity on soils with lower infiltration rates was assessed to estimate possible effects to peak flows in the subwatersheds that are not in the rain-on-snow zone. Recent timber activity or agricultural activity within these areas may tend to result in higher than normal peak flows due to the absence of the vegetation's buffering effects.

Approximately one third of the North Fork, Middle Mainstem and Delph Creek have mod-low infiltration rates and mod-high runoff rates in the lower portions with a few areas with low infiltration rates and high runoff rates. Timber units and agricultural properties within these areas comprise of 12-13% of the North Fork and Middle Mainstem Subwatersheds but comprise of 23% of Delph Creek subwatershed. Twenty-three percent of the Delph Creek subwatershed with reduced vegetation cover on soils with mod-low infiltration rates and mod-high runoff rates may result in increased peak flows.

Within the Lower Mainstem Subwatershed, about one third of the area has low infiltration soils with high runoff capabilities (mostly within the Currin Creek tributary drainage area) and another third has mod-low infiltration rates and mod-high runoff rates. Recent timber activity and commercial agricultural activity within these areas comprise of 15% of the total subwatershed area and may result in increased peak flows especially in Currin Creek. This percentage is probably even higher as smaller landholdings were considered fully vegetated due to the lack of information to estimate actual conditions.

The recent timber harvest and active agricultural activity within areas with low infiltration rates and high runoff capabilities may have increased peak flows in Delph Creek, Middle Mainstem, North Fork and Lower Mainstem.

Channel Network Expansion

Road ditches function as 'extensions' of intermittent streams, increasing overall drainage density and transporting water more rapidly than natural processes. Increased road densities increase the amount of water delivered to surface streams, affecting the timing and magnitude of peak flows.

To assess the potential expansion of the channel network from road ditches the length of road ditch directly accessing the stream was added to the length of streams. Since the exact culvert spacing could not be determined for each subwatershed, a 'best case' scenario (200 feet spacing) was used. The channel network extensions were 50.6 miles or a 10% increase of the channel network (Table 6). The subwatersheds channel network increase ranged from 0.5 -19.8 miles or from less than 1% to 20% of the channel network.

North Fork, Delph Creek and Lower Mainstem have greater than 10% increases in channel network due to high road density which may attribute to increased peak flows in these subwatersheds.

The combination of channel network expansion due to road ditches, and recent timber harvest or active agricultural activity within areas with low infiltration rates and high runoff capabilities may have increased peak flows in the lower three subwatersheds but quantification of the change is not possible with existing information.

Table 6. Stream Crossings and Stream Network Expansion by Subwatershed

Stream Crossings and "Stream Network Expansion" by Subwatershed						
Sub-watershed	Area (Acres)	"Natural" Streams (Miles)	Stream Crossings (#)	"Expanded" Streams (Miles)	Total Length (Miles)	Percent Change (%)
Lower Mainstem	9,104.0	67.2	136	10.3	77.5	15
North Fork	17,892.5	153.4	262	19.8	173.2	13
Delph Creek	7,753.7	56.8	150	11.4	68.2	20
Middle Mainstem	5,477.7	68.4	73	5.5	73.9	8
Upper Mainstem	12,436.8	30.0	7	0.5	130.5	<1
South Fork	4,846.8	48.8	45	3.4	52.2	7
Total for Eagle Creek	57,511.5	524.6	673	50.9	575.5	10

Stream expansion assumes a distance of 200 feet from closest ditch relief culvert on either side of stream crossing, adding an additional 400 feet to the effective channel length.

Sediment Delivery

Historically, sediment delivery was more episodic than continual with high levels of delivery occurring during periods when there had been recent large scale fire and/or floods. Causal agents for the sediment delivery were rain-on-snow events, floods or landslides.

Sediment delivery to streams were considered from landslides, roads, timber harvest and agricultural activities in this analysis. Forty-five landslides exist in the watershed of which 11 are considered ancient. Most of the landslides are debris flows located in the Salmon Huckleberry Wilderness in the Upper Mainstem Subwatershed due to the instability of weak resistant geologic unit in contact with a resistant geologic unit on steep ground. Past and/or present sediment delivery quantities were not estimated for the landslides. An assumption can be made that debris flows in the Upper Mainstem and South Fork Subwatersheds have always delivered sediment to streams at these contacts. Sediment from landslides initiated or influenced by management activities can be considered an addition to the sediment load of the system.

In the turn of the century few roads existed within this watershed so any sediment delivered from roads can be considered as an addition to the sediment loading of the system. Timber harvest and agricultural activity were also limited in the turn of the century although forest clearings due to wild or man-caused fires existed in large scale. Therefore the sediment produced from recent timber harvest or active agricultural activities may be similar to sediment delivery during periods when areas with large scale fires were vegetatively recovered but less during periods when there had been recent large scale fires.

Over the past two decades, hatchery personnel have observed substantial decreases in sediment rates based on the amount of accumulated sediment in settling ponds. Fish hatchery personnel attribute these trends to the re-growth of vegetation on the lands in the Middle Mainstem Subwatershed immediately upstream from the hatchery where timber harvest had occurred.

Sediment From Landslides

In this watershed, the geologic landforms with highest sediment delivery potential are resistant, intermediate or weak rock type on steep slopes. The weak rock type on steep slopes which has the highest potential for landslides exists all along Eagle Creek and the lower sections of South Fork, Delph Creek, North Fork and Bear Creek (tributary to North Fork). The dominant sediment transport mechanisms of these three rock types are debris flows, debris slides and stream bank failures.

Many of the recent debris flows appear to be associated with the 1964 100-year storm event. Forty two of the recent landslides are thought to have delivered sediment to the system. Management activities such as timber harvest, road construction or quarrying, has influenced or initiated 14 landslides.

Sediment from Roads and Soil Disturbing Activities

Methodology for estimating sediment delivery to streams closely follows methods for evaluating surface erosion from hillslopes and roads. The objectives of the methodology as applied to Eagle Creek Watershed are:

- to evaluate and document the relative potential for sediment delivery from roads and soil disturbing activities,
- evaluate consistency with the Aquatic Conservation Strategy Objectives, and
- to prioritize activities and locations for restoration.

Natural or undisturbed rates of erosion for the landform within the watershed are unknown. Swanson and Grant, 1982, estimated surface erosion rates for forested area as low, 0.007 tons/acre/year. Therefore surface erosion and sediment delivery estimated in this methodology could be considered an increase due to recent management activities. Total vegetative recovery is assumed after 5 years for harvest units and road revegetation and obliteration.

Data limitations necessitated alternate analysis than described in the methodology although the departures retain the logic and assumptions of the original methodology (Appendix C). While this methodology is based on the current scientific understanding of forest management and watershed processes, its predicted outputs have not been evaluated on the Mt. Hood National Forest. Therefore, the results should not be considered as exacting measures of potential sediment yield but instead provide a framework for understanding relative effects of different management activities in the watershed and a comparison of sediment delivery rates among subwatersheds.

Roads

Roads deliver chronic levels of sediment to streams over long periods of time from unvegetated cutslopes and running surfaces. Impacts to water quality occur when sediment is delivered directly to the stream system at road crossings where runoff accumulated in road ditch lines is diverted directly into streams. Roads that are located in close proximity to streams can also deliver sediment via overland flow to stream channels from culvert out flow.

The assessment of road erosion focuses on the three main factors associated with the road prism; i.e. cutslopes, fillslope and road surface. Sediment delivery was based on direct road ditch contribution and 10% of sediment transported from culvert out flow via overland flow less than 300 feet from a stream.

Approximately two thirds of the sediment delivered to streams from roads come from within North Fork (41%) and Delph Creek Subwatersheds (25%). The Lower Mainstem and Middle Mainstem subwatersheds deliver 30% of the sediment to the streams while the South Fork and Upper Mainstem contribute only 4% of the sediment delivered to streams (Table 7).

Table 7. Total Sediment Delivered From Roads

Subwatershed	Sediment Delivered		Road Length Delivering Sediment	
	Tons/Year	%	Miles	%
Lower Mainstem	45.3	18	21.4	17
North Fork	103.0	41	55.7	43
Delph Creek	62.1	25	27.3	21
Middle Mainstem	30.0	12	14.5	11
South Fork	8.3	3	7.8	6
Upper Mainstem	2.5	1	1.6	1
Watershed Total	251.2	100	128.3	100

Table 8. Road Lengths Delivering High vs. Moderate or Low Rates of Sediment to Streams

Subwatershed	Rating	Sediment Delivered		Road Length Delivering	
		Tons/Yr	%	Miles	%
Lower Mainstem	high	16.1	36	6.8	0.31
	mod-low	29.2	64	15.0	0.69
North Fork	high	34.7	34	1.9	0.18
	mod-low	68.3	66	8.5	0.82
Delph Creek	high	24.9	40	10.1	0.37
	mod-low	37.2	60	17.2	0.63
Middle Mainstem	high	10.1	34	3.5	0.24
	mod-low	19.4	66	11.0	0.76
South Fork	high	1.0	12	0.8	0.10
	mod-low	7.4	88	7.0	0.90
Upper Mainstem	high	0.8	32	0.5	0.31
	mod-low	1.7	68	1.1	0.69

Table 9. Total Sediment Delivered to Streams From Timber Harvest and Agricultural Activity

Subwatershed	Sediment Delivered		Area Delivering Sediment	
	Tons/Year	%	Acres	%
Lower Mainstem	800.4	32	884	33
North Fork	720.2	28	848	31
Delph Creek	734.8	29	721	27
Middle Mainstem	251.7	10	237	9
South Fork	22.9	1	40	<1
Upper Mainstem	4.3	<1	5	<1
Watershed Total	2,534.3	100	2,696	100

Approximately 128 miles of the total 509 miles of road in Eagle Creek have the capability to deliver sediment to streams. Sediment delivery rates range from 0.4-15.0 tons/mile/year. For comparison, in the Salmon Creek Watershed, sediment delivery rates ranged from 20-60 tons/mile/year. Differences between these watersheds could be partially attributable to:

- the inclusion of sediment delivered from dispersed recreation which were considered negligible within the Eagle Creek Watershed;
- the inclusion of 100% of sediment delivered via culvert outflow due to Geographic Information Systems methodology; and
- the inclusion of actual road cut and fill vegetated conditions which were considered fully vegetated due to the lack of data in the Eagle Creek Watershed.

Road segments that contribute **high** sediment quantities (greater than or equal to 0.25 tons/year) are concentrated in the southern section of the North Fork Subwatershed, consisting of 18.3 miles of road and scattered throughout Delph Creek, Middle and Lower Mainstem Subwatersheds, consisting of 10.1, 6.8 and 3.5 miles respectively (Map Road Sediment). South Fork and the Upper Mainstem subwatersheds only have 0.8 and 0.5 miles respectively of roads contributing high quantities of sediment (Table 8). This can be attributed to the large percentage of paved roads within the South Fork Subwatershed and the few number of roads within the Upper Mainstem Subwatershed.

Timber Harvest and Active Agricultural Activity

Approximately 90% of sediment delivered to streams from harvest units or agricultural lands come from the Lower Mainstem Subwatershed (32%), the North Fork Subwatershed (28%) and the Delph Creek Subwatershed (29%). The Middle Mainstem Subwatershed delivers approximately 10% of sediment delivered to streams while the Upper Mainstem and South Fork Subwatersheds each deliver 1% or less of the total sediment delivered (Table 9). The delivery rate averaged approximately 1 ton/acre/year.

Land units delivering the greatest amounts of sediment are spread out through the lower two thirds of the watershed. One quarter to one half of the sediment delivered were from ten or less land units within the Lower Mainstem, North Fork, and Delph Creek Subwatersheds. Another 20-25% of sediment delivered came from an additional 11-14 land units within each subwatershed.

Within the Middle Mainstem Subwatershed, 74% of the sediment delivered to streams were delivered from 8 land units with remaining 26% of the sediment delivered from 32 land units.

Sediment delivery within Delph Creek and the Middle Mainstem Subwatershed were the result of both agricultural and timber harvest activity while timber harvest units delivered most of the sediment in the North Fork subwatershed. Within the Lower Mainstem Subwatershed, most of the units delivering a majority of the sediment have agricultural activity.

Approximately 57% of the sediment delivered to streams from roads, agricultural and timber activities is from the North Fork and Delph Creek subwatersheds. These subwatersheds have a third or more of areas with low infiltration rates and high runoff capacity and are non-depositional channels. Therefore, the delivered sediment may be flushing through these subwatersheds faster and at a higher rate with resultant increases in deposition over the range of natural conditions in the Lower Mainstem channel. The Lower Mainstem Subwatershed also has high sediment delivery rates (32%) which may be further increasing the risks of excessive sedimentation and deposition.

Table 10. Total Sediment Delivered to Streams from Timber Harvest, Agricultural Activity and Roads

Subwatershed	Sediment Delivered		Area Delivering Sediment	
	Tons/Year	%	Acres	%
Lower Mainstem	845.7	32	905	33
North Fork	823.2	28	904	31
Delph Creek	796.9	29	748	27
Middle Mainstem	281.7	10	252	9
South Fork	31.2	1	47	<1
Upper Mainstem	6.8	<1	6	<1
Watershed Total	2,785.5	100	2,863	100

Increased deposition can cause increased channel scour, downcutting or decreased bank stability. Eight cases of intense stream bank erosion occur in the Lower Mainstem channel where the channel transitions from a narrow, constricted channel to a wider floodplain. In this area, the floodplain is not wide enough to decrease the energy flow of the water so that the creek cuts latterly into the weak Sandy River Mudstone formation that forms the shallow valley walls. This further contributes to the sediment load of the watershed.

Since the majority of this subwatershed has soils with characteristics of low infiltration and high runoff, increased peak flows within the Lower Mainstem Subwatershed may also be contributing to the stream bank instability within this subwatershed.

Increased deposition could also be causing channel aggradation; channel widening, braiding or sediment storage on floodplain, in gravel bars and with the channel causing decreased pool areas (Sullivan, et al., 1987) . The fish hatchery suspended production of fall chinook as the fish released from the hatchery were not coming back to the hatchery to spawn due to low flow conditions at the mouth of Eagle Creek and were instead spawning in the Clackamas River. This may indicate that excessive sediment loadings and deposition caused the channel to aggrade and/or widen resulting in decreased pool areas and/or shallow channels preventing fish from using.

Riparian Condition

Large Wood Supply Affecting the Aquatic Ecosystem

Large woody debris accumulated or removed from stream channels is the result of natural processes, and human activities. Natural processes include floods and landslides and include such things as the passive contribution of LWD to the channel from the riparian area, and the natural tendency of LWD to gradually migrate downstream. Timber harvest, stream channel "cleanups," residential development, and road construction are human activities that affect the amount of LWD that is present in a stream channel. The presence or absence of large wood in a stream channel dramatically affect the stream channel characteristics, i.e. shape, velocity, temperature and number of pools, riffles, waterfalls, or migration barriers. Fish require specific stream characteristics to survive.

In the late 1800's large forest fires swept through much of Eagle Creek drainage. Due to a lack of survey information, it is uncertain what actual affects occurred although a substantial amount of large trees and woody material were probably removed from the area. By 1946, much of the lower drainage had been converted to agricultural and residential uses. The practice of salvage logging of large wood from the stream channel occurred from 1965 through the early 1980's. Road construction has had substantial impacts on the aquatic system.

The BLM has begun restoration work on the lower 2.28 miles on the lower North Fork Eagle Creek to increase habitat diversity. A small restoration effort on the upper North Fork was also completed in 1991 by the Forest Service along river mile 8.6 to 10 to increase pool densities. No other substantial restoration efforts have been initiated in the Eagle Creek drainage.

Lower Mainstem and Delph Creek Subwatersheds has higher percentage of riparian vegetation in early seral stage (Map 3-13 RR w/Seral Stage) compared to RNV defined in REAP. South Fork Subwatershed is the only subwatershed within RNV (35-78%) for late seral riparian vegetation. In this analysis, riparian buffers were equal widths for federal and private lands.

Projected large woody debris recruitment in Eagle Creek watershed within Riparian reserves was modeled using the methodology outlined in the Washington Forest Practice Board (1993). Data limitations necessitated alternative analysis than described in the methodology although the departures retain the logic and assumptions of the original methodology (Appendix C). Areas with low large woody debris potential are scattered throughout the lower portion of the watershed (Map 3-14 Large Woody Debris). Lower Mainstem Subwatershed has the lowest large woody debris potential (Table ll) as only 26% of the subwatershed has potential for quality woody debris (late seral sized trees). Delph Creek, North Fork and Middle Mainstem subwatersheds have moderately low large woody debris potential as only about 50% of the riparian area has potential for quality LWD. South Fork and Upper Mainstem Subwatersheds have adequate LWD potential.

Table 11. Potential Large Debris Recruitment Within Riparian Areas

Sub-watershed	Low		Medium		High		No	
	Acres	%	Acres	%	Acres	%	Acres	%
Delph	503	16	805	26	1,593	51	238	7
Lower Eagle	1,050	32	913	28	833	26	462	14
Middle Eagle	378	13	843	30	1,409	50	188	7
Upper Eagle	315	6	1,073	18	4,317	74	131	2
North Fork Eagle	907	11	2,285	27	4,499	54	623	8
South Fork Eagle	249	11	337	15	1,692	74	9	0.03
	3,402	13	6,254	24	14,613	57	1,651	6

Note: *No potential includes non-vegetated/agricultural lands.*

Habitat Condition

The following is an analysis of the habitat condition of the Eagle Creek watershed. The information available indicates that conditions in the upper basin are conducive to sustaining wild trout populations with some improvement warranted in the North Fork subwatershed. General conditions in portions of the lower drainage however indicate a need for improvement towards increasing fish productions. This analysis is based on very little information, particularly on lands outside the Forest Service and BLM boundaries. Additional surveys are needed on private lands in order to provide overall watershed conditions. A map of the surveyed reaches can be found in Appendix ?? Map A-1.

Fish require complex habitat conditions for survival. An examination of their habitat can be divided into an investigation of the conditions within the streams themselves (instream conditions) and the conditions immediately adjacent to the streams (Riparian Areas). Instream conditions include: large trees to scour pool habitat, provide cover for fish, serve as a place for nutrient storage, and decrease water velocity to provide slow water refuge areas for fish. Side channels, braided areas and roughness components such as large boulders and wood are important for overwinter survival of fish populations. Riparian areas are important since they provide for shading (which maintains the proper water temperature for fish survival), organic input, and bank stability.

Upper and Middle Mainstem Eagle

Two surveys have been conducted in main channel of middle and upper Mainstem subwatershed. Resident cutthroat trout thrive in the excellent habitat there. Habitat complexity was highest in the wilderness with lots of side channels, channel braiding, and an abundance of still water. Spawning gravel is plentiful, well distributed, and associated with course woody debris (CWD). Woody debris, habitat complexity, and pool densities were highest in the wilderness and progressively decreased further downstream. Large and small woody debris levels were considered low compared to LMP standards in the middle mainstem (Table 12).

Stream temperatures are apparently naturally elevated as it leaves the wilderness. Temperatures exceeded state water quality standards (14.4°C) for all years with the exception of 1993 (Appendix C). Daily temperatures have been recorded at the hatchery for over 30 years. Average daily temperatures in August frequently exceeded the state water quality standard between 1962 and 1994 (Figure 5). The range of natural variation for stream temperatures in the Clackamas Basin estimated in the REAP analysis ranged from 14.5 - 20.0°C. Upper and Middle Mainstem and South Fork temperatures varied within this range with the exception of one summer at the station located at the Forest Boundary within the Upper Mainstem (Figure 5). This exception exceeded the range of natural variation in 1991.

The wilderness area is well vegetated with an overstory supplying good shade conditions. Stream banks are stable. Areas of timber harvest are present below the wilderness. CWD decreased moving downstream from the wilderness in the areas of timber harvest (Table 12). Post harvest conditions have left a deciduous canopy cover decreasing the potential for large woody debris (LWD) to fall into the stream.

Figure 5. Average August Temperature at Eagle Creek National Fish Hatchery

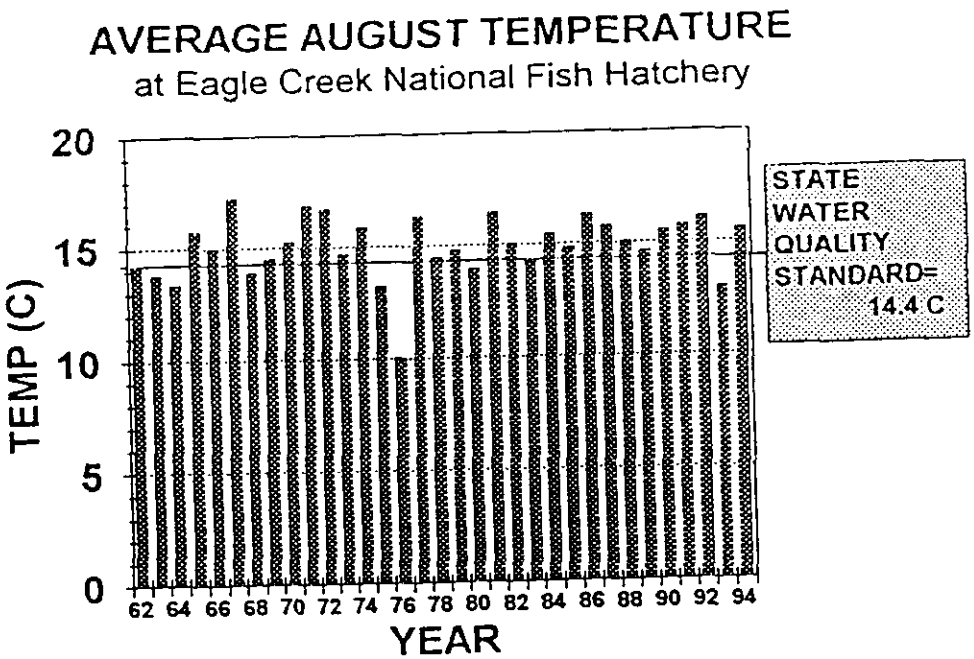
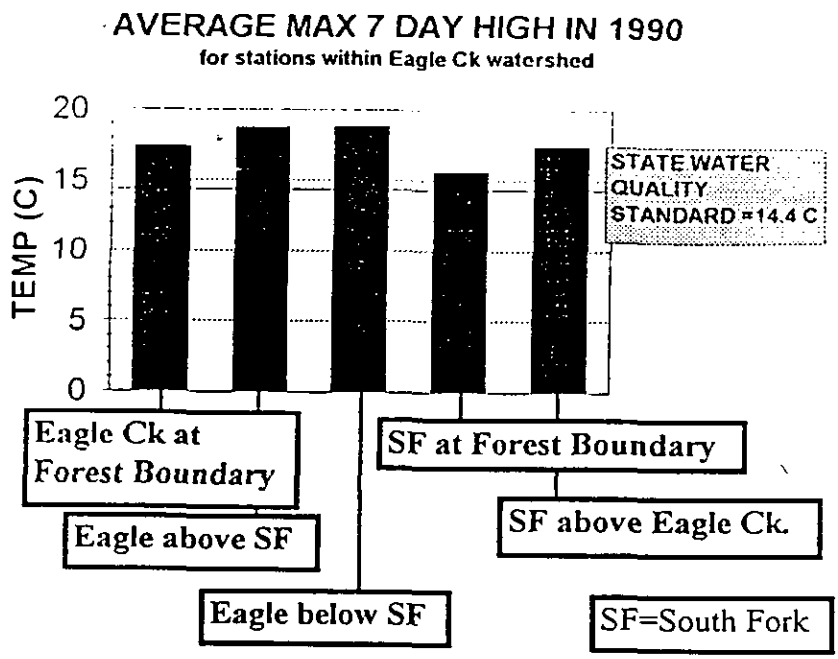


Figure 6. Average Maximum 7 Day High on Mainstem Eagle Creek



South Fork Eagle Creek

The overall habitat conditions for fish is rated as 'good'. Pools in the upper reaches are generally shallower and improve in size and depth as the stream gradient decreases further downstream. Spawning habitat and gravels are abundant in the lower sections of the stream. The rearing habitat is typically of poor value in the upper reaches due to a lack of LWD, pools of shallow depth, and insufficient effective cover from predators for young fish. The rearing habitat in the lower sections of the stream are of good quality providing moderate pools depths with effective cover. Aquatic invertebrate production is high. Depositional areas (pockets of erosion material that form islands, e.g. a sandbar) indicate that the watershed is capable of releasing large quantities of silt and sand. Most of the CWD in the stream in this section are the result of debris torrents (events leading to large amounts of material entering the water such as landslides, forest fires, heavy storms, etc.) and timber harvest debris. Large woody debris levels were adequate compared to LMP stands but small woody debris levels were less than the LMP standard (Table 12).

The number of pools did not meet LMP standards in two of reaches surveyed (Table 13). SF Eagle's lower temperatures helped to keep Mainstem Eagle creek's temperature from rising (Figure 6). The State water quality standard of 14.4 °C was exceeded in SF in 1990 and approached the standard in 1989 (appendix C).

The riparian zone in the upper section of this sub-basin supports numerous spring fed seeps and marshes. These marshy areas are contributing significantly to flow, temperature maintenance and water quality. There is evidence of slope failure from shallow soils and supersaturation. Most of the CWD that is present is positioned above the stream channel and not contributing to habitat diversity within the stream. Further downstream the riparian area provides more abundant CWD to the stream. Moderate timber harvest has occurred and mid seral stands exist resulting from fire. In this area ample supply of LWD exists in the stream channel. Debris flow tracks were observed in two tributaries probably from the historic fire event. The stream channel is rated as stable with an increasing trend toward stability. As the stream moves off Forest Service ownership, the dominate overstory is of Alder and Bigleaf Maple leaving a poor potential for CWD recruitment.

North Fork Subwatershed (includes Bear Ck. Little Eagle Ck)

Habitat information was available from stream surveys predominantly in the lower portion of the North Fork subwatershed. Large and small woody debris, and pool frequency did not meet LMP standards (Tables 12 and 13).

The habitat complexity is low in the sections of stream surveyed. There is a lack of instream wood in the channel making the streams riffle dominated with few of the pools that are essential to fish survival. The low levels of LWD have eliminated secondary channels, stream slowing, and provides few refuge areas for fish. This leads to poor overwinter survival. Sediment production is believed to have been increased from disturbances (timber harvest, road building, etc.) causing siltation of the stream substrate and decreasing the productivity of fish. The riparian overstory in generally dominated by hardwoods in the lower sections scattered with coniferous trees. The hardwood dominance is a result of timber harvest which occurred primarily in the 1960' and 1970's. As a result, there has been a loss of stream shading and there is low potential for LWD recruitment.

The BLM has begun restoration work on the lower 2.28 miles on the lower North Fork of Eagle Creek to increase habitat diversity. Results from this effort are currently being analyzed by BLM biologist but have not been completed at the time of this analysis. A small restoration effort on the upper North Fork of Eagle was also completed in 1991 by the Forest Service along RNs 8.6-10 to increase pool depth and densities. A comparison of pre-work to post-work conditions show a dramatic increase in available fish habitat. The pool:riffle:glide ratio changed from 2:89:9 to 14:83:3 in 1992. Small and large wood debris densities increased to 121/mile and 26/mile respectively.

Numerous man-made ponds exist throughout North Fork Subwatershed. The largest is Hope Lake which drains into Trout Creek. The creation of these ponds has increased the surface area of water exposed to solar radiations, probably increasing water temperatures.

Lower Mainstem and Delph Creek Subwatersheds

These subwatershed's are privately owned and managed and have no stream survey data available. Most of this area was harvested in the mid 1900's and since has been used for commercial agriculture and residential development. This form of development is generally associated with land clearing, little riparian protection, stream clearing, extensive road construction, soil erosion, water withdrawal for irrigation, an increase in stream temperatures as well as agricultural chemical applications. While there is limited survey data there is ample evidence to indicate that these subwatershed's have poor habitat conditions. Low levels of instream wood, decreased stream shading, and a generally low level of habitat complexity. Wood debris recruitment data derived from aerial photos show low potential for large woody debris recruitment throughout these subwatershed's with the exception of upper Delph Creek. Currin Creek, the major tributary to lower Mainstem, has been channelized. Little to no stream side vegetation is present which has removed the potential for LWD recruitment. The creek lacks stream shading resulting in elevated temperatures. Without regulation and careful study of the stream environment, the long term consequences of this type of utilization cannot be fully known. The potential for these waterways to become unsuitable for fish exists.

Less than 50% of the riparian area (___ ft. on both sides of stream) has adequate shade (70% or greater canopy closure) in both these subwatersheds. This lack of shade results in increasing water temperatures. In the lower Mainstem this lack of shade combined with decreased base flows may increase streams even greater.

Numerous man-made ponds exist throughout these subwatersheds. The creation of these ponds has increased the surface area of water exposed to solar radiations, probably increasing water temperatures.

Table 12. Comparison of Woody Debris in Basins Within the Eagle Creek Watershed and the LMP and PIG Standards

Stream	River Mile	LWD/Mile[1]	SWD/Mile[2]
Middle Eagle Creek Subwatershed			
Eagle Creek	13.6 -16.6	2.5	9.7
Upper Eagle Creek Subwatershed			
Eagle Creek	16.6 -18.0	14.8	13.6
Eagle Creek	18.0 -19.5	83.8	44.7
Eagle Creek	19.5 -21.7	89.3	5.9
South Fork Subwatershed			
South Fork Eagle Creek	0 -1.4	24.3	28.7
South Fork Eagle Creek	1.4 -2.4	44	57.5
South Fork Eagle Creek	2.4 -3.9	54.7	47.4
South Fork Eagle Creek	3.9 -6.0	53.7	81.4
North Fork Subwatershed			
North Fork Eagle Creek	0 -0.5	0[3]	0[3]
North Fork Eagle Creek	0.5 -1.8	0.5[3]	0.5[3]
North Fork Eagle Creek	9.0 -12.0	0[4]	0[4]
Bear Creek	0 - 1.0	6.2	33.3
Little Eagle Creek	0 -0.5	1.7	11.6
Little Eagle Creek	0.5 -1.2	0.8	0.8

[1] *LWD (large woody debris) is 36 inches in diameter and 50 feet in length*
[2] *SWD (small woody debris) is 24 inches in diameter and 50 feet in length*
[3] *Wood counts included only naturally introduced wood. wood counts do not include wood introduced from BLM's restoration work.*
[4] *Wood counts do not include Forest Service restoration work.*

LMP for LWD/Mile = 20; PIG for LWD/Mile = 80; LMP for SWD/Mile = 80

Note: shaded areas do not meet the LMP.

Table 13. Comparison of Existing Pool Frequency Conditions in Creeks in the Eagle Creek Watershed with LMP and PIG Standards

Stream	River Mile	Avg. Bankful Width (ft)	Total Pools/Mile	LMP[1] Standard (pools/mi)	PIG[2] Standard (pools/mi)
Middle Eagle Creek Subwatershed					
Eagle Creek	13.6 -16.6	47	24	16-23	26
Upper Eagle Creek Subwatershed					
Eagle Creek	16.6 -18.0	54	32	14-20	23
Eagle Creek	18.0 -19.5	54	39	14-20	23
Eagle Creek	19.5 -21.7	8	10.4	94-132	96
South Fork Subwatershed					
South Fork Eagle Creek	0 -1.4	27	22.3	28-39	26
South Fork Eagle Creek	1.4 -2.4	32	35.5	24-33	26
South Fork Eagle Creek	2.4 -3.9	30	30.4	25-35	26
South Fork Eagle Creek	3.9 -6.0	24	25.9	31-44	26 North Fork Subwatershed
North Fork Eagle Creek	0 -0.5	41	31.0[3]	18-26	26
North Fork Eagle Creek	0.5 -1.8	38	41.9[3]	20-28	26
North Fork Eagle Creek	9.0 -12.0	21	10	36-50	47
Bear Creek	0 - 1.0	19	50.4[3]	40-56	56
Little Eagle Creek	0 -0.5	18	25.0[3]	42-59	56
Little Eagle Creek	0.5 -1.2	18	39.9[3]	42-59	56

[1]*LMP - Mt. Hood National Forest Plan 1990*
[2]*PIG - Policy Implementation Guide 1994*
[3]*Measurements were taken by the BLM who use a different method for measuring pools than the FS. Their total pools per mile may be an overestimate since they include other types of pools than main channel pools.*

Note: shaded areas do not meet the LMP.

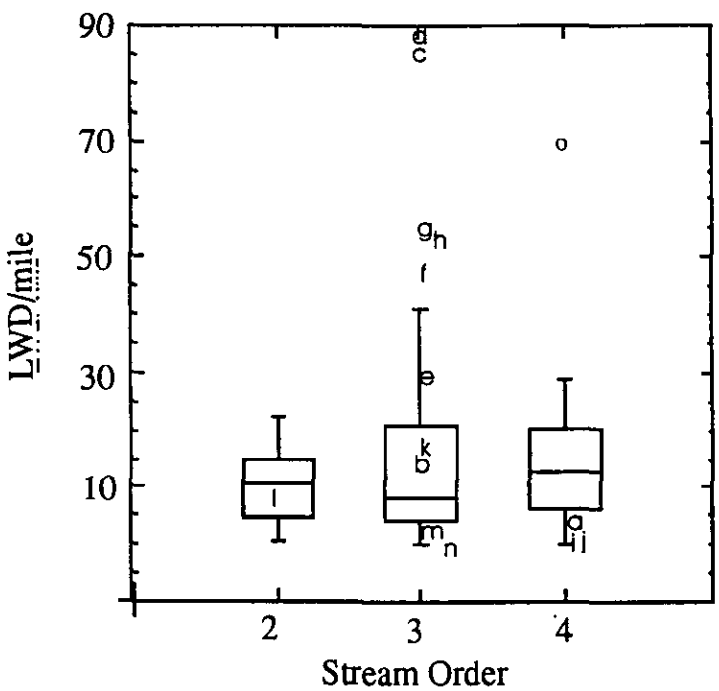
Estimated range of natural conditions (RNV's) for small and large woody debris, and primary and total pools were derived from streams within the Williamette basin of the same stream order that have no history of management activities (Figures). The sample size for this analysis was small and determining a history of no management activity can not take into account the effect of fire suppression activities both inside and outside of these streams that may have affected their condition.

From this analysis North Fork had low levels of LWD and SWD (Figures 7 and 8). Although the upper Mainstem channel had low levels of SWD they had extremely high levels of LWD.

All of the reaches in Eagle Creek had adequate total pools per mile with one exception (Figure 9). South Fork and North Fork had low levels of primary pools/mile (Figure 10).

Figure 7. Comparison of LWD/Mile in Stream Reaches in the Eagle Creek Drainage With Unmanaged Stream Reaches

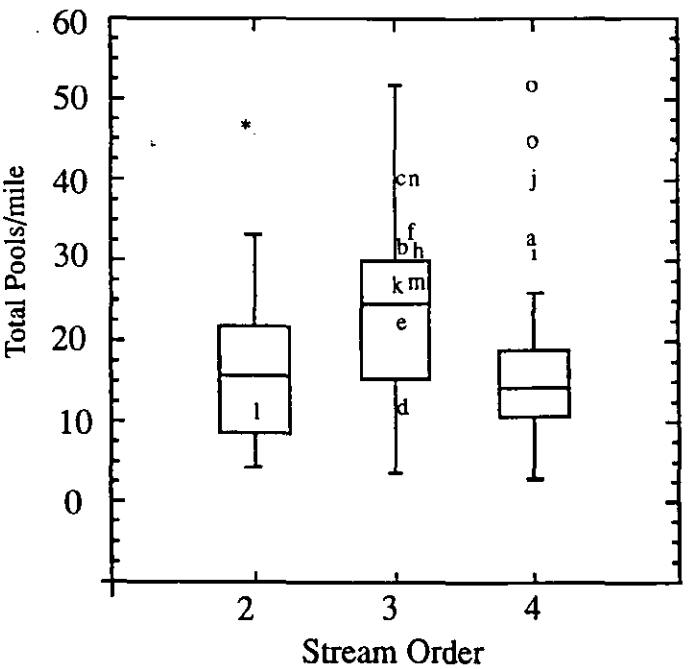
Box and whisker plot represents estimated RNV based on a study of unmanaged reaches outside the Eagle Creek Watershed.



Legend: stream reaches within the Eagle Creek Watershed
a. Eagle Creek reach 1
b. Eagle Creek reach 2
c. Eagle Creek reach 3
d. Eagle Creek reach 4
e. S.F. Eagle Creek reach 1
f. S.F. Eagle Creek reach 2
g. S.F. Eagle Creek reach 3
h. S.F. Eagle Creek reach 4
i. N.F. Eagle Creek reach 1 (BLM)
j. N.F. Eagle Creek reach 2 (BLM)
k. N.F. Eagle Creek reach 3 (FS)
l. Bear Creek reach 1
m. Little Eagle Creek reach 1
n. Little Eagle Creek reach 2
o far outside value
* outside value

Figure 9. Comparision of Total Pools/Mile In Reaches in the Eagle Creek Drainage With Unmanaged Stream Reaches

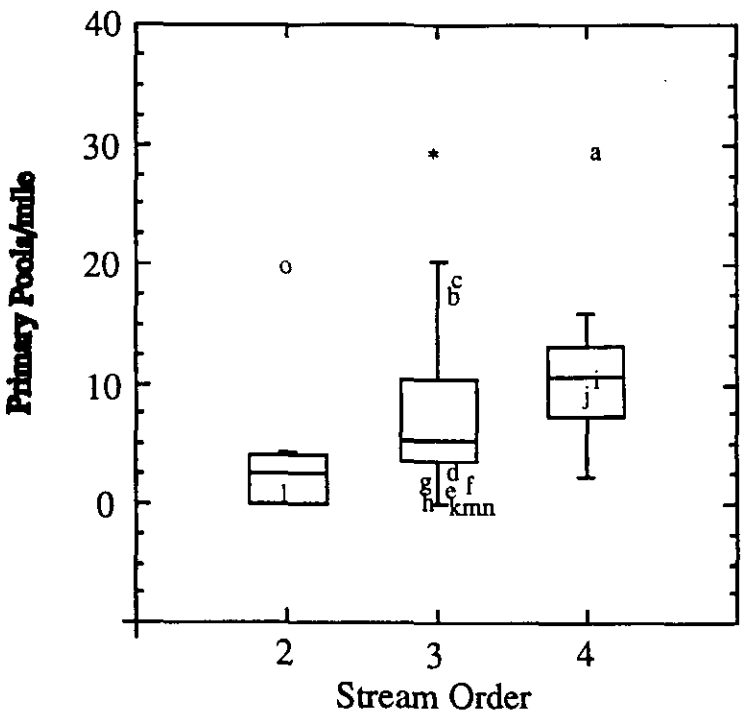
Box and whisker plot represents estimated RNV based on a study of unmanaged reaches outside the Eagle Creek Watershed.



Legend: stream reaches within the Eagle Creek Watershed.
a. Eagle Creek reach 1
b. Eagle Creek reach 2
c. Eagle Creek reach 3
d. Eagle Creek reach 4
e. S.F. Eagle Creek reach 1
f. S.F. Eagle Creek reach 2
g. S.F. Eagle Creek reach 3
h. S.F. Eagle Creek reach 4
i. N.F. Eagle Creek reach 1 (BLM)
j. N.F. Eagle Creek reach 2 (BLM)
k. N.F. Eagle Creek reach 1 (FS)
l. Bear Creek reach 1
m. Little Eagle Creek reach 1
n. Little Eagle Creek reach 2
o far outside value
* outside value

Figure 10. Comparison of Primary Pools/Mile in Reaches in the Eagle Creek Drainage With Unmanaged Stream Reaches

Box and whisker plot represents estimated RNV based on a study of unmanaged reaches outside the Eagle Creek Watershed.



Legend: stream reaches within the Eagle Creek Watershed
a. Eagle Creek reach 1
b. Eagle Creek reach 2
c. Eagle Creek reach 3
d. Eagle Creek reach 4
e. S.F. Eagle Creek reach 1
f. S.F. Eagle Creek reach 2
g. S.F. Eagle Creek reach 3
h. S.F. Eagle Creek reach 4
i. N.F. Eagle Creek reach 1 (BLM)
j. N.F. Eagle Creek reach 2 (BLM)
k. N.F. Eagle Creek reach 1 (FS)
l. Bear Creek reach 1
m. Little Eagle Creek reach 1
n. Little Eagle Creek reach 2
o far outside value
* outside value

Aquatic Organisms

Fish Species Presence and Distribution

There is little historical information on the distribution and population sizes of fish which utilize the Eagle Creek drainage. In the early 1900's. Clackamas fish were heavily harvested as well as adversely affected by industrial developments and pollutants below it's confluence with the Williamette River. The Clackamas and Eagle Creek drainages have a long history of hatchery operations with no data to identify the impacts of these hatcheries on the native fish. A summary of the hatchery releases are provided followed by a listing of the indigenous fish which occupy the drainage. Since documentation within the Eagle Creek drainage is poor, it is assumed that indigenous fish which occupy the Clackamas River, use the lower reaches of Eagle and North Fork of Eagle Creeks. Three waterfalls exist on Eagle Creek, the lower falls at river mile 5, middle falls at river mile 9 and the upper falls at river mile 13. It is believed that the middle falls was the historic migration barrier to anadromous fish (Map 3-12 Fish Distribution). A comprehensive overview of fish stocks within the Clackamas River can be found in the Upper Clackamas Watershed Analysis.

Indigenous Stocks

Coho

The Clackamas subbasin has a native run of late winter coho. Genetic testing is underway to determine the ecological significance of the run. It is believed to be the last self-sustaining wild run of coho salmon in the lower Columbia River (Cramer and Cramer 1994).

In 1991 Nehlsen et al. designated the Clackamas River native late run coho as "moderate risk for extinction". The lower Columbia coho salmon is also listed as "critical" on the Oregon State Sensitive Species List (ODFW 1992).

It is unknown if these coho continue to utilize Eagle Creek. Emphasis for the study on these fish have been focused on the Clackamas River rather than Eagle Creek since current production of Coho within Eagle Creek are primarily of hatchery origin. Historically, native Coho probably utilized lower Eagle quite extensively since it provides habitat conditions preferred by Coho. Commercial fish harvest, hatchery introductions, and ocean rearing conditions have had an affect on the abundance of Coho returning to the drainage.

Spring Chinook

The Clackamas River was historically believed to be one of the primary producers of spring chinook in the Pacific Northwest. Commercial harvest of chinook in the Columbia River during the mid 1800's contributed to the decline of the indigenous stocks from the Clackamas River. The continuance of the original stocks within the Clackamas basin is in doubt (ODFW 1991). The spring chinook which occur in the Clackamas Basin include both naturally and hatchery produced fish. Spring Chinook spawn in the Clackamas River from mid September through October. There is no specific data available within the Eagle Creek drainage, however, studies on the mainstem Clackamas have shown that the numbers of wild fish have dramatically declined (Fish Creek Watershed Analysis, 1994).

Winter Steelhead

In May 1994 all native stocks of steelhead trout were petitioned for listing under the Endangered Species Act across their Alaska-Southern California range. Findings and determinations are due within a year. Nehlsen et al. (1991) identified the Clackamas River native winter steelhead as at "moderate risk for extinction".

Two stocks of winter steelhead are thought to inhabit the watershed: an early run that may be of hatchery origin (or strays from the ECNFH), and a late run that is thought to be wild. Steelhead are utilizing habitat and spawning in the North Fork of Eagle Creek, the lower .3 miles of Bear Creek and are believed to be in the lower 2 miles of Little Eagle Creek.

Searun Cutthroat

This species is currently being reviewed for listing under the Endangered Species Act as an evolutionary significant unit throughout their distribution. Findings and determination are due within the year. The coastal cutthroat trout are listed as "critical" on the ODFW Oregon state sensitive species list.

Documentation of distribution and population size of Searun cutthroat is lacking. There are no specific records documenting the utilization of Eagle Creek although searun are suspected to primarily use North Fork of Eagle Creek. The appearance of searun at the ECNFH have been low in numbers with the most recent sitings in 1992 of two fish (Doug Dysart, ECNFH manager, personal communication).

Pacific Lamprey

Pacific Lamprey are a candidate species, category 2 (C2), under the ESA. The C2 designation means it probably should be listed but data is lacking to warrant listing at this time. This species is listed as "vulnerable" on the ODFW Oregon state sensitive species list.

Pacific Lamprey have been reported spawning in the lower reaches of Eagle Creek although numbers and distribution is not well known.

Resident Cutthroat

Fish upstream of the upper falls located at RM 13, have been isolated since the geological formation of the falls. Cutthroat trout are widely distributed through out the upper basin. These fish are endemic to the area and warrant special attention to maintain the genetic integrity of the stock. No fish stocking has occurred in the upper basin so there has been no dilution of the gene pool of the original group. There are currently no special harvest regulations in place to protect them from overfishing, however, it is currently believed that fishing pressure on these fish are low (Kathryn Kostcow, ODFW, personal communication).

Other Fish Species

Northern squawfish, Longnose dace, Redside shiner, Prickly sculpin, Reticulate sculpin, Largescale sucker, Mountain sucker and Western brook lamprey may inhabit the lower Eagle Creek drainage. No field surveys are available to confirm or deny their presence.

Amphibians

Habitat is present within the watershed to support a variety of amphibians. Sightings of Cope's Giant salamander have been recorded on Forest Service lands. Suitable habitat is present for Red-legged frog and Painted turtles on Forest Service lands in the upper watershed. Lands administered by the BLM have conditions suitable for Cascade frog, Foothill yellow-legged frog, Northern red-legged frog, and spotted frog (for a status of their listing, refer to wildlife discussion).

Fish Hatchery Production/Introductions

The Delph Creek hatchery was located on Delph Creek (a tributary to Eagle Creek) at river mile 2. Originaally, it was operated by the Oregon Game Commission for the production of trout. It was later transferred to the USFWS in 1936 to aid in the rehabilitation of salmonids. During the USFWS operation of the hatchery between 1943-1954, a total of 397,795 spring chinook smolts; 43,830 coho salmon pre-smolts; and 2,827,164 Fall Chinook smolts were released into Delph Creek (for a complete listing of the releases, refer to Appendix ___, Tables _____). The last releases from this facility occurred in 1954.

The Eagle Creek Fish Hatchery is located on the mainstem of Eagle Creek at RM 13. The hatchery was built in 1956 and is operated by the USFWS. There are two falls below the hatchery. Fish ladders were constructed on each of these falls to aid in the return of anadromous fish. A third falls is located above the fish hatchery and is the final barrier to upstream migration for anadromous fish on the mainstem of Eagle Creek. Prior to the construction of the fish ladders on the two lower falls, it is believed that the middle falls was the historic migration barrier to anadromous fish. Though the lower falls would be a challenge, the general consensus of fish biologists with the BLM and the Forest Service is that fish would have been able to pass over the falls under the right flow conditions without the fish ladder. The middle falls has a vertical drop of approximately 20 feet with no step pool formations making fish passage unlikely. The hardiest of wild winter steelhead under the right flow conditions may have passed the falls, but it is unlikely that large numbers passed over making the spawning population above the falls very small. The Eagle Creek Hatchery began producing fish in 1957. A summary of the total number of fish released within the Eagle Creek Basin is listed below in Table 13. For a more thorough examination of the timing of the releases, refer to appendix-, tables-.

Table 14. Early Run Coho - Summary of Fish Released

Fry	Pre-smolts	Smolts	Adults	Release Site
North Fork Subwatershed Totals				
37,600	91,763	0	0	Bear Creek
0	30,040	0	0	Grabenheim
24,675	85,014	0	0	Trout Creek
24,675	39,900	0	0	Little Eagle
234,181	691,944	175,461	0	North Fork
Delph Creek Subwatershed Total				+
299,825	308,891	0	100	Delph Creek
Middle Eagle Subwatershed Total				
2,658,285	2,915,335	35,020,795	0	ECNFH
Total Coho Released				
3,279,241	4,162,887	35,196,256	100	

The original stock of Early Run Coho used at ECNFH was primarily early run Sandy stock though it has been crossed with naturally produced Early Run Coho from the Clackamas subbasin.

Smolts are released into Eagle Creek between late April and early June.

Adults are in harvested in the lower Clackamas and Eagle Creek from September to October.

Adults return to ECNFH between the months of September and December. (personal communication, D. Dysart, manager , ECNFH).

Table 15. Spring Chinook - Summary of Fish Released

Fry	Pre-Smolt	Smolts	Release Site
Middle Eagle Subwatershed Total			
961,222	318,621	6,156,060	ECNFH

Fry and presmolts were released from September-October.

Smolts were released between from March-May.

Adults returned to the ECNFH from May through October.

High water temperatures at the hatchery created problems in holding spawning adults so production of spring chinook was stopped.

Spring Chinook were produced from 1957-1987.

Table 16. Fall Chinook - Summary of Fish Released

Fry	Pre-smolt	Smolts	Release Site
Middle Eagle Subwatershed Total			
4,096,752	0	13,616,222	ECNFH

The original stock of Fall Chinook used at ECNFH came from the Spring Creek Hatchery (Tule stock).

Smolts were released April, May, and June.

The adults were unable to return the ECNFH due to low flows at the mouth during the month of August and spawned in the lower Clackamas River.

Fall Chinook were produced at ECNFH 1957-1963.

Table 17. Winter Steelhead - Summary of Fish Released

Fry	Pre-smolt	Smolts	Release Site
Middle Eagle Subwatershed Totals			
0	201,599	2,813,290	ECNFH

The stocks of Winter Steelhead used at ECNFH have been numerous. Stocks have included: Clackamas and Eagle Creek stocks, Washougal and Big Creek.

Presmolts are released June-July.

Smolts are released in April.

Adults return to ECNFH December-May.

Rainbow Trout

The Oregon Department of Fish & Wildlife (ODFW) began been releasing catchable (6"-8") Rainbow Trout into Eagle Creek as early as 1948. The fish were released at Eagle Fern Park to provide a recreational fishery associated with the park. A total of 175,274 Rainbows have been released since the stocking program began.

Rainbow trout were also stocked in the North Fork of Eagle Creek at the BLM campground located at river mile 1.8. Stocking occurred from 1966-1994 with a total of 45,822 fish released.

All releases of the Rainbow occurred during the months of May, June, and July. Due to a decrease in budgets, ODFW eliminated both of these sites from their stocking program.

There are currently no plans for stocking in the future. (for a complete listing of the numbers stocked by year, refer to Table- in Appendix_).

Lakes, Springs and Wetlands

There is one lake within Forest Service ownership, Baldy Lake, located in the Salmon Huckleberry Wilderness. Baldy Lake drains into the mainstem of Eagle Creek. It is 2 acres in size and there are conflicting reports on the history of the stocking of this lake. A survey conducted in 1993 found no evidence of trout within the lake; however, the lake does support a large population of rough skinned newts. There is no direct trail to the lake, therefore recreational impacts are minimal to nonexistent.

There are numerous man-made ponds throughout the lower watershed. The largest is Hope Lake which drains into Trout Creek. A pond located at "Brian's Ranch" is used as a rainbow trout propagation farm. This pond is screened preventing the migration of fish into the natural system. Fish stocking and screening on the other ponds throughout the drainage is currently unknown.

The National Wetlands Inventory conducted by the USFWS identified several wetlands, most of which are in the lower drainage on private lands. Most of these wetlands were identified through aerial photo interpretation. Extensive field surveys have been conducted in the SF of Eagle creek finding numerous springs and wetlands often under a dense forest canopy which would not have been detected through aerial photo interpretation (see Map special habitats). The total increase in wetlands identified in the field would indicate to the possible existence of numerous wetlands that have not been identified in areas where field surveys have not been conducted.

Aquatic Insects

In 1992 a biomonitoring program was begun on Eagle Creek. Samples were collected at two points on the mainstem Eagle; one at the Wilderness Boundary and the other at the Forest Boundary. The objectives were to monitor the effect of timber harvest activities below the wilderness boundary.

Taxa at the wilderness boundary are consistent with those found in larger, mid-elevation, streams that have not been affected by management activities in the western cascades. The wilderness boundary site had a larger complement of the more intolerant taxa. Analysis reveals that the scores of the wilderness boundary location was 10% above the scores of the forest boundary location. This indicates a degradation in habitat integrity between the two sites (Benthic Monitoring Report 1992-1993). Clear cutting between the two sites has increased the amount of terrestrial inputs of dead organic material (detritus) due to the increase in hardwoods. Negative indicators at the forest boundary are a high percentage of collectors. There are no taxa present that would indicate that substrates are fouled by silt or filamentous algae. There have been no other macroinvertebrate collections within the drainage.

Threatened, Endangered or Sensitive Species

Suitable habitat for Mt. Hood Primitive Caddisfly (*Eobrachycentrus gelidae*), Mt. Hood Farulan Caddisfly, (*Farula jewetti*), One-spot Caddisfly (*Rhyacophila unipunctata*) and Cascades Apatanian Caddisfly (*Apatania tavala*) have been identified in several springs along the Eagle Creek Trail. Collections of these species have only occurred on the southern slopes of Mt. Hood. The extent of their range is sketchy. No field collections have been made in Eagle Creek.

Summary

From this analysis, hydrologic changes were decreased baseflows in the Lower Mainstem Subwatershed, increased peak flows in the Lower Mainstem and Delph Creek Subwatersheds, and increased sediment delivery and degradation of riparian habitat in all the subwatersheds with the exception of the Upper Mainstem and South Fork Subwatersheds and degradation of stream habitat conditions in North Fork subwatershed and probably Delph Creek and Lower Mainstem Subwatershed, although little information is available (Table 17).

Recreation Current Condition

Unlike other watersheds in the Clackamas River drainage, the Eagle Creek watershed offers few recreation features which attract large crowds of users like the Clackamas River, Olallie Scenic Area, or Bagby Hotsprings. On Forest Service land at the headwaters of the watershed, however, trails offer a variety of recreation experiences for hikers, equestrians, and off-highway vehicle users. The watershed also provides trails into the Salmon Huckleberry Wilderness which receives low visitor use in the Eagle watershed. The landscape characteristics of the Forest Service lands, indirect access from Highway 224, and management direction are the primary factors which determine the types and rate of recreation use in the watershed. Issues include the scenic quality of viewsheds and the management of two Roadless Areas on Forest Service land.

Clackamas County also offers a variety of hiking trails at Eagle Fern Park as well as opportunities for more social recreation like group picnics and sports. Management of BLM land immediately adjacent to the park could have an effect upon the park setting. Access to the Clackamas River and the historic river crossing of the Oregon Trail is also provided by the county at Bonnie Lure Park. Although these two parks play a significant role in the provision of recreation settings in the watershed, especially for local residents, this analysis focuses upon the recreation opportunities on National Forest land. No analysis is offered for BLM lands due to the lack of developed facilities or trails.

Table 18. Changes in the Aquatic Ecosystem

	Lower Mainstem	North Fork	Delph Creek	Middle Mainstem	South Fork	Upper Mainstem
Change in Baseflows	Y	?	?	?	?	?
*Management Activity	High	High	High	High	Mod	Low
*Deciduous Species Conversion in Riparian Area	Mod	Low	Low	Low	Low	Low
Change in Peakflows	Y		Y			
*Water Available Runoff as Compared to Fully Forested	NA	NA	NA	NA	No Change	No Change
*Absence of Vegetation on Soils with Low Infiltration	Mod	Low	Mod	Low	NA	NA
*Channel Network Expansion Due to Roads	Mod	Mod	High	Low	Insignifi-cant	Low
Change in Sediment Delivery	Y	Y	Y	Y		
*Roads	Mod	High	High	Mod	Low	Low
*Timber Harvest and Agricultural Activity	High	High	High	Mod	Low	Low
Change in Riparian Condition	Y	Y	Y	Y		
*LWD Recruitment Potential	Low	Mod	Mod	Mod	High	High
*% in Late Seral as Compared to RNV	Mod	Low	Low	Mod	No Change	Mod
*% in Early Seral as Compared to RNV	Above	No Change	Above	No Change	No Change	No Change
Change in Habitat Conditions	?	Y	?			
*In-channel LWD and SWD as Compared to RNV	No Data	Low	No Data	Mod	No Change	Mod-High
*Pool Frequency as Compared to RNV	No Data	Low	No Data	Mod	Low	Mod
*Stream Temperature as Compared to State Standard	No Data	No Data	No Data	Above	Above 1 yr	Above
*% Riparian Reserve With Canopy Closure >69	Low	Low	Low	Mod	High	High

Recreation Uses

The Forest Service land at the headwaters of the watershed is a steeply sloping landscape dissected by many creeks and wetlands with little flat land for facility development. There are no natural features like lakes, rivers, buttes, or hotsprings to attract large crowds of users. Recreation use on Forest Service land therefore consists of dispersed recreation on trails, roads, and creeks. The mainstem of Eagle Creek has been developed with trails at both Eagle Fern Park (which includes other developed recreation facilities) and at the headwaters in the Salmon Huckleberry Wilderness. Other system trails on Forest Service lands access ridgelines and mountain tops for vistas. Table 17 illustrates specific information about the Forest Service system trails.

Fishing occurs in the watershed but is low and is dependent on the availability of sport fish. Deer and elk hunting also occurs on Forest Service land but use is also low depending on the size of herds and habitat. Forest Service lands are considered a destination for mushroom harvesters and two rock pits serve as target shooting areas which is neither managed or encouraged by the Forest Service. Winter sports also occurs on Forest Service land but is contingent upon appropriate snowpack.

Management Direction

The primary issues for recreation management on Forest Service land in the watershed includes 2,825 acres of the Salmon-Huckleberry Roadless Area, the eligibility of the mainstem of Eagle Creek for classification as recreational and wild under the Wild and Scenic Rivers Act, the identification of "special places" as defined by Mt. Hood Forest Plan, and the management of scenic quality from trails, roads, and viewpoints in and around Estacada.

Roadless

The existing Salmon-Huckleberry Roadless Area was part of a larger land allocation which became the Salmon-Huckleberry Wilderness in 1984. The two remaining roadless areas on Forest Service land were allocated a non-wilderness designation of B-6 Special Emphasis Watershed in the Forest Plan. The two Roadless areas have been both bisected by roads and affected by previous timber harvests. Evaluation of the Roadless areas focuses upon six characteristics and wilderness features which include:

- Natural integrity,
- Apparent naturalness,
- Remoteness,
- Solitude/primitive recreation opportunities,
- Unique features, and
- Manageability/boundaries.

An additional component of the roadless resource is special places and/or activities as well as cumulative impacts in relation to the remainder of the Salmon-Huckleberry roless alysis two ros the t (868the eastern segment (1,957 acres) which shares a boundary with the Salmon-Huckleberry Wilderness.

Natural Integrity

Natural integrity is the extent to which long-term ecological processes are intact and operating. Impacts are measured by the presence and magnitude of human induced change to an area. Both the western and the eastern segments have been affected by timber harvests. Approximately 142 acres of the western segment and 116 acres of the eastern segment have had clearcut harvests.

Apparent Naturalness

Apparent Naturalness means that the environment looks natural to the visitor and the landscape generally appears to be affected by the forces of nature. Both the eastern and western segments have been impacted by road building and timber harvests to a degree that allows human activities to predominate over general effects caused by the forces of nature.

Remoteness

This characteristic is a perceived condition of being secluded and inaccessible. This influenced by the presence of roads and the quantity and type of traffic. This characteristic is also defined by a spatial distance of 1/2 mile from existing roads. Due to the effects of the current road system, none of the 868 acres in the western segment meet the 1/2 mile distance from roads criteria. Only 361 acres of the 1,957 acres in the eastern segment meet this criteria. Ridges and steep terrain in the area, however, provide pockets where a perceived condition of being secluded and inaccessible.

Solitude/Primitive Recreation Opportunities

This characteristic can be evaluated by the Recreation Opportunity Spectrum (ROS). The "ROS Setting Criteria" used for classification include:

- Remoteness,
- Size,
- Evidence of humans,
- User density, and
- Managerial regimentation and noticeability.

Solitude is best represented in the Primitive and Semi-Primitive Non-Motorized classification.

The ROS classification for both roadless areas are Roaded Natural (RN) except for the 361 acres in the eastern segment 1/2 mile away from roads which is classified as Semi-Primitive Non-Motorized (SPNM). Of these ROS criteria, only the User Density and Managerial Regimentation criteria are met by the remaining roadless areas. 313 acres of the eastern segment meet the size criteria because of its shared boundary with the wilderness.

Unique Features

Unique features are geological, ecological, cultural or scenic features that may be located in roadless areas. Three features have been identified which meet this criteria:

- The mountain known as "Old Baldy" is a prominent land feature.
- A cultural resource site and natural spring are located within the eastern segment.
- Scattered viewpoints into the adjacent wilderness area exist along the Old Baldy Trail #502.

Manageability/Boundaries

This characteristic relates to the ability of the Forest Service to manage an area to meet size criteria and the previous five characteristics. Both the eastern and western segments are compromised by roads and neither are 5,000 acres in size. A boundary between the designated wilderness and the eastern segment is formed by a distinct ridgeline. The western segment is isolated and does not connect with either the eastern segment or the wilderness.

Special Places/Special Activities

Special Places and Activities were identified by members of the public during previous planning efforts. These include:

- Travel of the trail and road systems.
- The old, non-maintained "Bissell" trail.
- An old abandoned campsite.
- A favored timber stand of large Noble Fir near Githens Mountain along the Old Baldy trail.
- Roads used for winter sports.
- Mushroom harvest.
- A Clackamas iris site identified by the Native Plant Society and the western Iris Association for a viewing site.

Wild and Scenic River Eligibility

The non-wilderness section of the mainstem of Eagle Creek on Forest Service lands which is eligible for designation as a "recreational" segment is currently in a Late Seral Reserve land allocation under the Northwest Forest Plan.

Scenic Quality

The viewshed from the main roads in the watershed varies with land ownership, from pastoral to industrial forest, to wilderness. The headwaters of the watershed administered by the Forest Service are visible from viewpoints in and around the town of Estacada including the county owned McIver Park. There are, in addition, viewsheds specific to each trail and along the roads.

See Table 18 for specific evaluations of trail viewsheds. The background view of the headwaters from McIver Park currently appears "slightly altered" and exceeds the forest plan standard of modification. The view from F.S. Road 4615 meets the forest plan standard of modification.

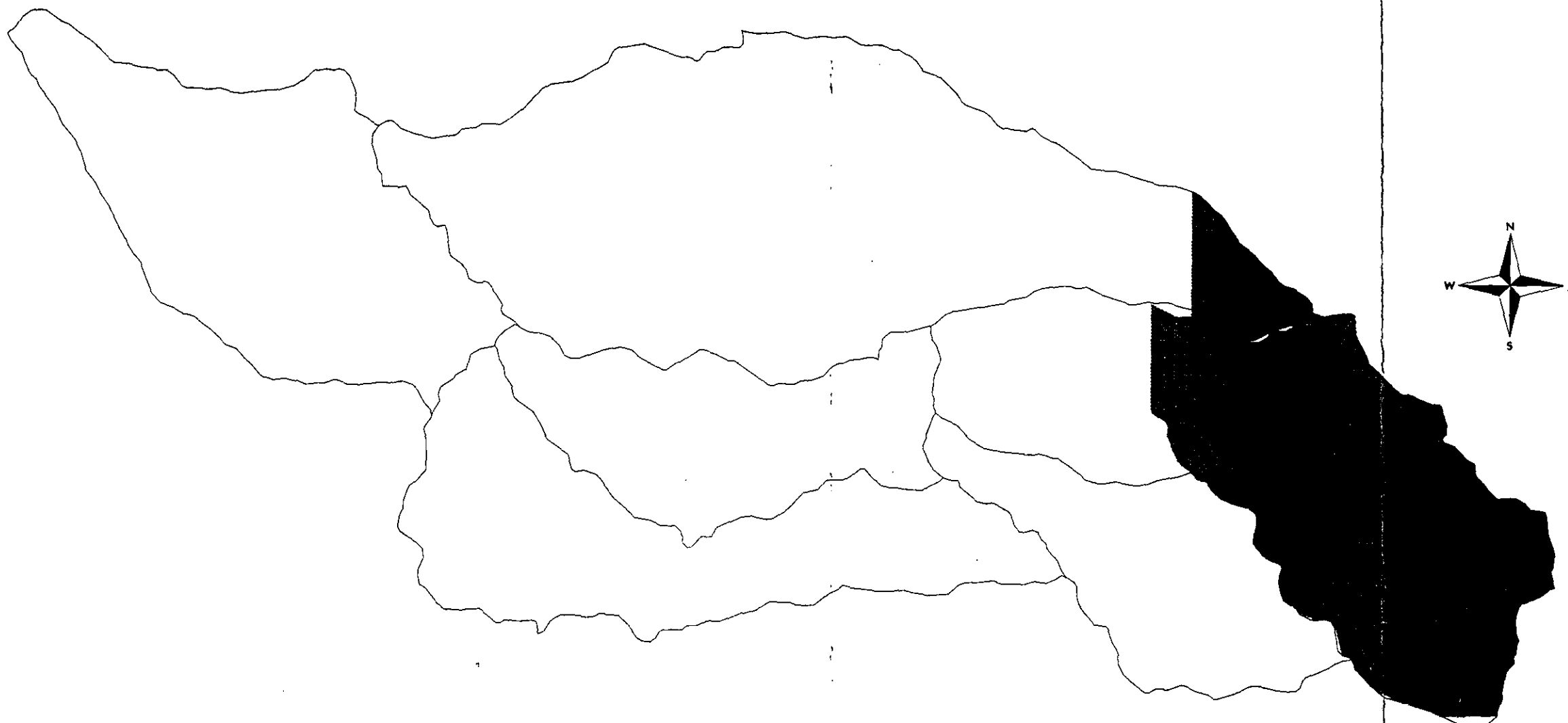
Table 19. Forest Service Trails in Eagle Creek Watershed

	Trails					
	502	**505**	**501**	**504**	**781**	**502A**
Length	7 mi	4.2 mi	7.1 mi	2.5 mi	5 mi	1 1/4 mi
Permitted Users	Hikers Horses Mtn Bike	Hikers Horses Mtn Bike/OHV	Hikers Horses	Hikers Horses	Hikers Horses	Hikers Horses Mtn Bikes
Landform Position	Ridge	Ridges	Riparian	Midslope Ascent	Ridge	Midslope Ascent
Special Interest	Vistas	OHV	Eagle Cr	Shortcut Between 501 & 502	Vistas	Shortcut to Trail 502
Vegetation Type	2nd Growth	2nd Growth	Riparian	2nd Growth	2nd Growth	2nd Growth
Sedimenta-tion	Possible	Possible	Yes	Possible	Possible	Possible
Sensitive Habitat	Possible Outside Watershed	No	Yes	No	Possible	Possible
Compaction	No	Possible	Yes	Possible	Possible	Possible
VQO*	Retention	Partial	Retention	Retention	Retention	Retention
EVC*	Retention	Modifica-tion	Retention	Retention	Retention	Maximum Mod.
Sensitivity Level	I	II	I	I	I	I
Amount of Use	Low	Low	Low	Low	Low	Low
Ease of Road Access	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect
Externally Linked Outside Watershed	Yes	No	No	No	Yes	No

**VQO - Visual Quality Objective; EVC - Existing Visual Condition*

Eagle Creek Watershed

Spotted Owl Critical Habitat (CHU)



CHU OR-10

Wilderness

SCALE 1:100000

1 0 1 2

MILES

MAP 3-5A

Eagle Creek Watershed

Interior Forest

Interior Forest

SCALE 1:100000

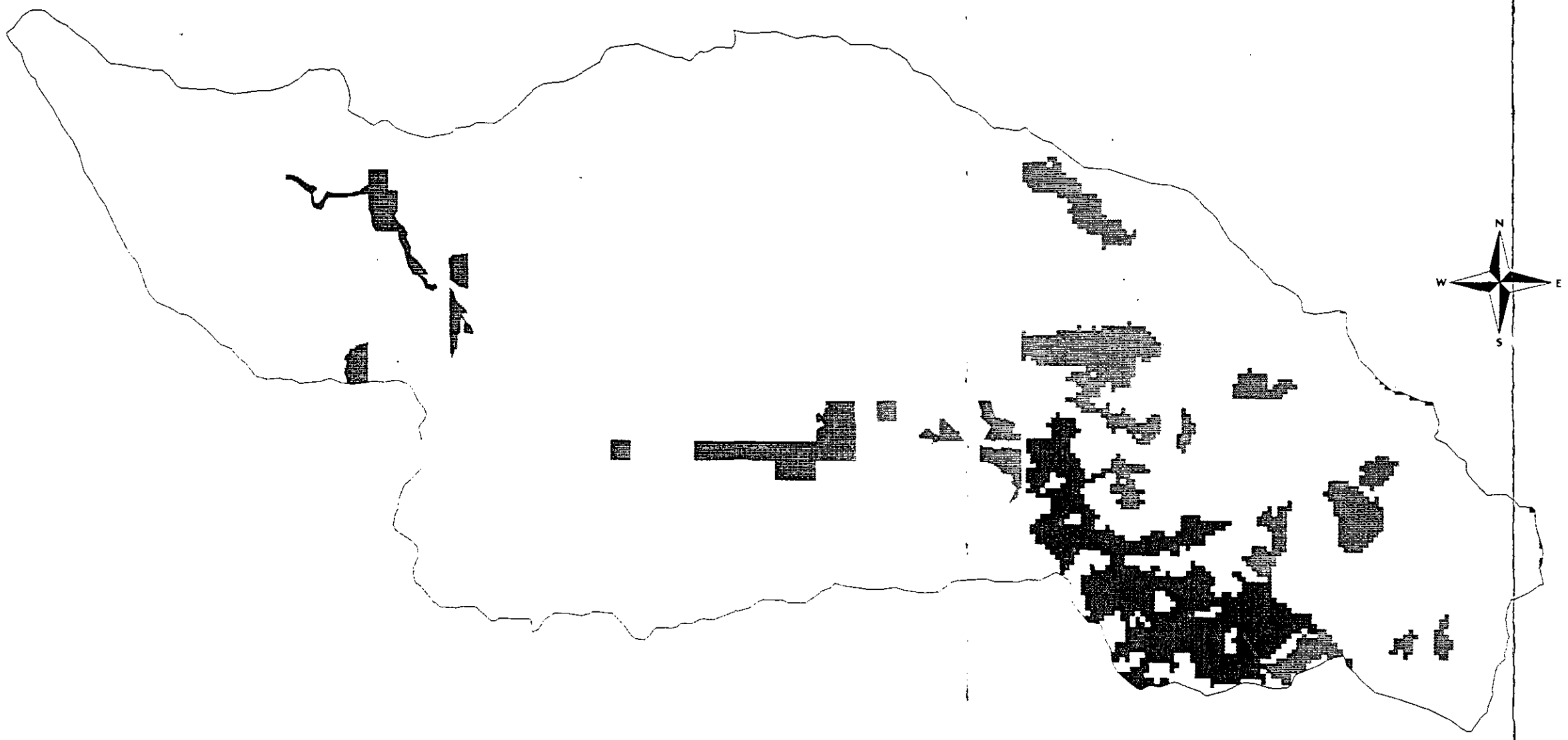
1 0 1 2

MILES

MAP 3-6

Eagle Creek Watershed

Connectivity Of Late Seral Habitat



1 Suit 50% HR Rule

3 Suit 70% Rule

4 Not Suit, But Contributing

5 Not Suit, Not Contributing

6 Not Suit, Too Small

SCALE 1:100000

1 0 1 2

MILES

MAP 3-7

Eagle Creek Watershed

Special Habitats

NON FOREST, WATER

ROCK OR TALUS SLOPES

NATIONAL WETLAND INV

LOCAL WETLAND INV < ONE ACRE

LOCAL WETLAND INV > ONE ACRE

SCALE 1:100000

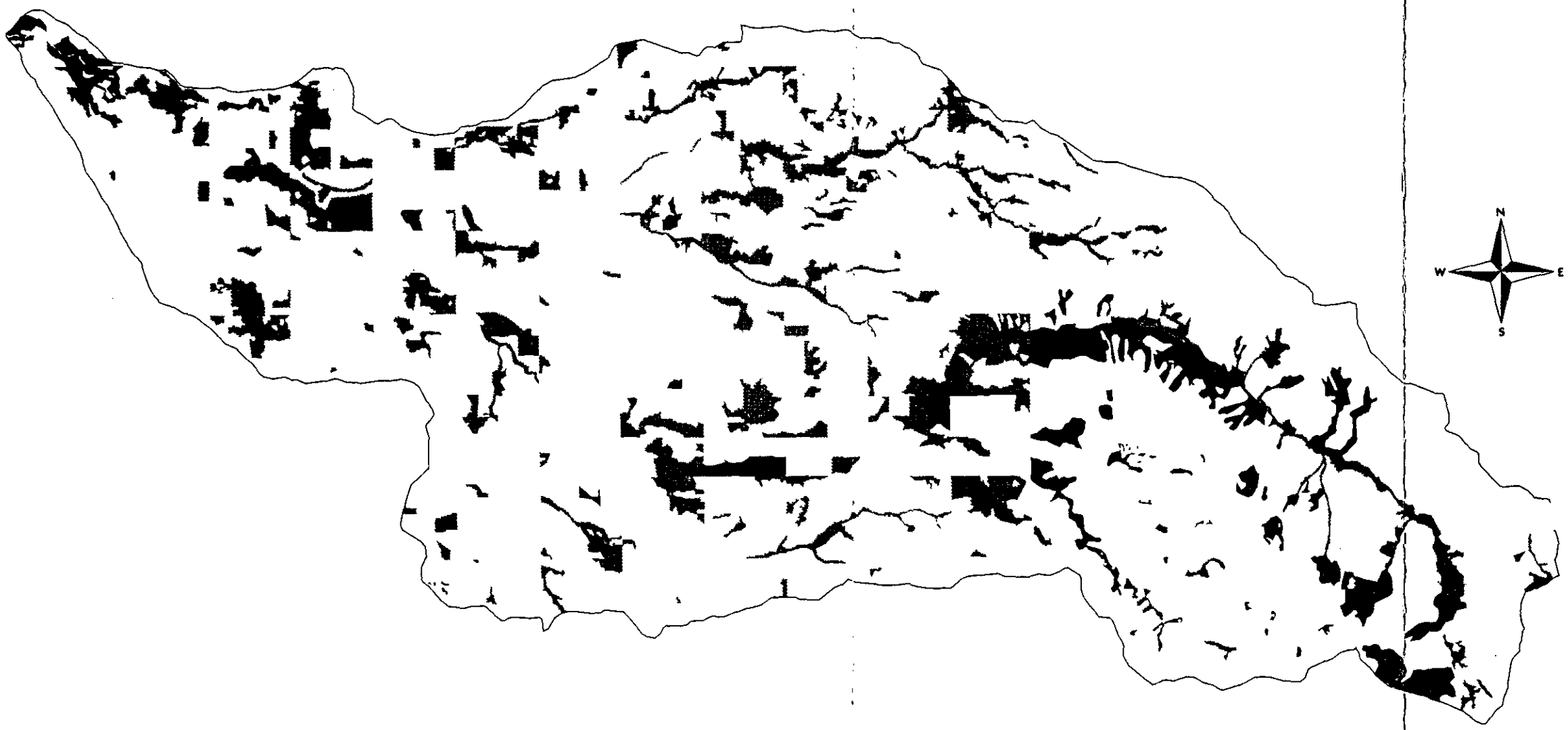
1 0 1 2

MILES

MAP 3-8

Eagle Creek Watershed

Special Riparian Habitats



BIGLEAF MAPLE & OTHER HARDWOOD

RED ALDER

RIPARIAN VEG

SCALE 1:100000

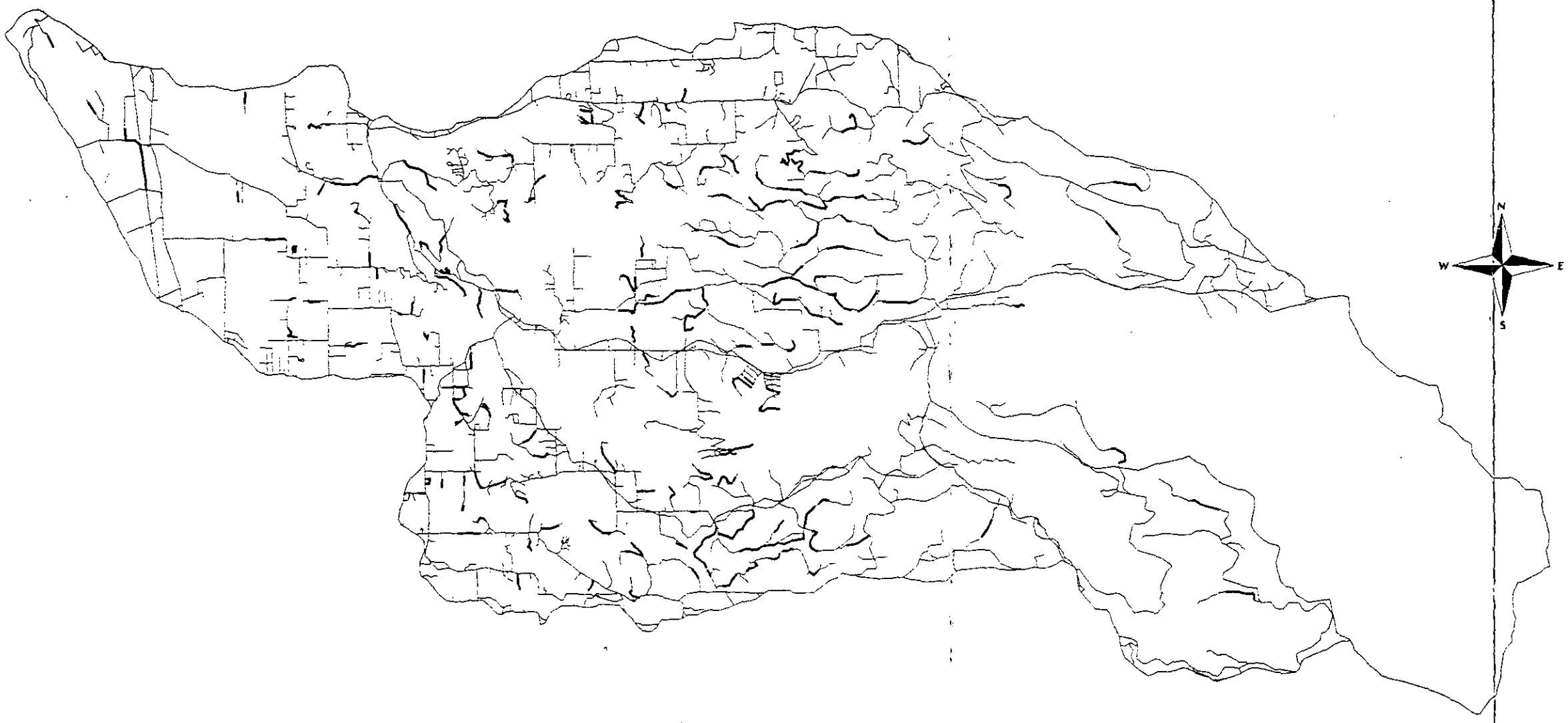
1 0 1 2

MILES

MAP 3-9

Eagle Creek Watershed

Sediment Delivery From Roads



High Sediment Delivery

SCALE 1:100000

1 0 1 2

MILES

MAP 3-10

Eagle Creek Watershed

Sediment Delivery From Timber Harvest And Agricultural Activity

High sediment delivery

Mod - Low Sediment Delivery

SCALE 1:100000

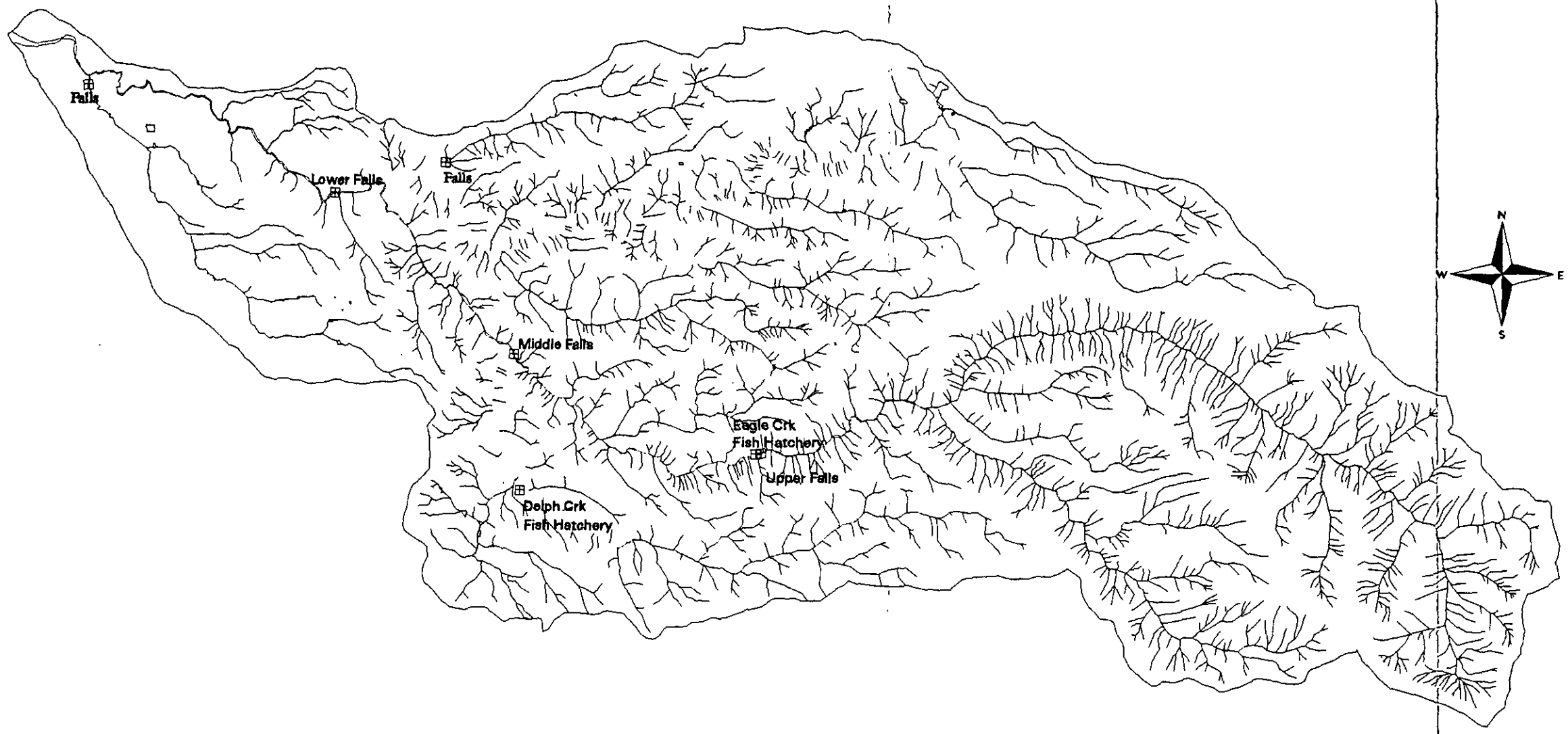
1 0 1 2

MILES

MAP 3-11

Eagle Creek Watershed

Fish Distribution



Steelhead, Coho, Rainbow, Cutthroat, Sculpin

Cutthroat, Sculpin

Chinook, Coho, Steelhead, Rainbow, Dace, Sculpin

Fish Suspected, Not Verified

Non-Fish Bearing

SCALE 1:100000

1 0 1 2

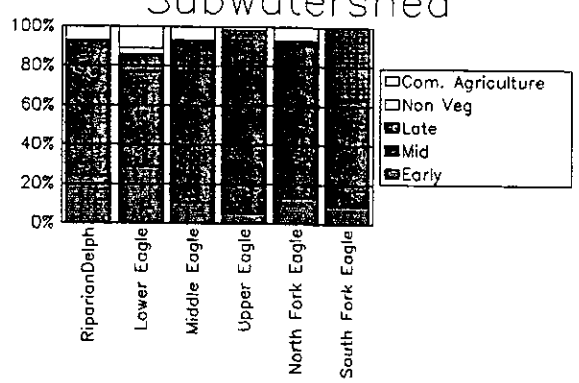
MILES

MAP 3-12

Eagle Creek Watershed

Riparian Buffer By Seral Stage

Percent Seral Stage by Subwatershed



- Early Seral
- Late Seral
- Mid Seral
- None Veg.
- Commercial Agriculture

SCALE 1:100000

1 0 1 2

MILES

MAP 3-13

Eagle Creek Watershed

Large Woody Debris Recuitment

High LWD Potential

Low LWD Potential

Mod LWD Potential

No Recruitment Pot

SCALE 1:100000

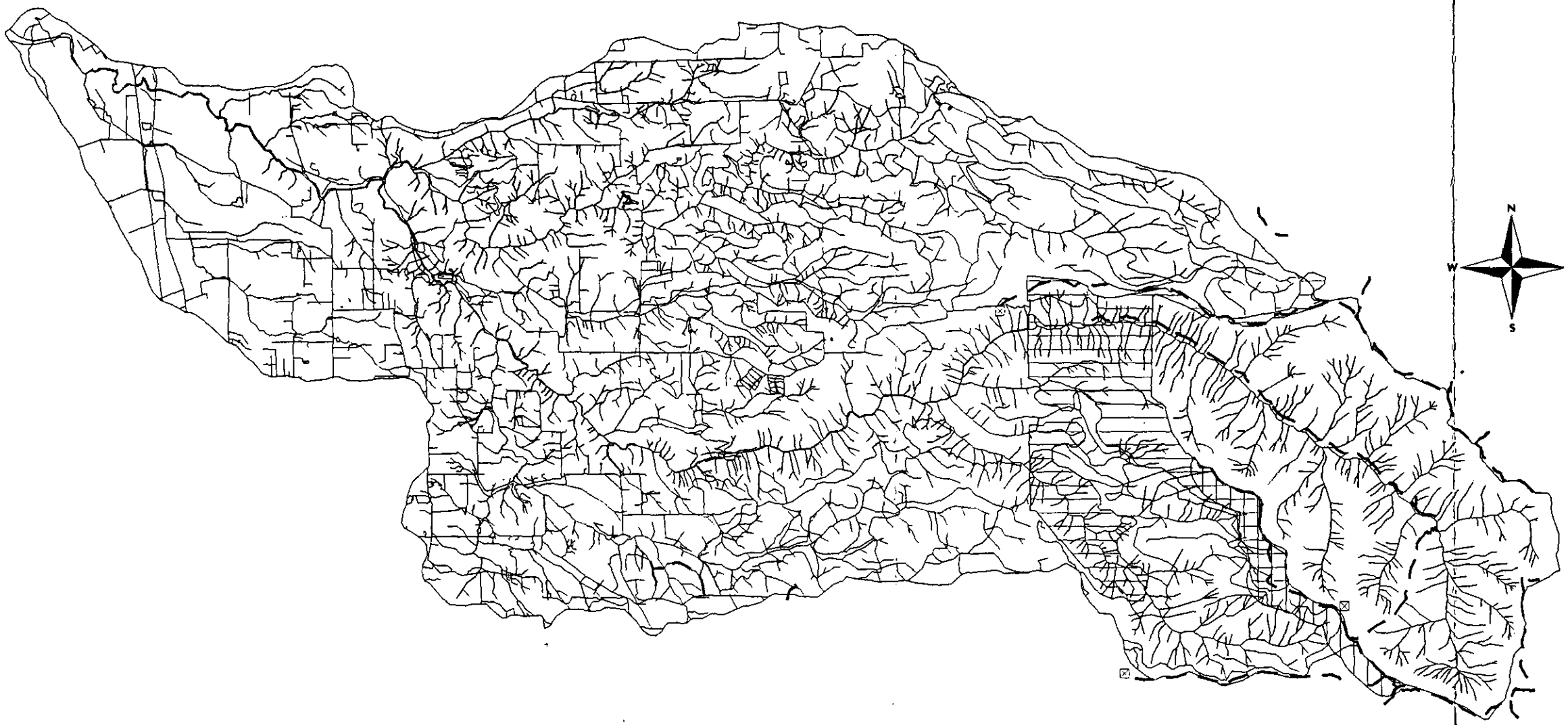
1 0 1 2

MILES

MAP 3-14

Eagle Creek Watershed

Recreation



Roadless Area

Wilderness

Trails

Trail Head

Trail Viewshed

Streams

Roads

SCALE 1:100000

1 0 1 2

MILES

MAP 3-15

Chapter 4

Interpretation and Management Objectives

Chapter 4
Interpretation and Management Objectives

One objective of watershed analysis is to bring together the many different resource data findings about a watershed into a synthesized product. This chapter presents those synthesized products as products of Landscape Analysis and Design (LAD), Trends, and Answers to Key Questions. The Eagle Watershed Analysis Team used the Landscape Analysis and Design process as the tool to synthesize the resource reports. The results of LAD were then used to predict trends and future uses of the Eagle Creek watershed. Since Eagle Creek watershed is owned by many different entities (Federal, Clackamas County and numerous private landowners) and analysis was done on the entire watershed, predictions about private land holdings is based on current state of Oregon and Clackamas County land use zoning regulations. Key questions have been brought forward into this chapter and given short answers.

Landscape Analysis and Design

The Landscape Analysis and Design (LAD) process unites forest planning with the principles of landscape ecology and emphasizes the conscious design of vegetation patterns in the landscape based upon social objectives. The premise of the LAD process is that different landscape structures in the watershed can be arranged spatially according to the social expectations of the landscape. Information about the LAD process is described in detail in the publication (Diaz and Apostol, 1992). The goal of using the LAD process in the Eagle Creek Watershed Analysis is to synthesize current management direction from the Northwest Forest Plan, BLM Resource Management Plan, and the Mt. Hood National Forest Plan, with the recommendations from the watershed analysis and form a spatial plan of vegetation patterns and forest structures. In addition, the LAD process was used in the watershed analysis as the synthesis step to coalesce individual resource analysis into a large scale understanding of the landscape. Three maps developed during the LAD process include an Opportunities and Constraints map, a Conceptual Watershed Design, and an Interim Operating Plan.

Opportunities and Constraints Map

The first step to developing a Conceptual Design for the watershed began with mapping the opportunities for and constraints to management activities and vegetation patterns. The opportunities and constraints identified were those located outside management areas with explicit objectives regarding the vegetation patterns or ecological processes, such as the Salmon-Huckleberry Wilderness, the Late Seral Reserve, and the Riparian Reserves. To be considered, an opportunity or constraint had to drive a vegetation pattern type particularly the size and distribution of created openings in the forest or targeted forest structure. Only federal lands were mapped except identified stream restoration projects on private industrial forest land (Map 4-1). Opportunities and Constraints in the Eagle Creek watershed included unstable landforms, wetland complexes, sensitive trail viewsheds, and stands of late seral forest outside the reserve areas.

Recommendation for Protection of Sensitive Areas

The ROD for the Northwest Forest Plan provides guidelines for managing the forests of public land in the northwest. Current Mt. Hood Forest Plan and Salem District's Resource Management Plan (RMP) supplement, meet or exceed these standards. Management of Northern Spotted Owl Critical Habitat as designated by USFWS in 1992 is also included in these land use plans. The standards and guidelines provide for protection and management of Riparian reserves, Late-successional Reserves and matrix forest areas. Additional management of other resource features as wildlife special habitats can be found in the two resource management plans.

Four additional management needs have been identified in this analysis. They are:

- **Interim Old-Growth Management Areas** -Old-growth forests (+200 yrs) make up less than 2% of the watershed. Much of the late seral stands in the matrix are several decades from becoming structurally adequate old-growth. Therefore, we recommend maintaining existing old-growth outside the LSR, Wilderness, and Riparian Reserves for several decades until sufficient quality and quantity of old-growth develops within the reserves (Map 4-1).

- **Geologic Contact Areas Management** - The geologic "contact areas" between two dissimilar rock types, particularly the upper Sardine or Troutdale formation and the Lower Sardine formation that are subject to disturbance, failures and sediment release into nearby streams need to be protected. Those "contact areas" (map3-x) that are close to Riparian Reserves were included in the Riparian Reserves.

- **Wetland Complex Management Areas** - Several small wetlands (acre) have been found by ground surveys. These wetlands that form complexes close to the riparian reserves were included in the Riparian Reserves to prevent fragmentation and disturbance of sensitive headwall areas habitats.

- **Trail Viewshed Management** - Several trails go through the watershed within the matrix. The view from these trails are important foreground viewsheds. Therefore, the viewshed along selected trails (#502 and #781) should maintain or enhance the desired vegetation structure within these viewsheds.

Conceptual Landscape Design

The Conceptual Landscape Design graphically displays the vegetation patterns desired under the existing management objectives found in the Northwest Forest Plan and the Mt. Hood National Forest Plan. Information generated during the watershed analysis regarding forest stand conditions, high blowdown potential, silvicultural treatment issues, and scenic quality issues was also used to develop the arrangement of vegetation patterns. The Conceptual Landscape Design provides information specific to each pattern type, its management objectives, recommended activities, and a conceptual illustration of the pattern type (Map 4-2). Unstable areas were not mapped as a pattern type but are to be identified in the field during project planning. Land allocations were of particular importance in determining the vegetation pattern types on BLM lands.

It is important to note the difference in treatment between federal and privately owned land in the Conceptual Design. For federal lands, the design represents the conscious, spatial arrangement of vegetation patterns according to current management direction. The pattern displayed on lands under private ownership is only a graphic projection of expected vegetation patterns under state law and county zoning ordinances for industrial forest land, agricultural land, and rural residential developments.

Interim Operating Plan

The Interim Operating Plan serves as a guide for the transition toward the Conceptual Landscape Design through the scheduling of silvicultural and restoration activities. It is derived from the Conceptual Landscape Design, the seral stage map, and an analysis of the landforms and includes only federal lands. The Interim Operating Plan is a refinement of the Conceptual Design into smaller "design cells" based on seral stage and landform and can guide future management activities by delineating logical and reasonable units for planning. Some of the design cells reflect a single vegetation pattern type on a uniform landform like a long, broad ridge. Other design cells encompass several pattern types which will need planning coordination for the design of openings to reduce edge effects or the risk of blowdown. Ownership boundaries were used to determine design cells on BLM land instead of landforms. Boundaries of the design cells should be refined after field verification during project planning.

Recreation Trends

The most important factor influencing the trends in recreation use in the Eagle Creek watershed is population growth. The Mt. Hood National Forest and Bureau of Land Management tracks are considered an urban forest area within the Portland Metropolitan region. Population growth will affect both demand for recreation resources as well as the condition of those resources. Oregon's state population grew 8% in the 1980's, with the majority of the growth occurring in metropolitan areas while rural populations declined. Currently 71% of the state's population live in communities greater than 2,500 people, with two-thirds of the population concentrated in just four cities:

- Portland,
- Salem,
- Eugene-Springfield, and
- Medford.

In addition, the predicted increase in Recreational Visitor Day (RVD) demand for the Mt. Hood National Forest from 1987 to 2000 is 57%, from 4,034,010 RVDs to 6,333,398 RVDs. While no studies have indicated how much of this increased use would occur in the Clackamas drainage, it is assumed that recreation use would grow in proportion to the residential growth of Clackamas County.

In addition to the residential growth patterns of Clackamas County, the Eagle Creek watershed's mix of private and federally owned land could have a strong influence on the demand for recreation on Forest Service land. Currently, the town of Estacada, which is in closest proximity to the watershed, has a population of just over 2,000. The rural residential community outside the incorporated town limits, however, is approximately 15,000 and many of those residents commute to jobs in Portland. The effect of further rural residential development in the Eagle Creek Watershed could increase or change local demands for specific recreation experiences in the watershed such as equestrian trails, bicycling, and winter sports. Use of the county Eagle Fern Park would increase and receive even greater demand.

In 1991, the Oregon State Parks and Recreation Department completed the Statewide Comprehensive Outdoor Recreation Plan (SCORP) which examined user demand, supply, and preferred settings for all geographic regions of the state. The Portland region indicated a general increase in demand for all recreation activities. The following summarizes projections for low, medium and high growth potential of current recreation uses in Eagle Creek Watershed.

High: Activities which show a demand greater than 50% are day hiking (67%), nature/wildlife observation (52%), bicycling on roads (105%) and bicycling on designated trails (93%).

Medium: Activities which have a projected demand between 30% and 50% are tent camping (35%), big game hunting (34%), scenic driving (45%), off highway vehicle use (42%), picnicking (35%), cross country skiing, and off road bicycling (38%).

Low: Activities which indicate a lower rate of projected growth are freshwater fishing from banks (21%), upland bird hunting (3%), snowmobiling (8%), bow hunting (5%), and overnight hiking on trails (29%).

In addition to user demand, the SCORP study also included a needs analysis for Forest Service lands based upon use, user demand for preferred setting (settings defined by the Recreation Opportunity Spectrum or ROS), and supply of settings as allocated in the Forest Plans. The study concluded that the greatest discrepancy between supply and demand occurs in the provision of settings on the primitive and semi-primitive end of the ROS settings. The situation is considered most serious in the provision of semi-primitive motorized and non-motorized settings. For the Mt. Hood National Forest the category of semi-primitive motorized show the greatest discrepancy between supply and demand while surpluses occurred in almost every other category. A shortage of semi-primitive settings may shift pressure to more primitive areas and/or intensify use in existing settings.

In the Eagle Creek Watershed, the preferred settings for recreation, ridgeline trails and riparian areas for hiking and fishing can be expected to be under even greater use demand as Portland's population grows. The lack of landscape features like lakes, hotsprings, or historic structures, could limit both the types of recreation development as well as the total number of users in the watershed as compared to other watersheds on the forest. The indirect road access to the Forest Service lands and trailheads could also serve to limit use. The current pattern of trail and road based recreation use should experience only marginal changes but the rate of use can be expected to increase. The preferred recreation settings which are currently valued for solitude and lack of managerial control are in limited supply and could increase in demand as recreation use increases in other watersheds.

As the population increases, the perception of proximity can also change. Activities which are now marginal in the watershed because of driving distance from Portland, like mountain biking and dispersed camping, could receive increased pressure as people drive further to recreate in their preferred setting. Increased use can also increase the number of social encounters and user conflicts which can also increase the amount of social violence already present in the drainage. In summary, the increased population growth of the Portland metropolitan area and the increase of rural residential development in and around the Eagle Creek Watershed can be expected to lead to an increased concentration of use within the existing pattern of recreation use.

Vegetation Patterns and Trends

Seral Stage, Forest Series, and RNV

Currently, the watershed can be classified into three large scale patterns. The lower western end is generally large agriculture and rural development lands. The mid section supports a series of rectangular patterns of pastures, small woodlots, contiguous mid-seral forest, and small homesites. The upper reaches of the watershed within the National Forest hold the largest block of natural stands (both mid and late seral).

The future vegetation pattern for the lower section in the next ten to forty years will primarily remain the same, although small blocks will continue to be cleared for rural development as the Portland metropolitan area increases in population. Riparian forest vegetation will remain sparse.

The mid section contains lands that will be intensively managed for timber production. Within the Clackamas County Forest zone, minimum ownership size is 80 acres and riparian vegetation buffers in 10 to 40 years will have variable widths depending on fish presence and subdrainage area. Wetlands over 8 acres would have riparian vegetation with 100 foot buffers. Much of the area will continue to have mid seral plantations no older than 60 years, and under high intensity timber management (short rotations), few stands are expected to convert to late seral, or have suitable snags and coarse woody debris. Eagle Fern Park will provide an isolated large patch of older late seral stands (presently about 190 years old). Because trees may become hazardous to park visitors, individual old-growth trees (greater than 200 years) within this late seral forests may be removed. Other isolated patches of late sera! within the mid section of the watershed include the BLM Matrix - Connectivity/ Diversity block. The longterm land management objective of the Connectivity/Diversity block is to maintain 25 to 30 percent of the block in late-successional forest at any point in time. Riparian Reserves and other allocations with late-successional forest would count toward this percentage. Presently, 70 percent of the block is in late-successional riparian reserves and would most likely remain so throughout the next 40 years if maintained under the current land management objectives.

The upper third of the watershed has the most late seral, and natural mid seral stands. This area encompasses the National Forest lands, including the Salmon-Huckleberry Wilderness, LSR, and most of the Matrix. This area includes all of the Oldgrowth within the watershed (see Map 3-5). If left unmanaged, most of the 160 to 190 year old late seral stands (950 acres) would convert to Oldgrowth within the next 10 to 40 years. The North Fork, and South Fork Subwatersheds have a fragmented pattern resulting from recent clearcut units (see Map 3-2, harvest history). Overall, this section of the watershed is mostly natural mid seral resulting from widespread wildfire within a relatively short time frame (40 years). These stands range from 100 to 140 year of age, more than half of which are expected to convert to late seral (trees 21" dbh or greater) within the next 20 years. These stands will all be late seral within 40 years, and earlier if thinned. The long term patterns as described by the conceptual design (see the Landscape analysis and Design section) will exhibit intact late-successional stages for riparian reserves, LSR, trail viewsheds, Oldgrowth retention areas, and the wilderness within the next 20 to 40 years. These areas will comprise about 70 percent of the National Forest lands. This analysis assumes no large scale natural disturbances would occur.

Future early seral forests within National Forest lands will be within the RNV (about 15 percent of National Forest lands) if the watershed is managed as suggested in the landscape design. Natural openings presently account for 290 acres within federal lands, and would most likely remain so for the duration of at least 40 years.

As most of the mid seral forests become late seral within the next four decades for the upper third of the watershed , the total late seral area would exceed the RNV (40%) for the Pacific Silver Fir zone (see Figures 2 and 4). The closer a stand gets to the higher elevation mountain hemlock zone, the chances for growing the larger tree diameters required for late seral forest will decrease. Within the western hemlock zone on Federal land, the conversion of mid seral to late seral would be within the RNV for late seral during the next 40 years (see Figures 2 and 4). It is assumed and is very likely that if half of these western hemlock zone acres convert to late seral by the next 20 years, the RNV would be reached.

BLM's RMP Trends

Salem District's Resource Management Plan established quidelines for resource management within the district for at least the next ten years. This plan incorporated the management requirements as directed in the ROD. BLM lands within Eagle Creek watershed will be managed for several management allocations, Riparian Reserves, General Forest Management Areas (GFMA), and Connectivity\Diversity blocks with a variety of management guidelines for special areas within these land use allocations. Of the 4004 acres administered by BLM in the Eagle Creek watershed, about 1600 acres are in Riparian Reserves, 1400 acres are in GFMA, and 579 acres in Connectivity\Diversity blocks. Riparian Reserves will be managed to maintain or enhance riparian older forest characteristics in accordance with the Aquatic Conservation Strategy. Therefore, it can be expected to become more late seral riparian forest. The GFMA will be managed for timber production outside the Riparian Reserves and may be expected to be maintained in the young mid seral conditions. Connectivity\diversity block will be managed on a extended rotation with additional wildlife trees retentions.

Windthrow, Fire, Insects, and Disease

The future trends for windthrow, fire, insects and diesease are unpredictable. However, areas at risk for windthrow were integrated into the landscape design process. Here, special considerations for windthrow were incorporated as design cells in and around high risk areas. Many of the high risk areas are included in riparian reserves, which in the long term may reduce the effects of within-stand wind patterns. In the situation where windthrow is reduced, an indirect benefit may be realized as less and less breeding habitat for Douglas-fir bark beetle becomes available. However, in areas where salvage is highly controlled such as in riparian reserves (see pg. C-32 in the ROD) and in the LSR (see pg. C-13 in the ROD), we may expect a population increase in Douglas-fir bark beetle. This in turn may lead to an increase in green tree mortality and added fuel loadings. Added fuels will increase the hazard of wildfires.

The biggest threat to stand health is overstocking. If stands are left to natural thinning, trees may experience stress by competing for needed sunlight. This would expose the stands to higher susceptibility to insects such as spruce budworm or root rot. Presently many of the stands are near or above stocking levels recommended for optimum vigor.

As described in the historic vegetation/fire history section, Webber (1992) estimates a mean fire occurrence of less than fifty years between large-scale fires in the upper third portion of the watershed. The effects of such fires could be significantly reduced by future suppression efforts. As the fire regime is altered by these efforts, the understory vegetation , soil depths, small openings resulting from disturbances such as root rot, and subsequent woody debris would probably increase providing more complex, diverse stand characteristics.

Scenic Vegetation Patterns

Barring any large-scale changes in the forest cover from natural events such as fires and insect epidemics, changes in scenic quality on Federal land will primarily be a function of tree growth and timber production. The vegetation patterns proposed in the Conceptual Landscape Design could create opportunities for improvement in scenic condition depending upon site-specific management activities. The progression of early seral stands to mid seral would serve to improve scenic quality as the forest canopy merges and edges between patches become less visually apparent. Changes in the scenic condition on private land could be determined primarily by the type and rate of residential development and industrial timber harvest.

LSR and Wilderness Habitat Trends

The Northwest Forest Plan assumes that LSRs adjacent to wilderness Areas will function in concert with each other to provide habitat needs for older forest associated species. The combination of LSR and wilderness in the Eagle Creek watershed is approximately 10,000 acres of nearly closed canopy forest. This forest is about 20% late seral forest with 25% of that being old-growth (Table 19.) This late seral forest will not develop into old-growth within the next forty years because of its present young structural condition. The remaining 70% is mid seral forest and will develop into late seral stage within the next several decades because it is very close to that stage now. Riparian areas have late seral stands with abundant large standing and downed woody material. Late seral stand conditions should continue to develop toward a climax riparian ecosystem. Most of the early seral vegetation is from past harvest units that should grow quickly into mid seral in the next few decades. The few natural openings are rock, scrub alder, or wetlands which area not expected to change to conifer forest in this time period.

The area designated Critical Habitat is only 17% late seral forest. the remaining early (27%) and mid (54%) seral stages will continue to develop toward old-growth habitat, but many of these stands will not become late seral in the next 40 years.

Owls

Eagle Creek watershed is part of the Designated Conservation Area (DCA) OD-3 listed in the draft Northern Spotted Owl Recovery Plan and Critical Habitat Unit OR-10. Four pairs of spotted owls are found within the LSR and wilderness portion of the watershed. Although DCA OD-3 is only about 50% occupied with known owl sites, Eagle Creek is not expected to increase by more than one or two pairs in the future because of the lack of remaining unoccupied habitat.

Table 19. Seral Stage Diversity Within the LSR and Wilderness

	Acres of Seral Vegetation				
	Acres	Early	Mid	Late	OG
LSR	1620	180	940	490	149
Wilderness	8770	200	6,420	1,840	578
Total	10,390	380 (3%)	7,360 (71%)	2,330 (22%)	

Connectivity/Diversity Habitat Trends

Connectivity/Diversity Habitat is mostly riparian and late seral conifer forest. The riparian habitat has been simplified from historic fires and some management. Most of the connectivity block is in the Riparian Reserves (80%) and will be managed to increase streamside protection and vegetation diversity, particularly the older forest components. The riparian habitat is not expected to be fully functioning riparian habitat for many decades in the future. The remaining matrix lands are in a young condition with few large trees or large snags. Large tree retention and longer rotation will add some diversity to the stands but these areas are not planned to be managed for old-growth forest.

Elk Population Trends

Currently the elk population is very low. With continued forest openings. The elk herds are expected to increase. Increased damage complaints from the small private landowners in the lower and middle watershed will place added restriction on elk population growth in this section. Habitat improvement projects in the upper portions of the watershed would be the only way to alleviate this problem. Hunting pressure is light because of low elk numbers and difficult access. Elk may eventually be limited by forage in the upper watershed and continued of rural development in the lower watershed.

Aquatic Trends

Hydrologic Condition

Upper Mainstream and South Fork base flows and peak flows are within the range of natural variation and will probably remain within the range due to guide lines associated with present land allocations, LSR and Wilderness in the Upper Mainstem and Key Watershed and Special Emphasis Watershed in the South Fork.

Base flows have probably decreased in Lower Mainstream due to a conversion of coniferous vegetation to deciduous vegetation within riparian areas. This reduction in base flow will continue. Reestablishing coniferous vegetation within riparian areas is a restoration opportunity.

Base flow regulate the amount of available spawning area, furnish refuge areas for young fish, and supply adequate flows for returning adult fish.

Peak flows in Lower Mainstream and Delph Creek have increased. This conclusion was based on a moderate or high increase in channel network expansion and a moderate decrease in the buffering effects of vegetation on soils with relatively low infiltration and high runoff characteristics. These two subwatersheds may experience increases in residential development due to urban growth further increasing peak flows by replacing vegetation with impervious surfaces (roads, sidewalks, and houses). Increased peak flows will continue in these two subwatersheds. Restoration opportunities such as establishing holding ponds in residential development areas may help to slow waters, decreasing the contribution of water during peak flows from these areas.

Increased peak flows can cause excessive scoar which may result in loss of fish eggs which are in the gravel and flush young fish down stream to less optimal rearing habitat, especially since limited refuge habitat is available.

Sediment Delivery

Sediment delivery in the Upper Mainstream has increased only slightly from minor amounts of road building and timber harvest in this watershed. Three of the many debris flows within the Upper Mainstream Subwatershed were influenced or initiated by timber harvest units. All of these debris flows delivered sediment to streams. Although future sediment delivery from management activities will be limited in the majority of this subwatershed, a fairly large track of land (640 acres) is owned by Longview Fiber. Timber harvest on their land may increase sediment delivery by initiating additional debris flows as this is a geologically unstable area due to a intermediate resistant rock type overlaying a weak rock type. Most of this ownership is presently in an early seral stage.

Sediment delivery in the South Fork has been influenced by moderate levels of timber harvest with some road construction. Most of this management activity avoided riparian areas, minimizing sediment delivery. One of the five debris flows within the South Fork Subwatershed was influenced or initiated by quarrying activity and delivered sediment to streams. Sediment delivery from landslides can be avoided in this subwatershed as most of the stable and potentially unstable lands have either been included within the riparian reserves or have been mapped as areas where close project review by a qualified geologist is recommended.

Sediment delivery may decrease in these subwatersheds with implementation of the Pacific Northwest Forest Plan and Mt. Hood National Forest Land Use Plan. Guidelines for zero net gain in roads and no road construction in roadless areas within a Key Watershed along with implementation of the ACS and designation of Riparian Reserves including unstable lands, will decrease the sediment delivered to streams.

Sediment delivery rates have increased above the range of natural variation in the lower four subwatersheds. This conclusion was based on high or moderate levels of sediment delivered from roads, agricultural activity and timber harvest including sediment delivery from landslides initiated or influenced by timber harvest including road construction. Sediment delivery will continue at the present rate with new road construction and timber harvest continuing at the same level. As demands for wood products increases, timber harvest and associated road building may increase. The lower subwatersheds may experience increases in residential development due to urban growth further increasing sediment delivery due to vegetation clearing within riparian areas. These increases in sediment delivery degrade fish habitat by embedding spawning gravels with silt, increasing deposition in depositional reaches which can further degrade habitat by limiting pool depth and losing side channel habitat.

Riparian Condition

Good riparian conditions provide adequate riparian habitat and high levels of potential large woody debris in streams in the Upper Mainstem and South Fork Subwatersheds. As these subwatersheds are managed under the guidelines of the Aquatic Conservation Strategy and with the establishment of Riparian Reserves, riparian conditions should remain good.

Riparian conditions within the other subwatersheds have deteriorated. This conclusion was based on moderate to low potential for large woody debris recruitment into streams and low to moderate amounts of vegetation in late seral stage. Two of the subwatersheds, Lower Mainstem and Delph Creek also have high percentages of areas in early seral as compared to the range of natural variation.

Riparian conditions within these lower subwatersheds on commercial forest lands may slightly improve with the recent changes to the Forest Practices Act and implementation of the 1994 Protection Rules for private landholders in areas zoned as Forest Lands. North Fork and Delph Creek Subwatershed will have improvements on federal lands as designated riparian reserves are managed for natural stand characteristics. As vegetation in early and mid seral stage mature, stand structure will diversity and LWD recruitment potential will increase thereby improving riparian habitat conditions on federal lands and private lands zoned as Forest. Conversely, the lower subwatersheds may experience increases in residential development due to urban growth, increasing the risk of riparian degradation resulting from to vegetation clearing and\or reduction in LWD recruitment potential. Currently, few regulations exist for residential land owners concerning riparian protection.

Habitat Condition

Habitat conditions are considered good but below optimal in the Upper Mainstem and South Fork Subwatersheds. Suboptimal conditions were caused by a relative lack of large and small woody debris, low pool frequency and high water temperatures. Adequate canopy closure within the riparian reserves exist in the Upper Mainstem (80% of the area with greater than 70%crown closure) and South Fork (70%) but is lacking in the Middle Mainstem with only 62% of the area with canopy closure greater than 70%. Forest fires swept through much of the watershed clearing large areas and may explain the lack of optimal habitat conditions. Even though habitat conditions are below optimal, a productive resident fishery exists and will continue to thrive.

Implementation of the Aquatic Conservation Strategy on Federal lands should help to improve habitat conditions although water temperature within the Upper Mainstem Subwatersheds may be naturally high and remain elevated. Implementation of the 1994 Protection Rules for private land holders in areas zoned as Forest Lands may also help improve habitat conditions within the Middle Mainstem but to a lesser extent.

North Fork, Delph Creek and Lower Mainstem are believed to have deteriorated habitat conditions although limited data is available. North Fork habitat conditions lack woody debris and have low primary pool frequency. Elevated stream temperatures are suspected due to lack of adequate canopy closer within the riparian areas (less than half of the riparian areas have adequate canopy closure).

Management activities such as timber harvest, road construction, commercial agriculture, and the removal of riparian vegetation for residential development have caused the degradation of habitat by reducing woody debris, decreasing pool frequency, reducing stream shade and there by increasing stream temperatures. Current knowledge of quality fish habitat will result in less removal of log jams or stream "clean outs". Restoration opportunities for riparian plantings that supply shade to the streams could reduce stream temperatures.

Answers to Issues and Key Questions

- **What are the processes affecting vegetation and landscape patterns, both natural and human caused? What are the current conditions of the landscape and stand vegetation, and how does this affect species composition and diversity?**

Processes

- wildfire including lighter burns in riparian areas,
- short-rotation timber harvest,
- administratively withdrawn wilderness areas,
- stand conversion conifers to hardwoods,
- rural development

Current Condition

- Lower Watershed - rural housing and agriculture
- Middle Watershed - intensive timber management and small woodlot
- Upper Watershed - relative intact late seral/old growth

Species Conservation and Diversity

- Lower and Middle watershed has limited old growth associated species and many exotic plant species associated with agriculture and rural development
- Upper watershed, in general, has old growth associated species, composition and diversity. Species are restricted due to lack of old growth

- **What is the role of the watershed in conservation of old growth associated species (i.e. the spotted owl) and non-old growth dependent species (including plants)?**

Old Growth Associated Species

- Watershed supports larger conservation area for associated old growth species but is not a connectivity link.

Non-old Growth Associated Species

- Watershed provides habitat for an assortment of non old-growth dependent species, i.e. elk.

- **What landscape patterns would attain or affect ecological objectives and social expectations?**

  - Lower Watershed will have continued fragmentation to meet social needs.
  - Middle Watershed will have fragmentation of younger standswith limited patches that meet older forest ecological objectives.
  - Upper Watershed will have large contiguous blocks of older forest with high ecological diversity and meets social conservation expectations. these larger contiguous blocks are surrounded by patches of younger forest.

- **Where are the opportunities for commercial timber harvest?**

  - Lower Watershed - reduced opportunities with increased rural development
  - Middle Watershed - extensive opportunities from industrial forest lands
  - Upper Watershed - limited opportunities due to land management directions

- **What are the processes affecting riparian and stream conditions, both natural and human caused? What changes have affected riparian and aquatic dependent organisms, and recreational opportunities?**

Processes

- changes in sediment delivery,
- base and peak flows,
- riparian area seral stage,
- large wood recruitment,
- pool frequency,
- temperature and shade

Changes

- Lower Watershed - degraded riparian and stream conditions with decreased fishing opportunities
- Middle Watershed - degraded riparian and stream conditions with scattered intact riparian areas
- Upper Watershed - relatively connected high quality riparian areas and stream conditions

- **What is the role of Eagle watershed in conservation of aquatic and riparian dependent species?**

  - Mid basin location of Eagle Creek on the Clackamas River strategically important, but degraded habitat limits production of anadromous fish.
  - Provides fish dispersal to key low elevation areas (Clackamas River), but poor riparian area conditions limit its effectiveness.

- Upper watershed generally provides good habitat for species of concern e.g. cut-throat trout and sensitive plants.
- Impacts from Eagle Creek Fish hatchery are unknown.

❑ **What is the role of the watershed in providing recreation opportunities?**

Recreation Opportunities

- Relatively close trail system to Metropolitan Portland
- Provides access to Salmon-Huckleberry Wilderness
- Eagle Creek National Fish Hatchery provides stock for many fisheries
- Increased social pressure on decreased recreation resource base

❑ **What type of access and transportation is needed?**

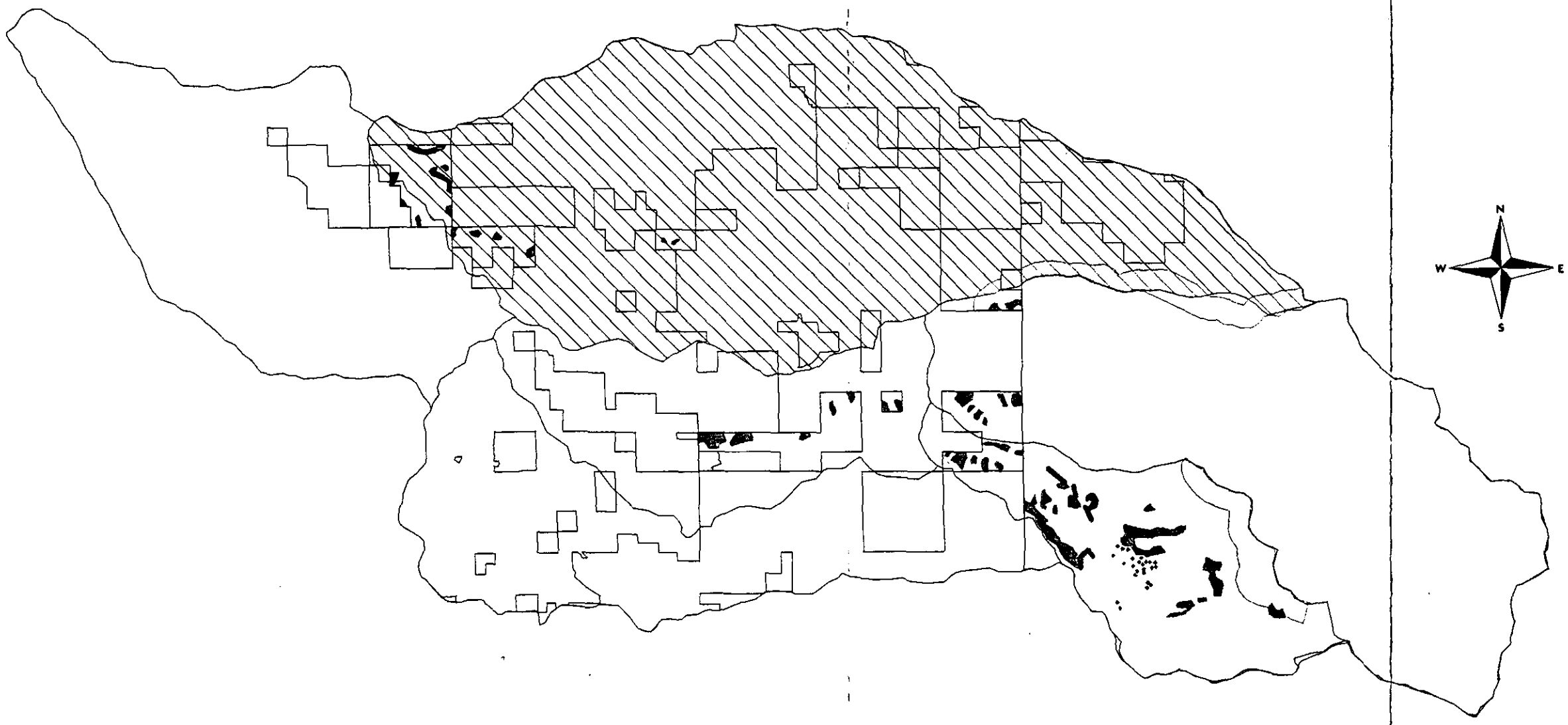
- Lower Watershed - More permanent roads for rural development
- Middle Watershed - Continued use of non-paved roads for timber harvest
- Upper Watershed - High quality roads and trails with limited access

Chapter 5

Recommendations

Eagle Creek Watershed

Opportunities and Constraints



Contact Zone

Instability Contraints

Remnant Old Growth

Mosaic of Small Wetlands

Trail Viewshed

Interagency & Private In-Stream Habitat Restoration Opportunities

Note:

See Transportation System in Chapter 5

For Road Restoration Recommendations

SCALE 1:100000

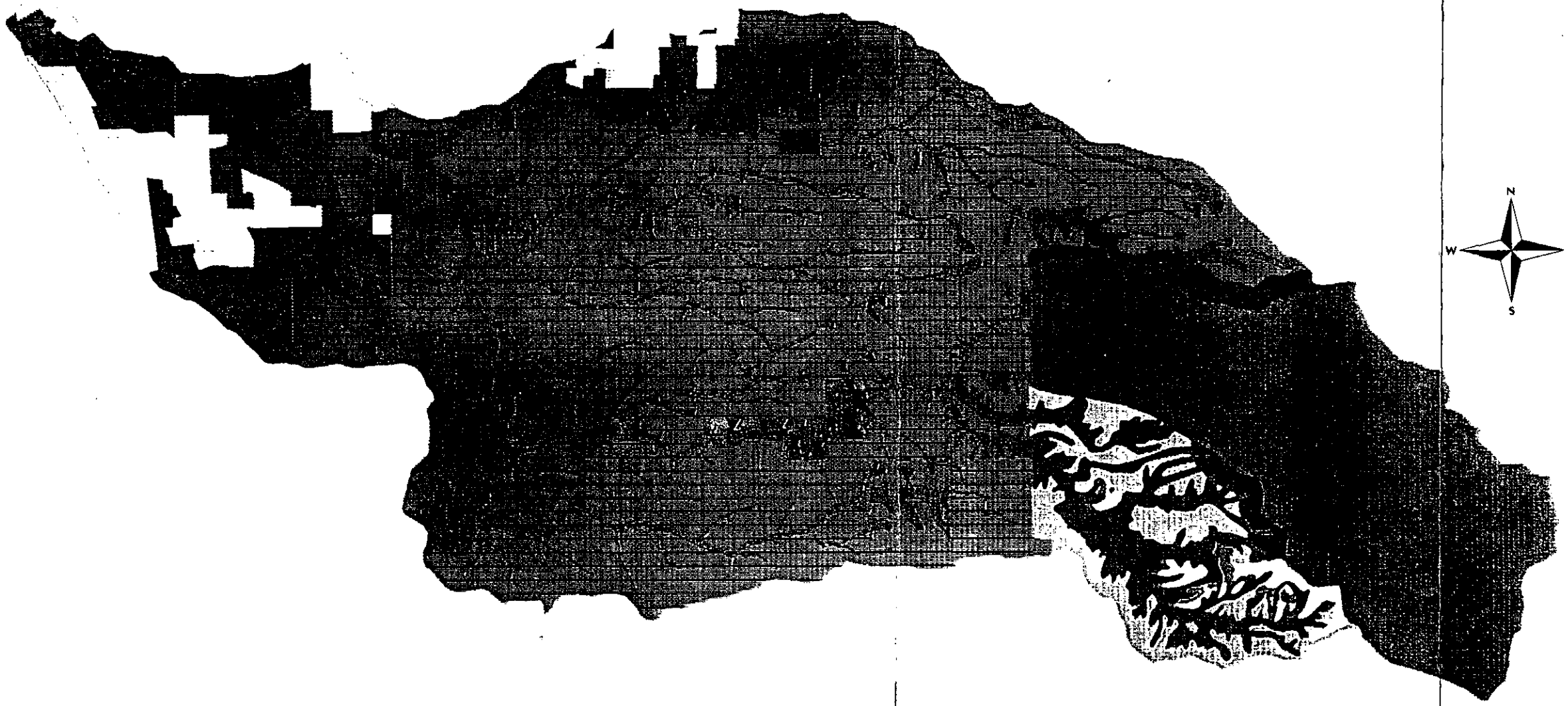
1 0 1 2

MILES

MAP 4-1

Eagle Creek Watershed

Conceptual Landscape Design



N
W E
S

- Fragmented
- Interim Retention Of The Oldest Forest Patches
- Inverse Perforation
- Open - Agriculture
- Patchy
- Retain and Promote Late Seral
- Small Perforations and Thinning (< = 2 Acres)
- Small Perforations & Thinning (2 to 5 Acres)
- Variable Perforated Pattern and Thinning
- Fragmented Private Idustrial Forestland
- State Forest Act Riparian Buffers

SCALE 1:100000

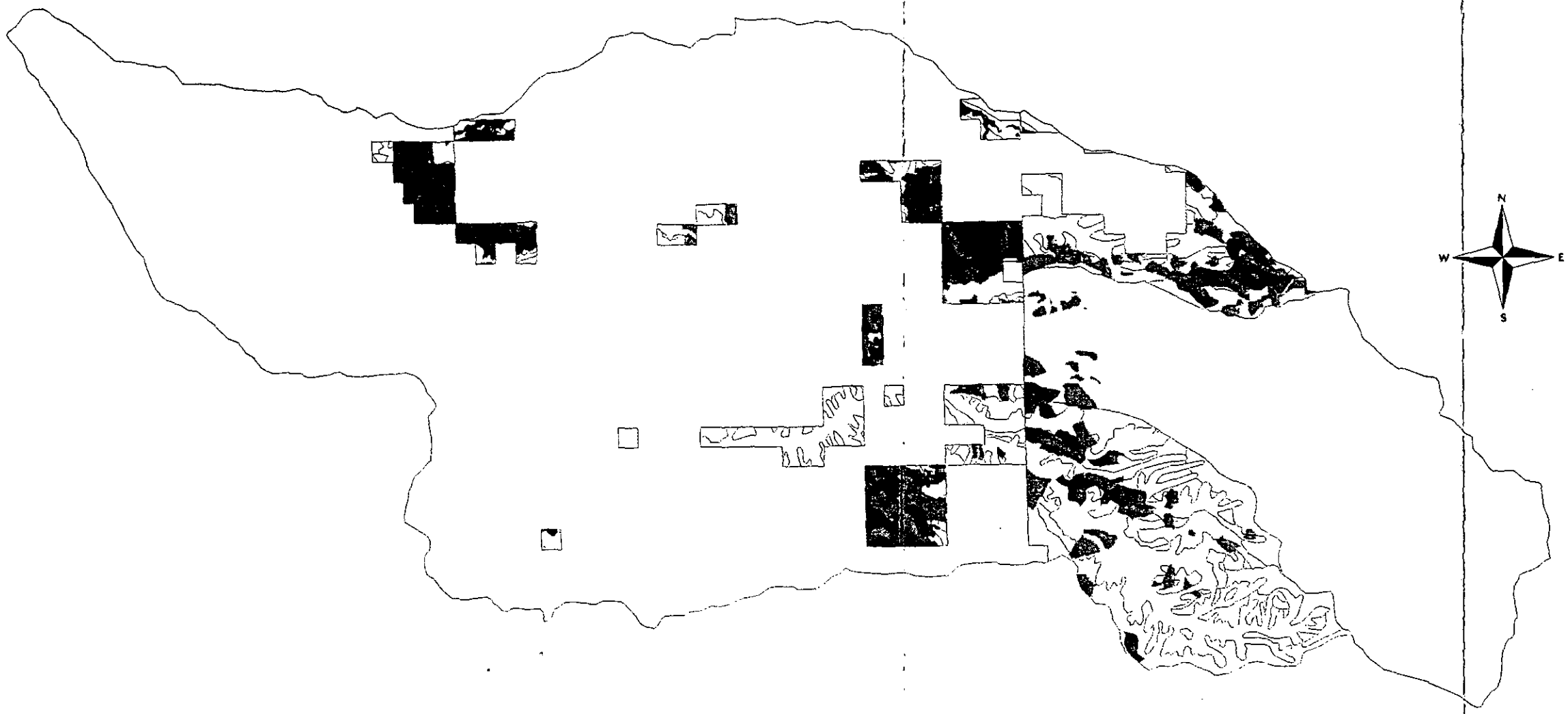
1 0 1 2

MILES

MAP 4-2

Eagle Creek Watershed

Interim Operating Plan



EARLY SERAL PLANT/TIMBER PROD

EARLY SERAL PLANT/LATE SERAL

MID SERAL PLANT/TIMBER PROD

MID SERAL PLANT/LATE SERAL

SCALE 1:100000

1 0 1 2

MILES

MAP 4-3

Chapter 5
Recommendations

The recommendations presented in this chapter are set in the context of the Northwest Forest Plan, the Mt. Hood National Forest Plan, and the Bureau of Land Management Resource Management Plan. All recommendations fall within this existing direction. These recommendations can be used to help guide development of site specific projects, including timber sales, restoration, access and travel management planning and biodiversity enhancement.

The findings in this chapter as designed to meet expectations of the Federal Guide for Watershed Analysis (1994) and planning needs of the BLM and Forest Service. These recommendations are broad ranging from site specific road closures to predictions of sustainability of natural resources in the Eagle Creek watershed. All recommendations are based on data analysis results, and findings the Eagle Creek Watershed Analysis Team felt were important for the Eagle Creek watershed. The Eagle Creek Watershed Analysis Team focused only on recommendations they felt were important for Eagle Creek, resulting in both lengthy and short and concise recommendations. Recommendations for activities on private lands may be useful for other agencies or private landowners as they plan management activities on their property.

Recommended Riparian Reserve

Riparian reserves are specified for five categories of streams or waterbodies (includes unstable and potentially unstable lands) in the ROD. The distances specified as site potential tree heights were the riparian reserve widths designated for Eagle Creek Watershed with some additions. The site potential tree size used in this watershed is 208 feet. Site potential tree heights can be refined during project level planning.

Within the North Fork and South Fork Subwatersheds the riparian reserves were expanded in a few sites for the following reasons.

- Inclusion of unstable geologic areas (contact between the Upper Sardine or Troutdale Formations and the Lower Sardine Formation)

- Joining of wetland complexes or joining of single wetlands with downslope riparian reserve if distance was small. Other wetlands may be located during project level planning and could also be connected to the riparian reserve if distance is small.

- Inclusions of matrix lands in between densely spaced riparian reserves as separate management objectives for these small area was impractical.

- Inclusion of the alder patch along Tributary B of the Upper Mainstem as field visit identified this area to be wet.

Reasons for not decreasing riparian reserve widths were:

- Riparian Reserves on Federal lands could provide good available habitat and connectivity as poor habitat and connectivity exist on non-federal lands where minimal to no riparian protection measures are required.

- Stream temperatures in the mainstem (and probably in North Fork and Delph Creek) exceed the State Standards during most summers so all measures should be taken to prevent additional thermal inputs to streams.

- The Eagle Creek National Fish Hatchery requires high water quality and stable water quantities to manage their production of Early Run Coho and Winter Steelhead.

- Limited site specific information exists to determine opportunities to decrease riparian reserve widths.

Aquatic Conservation Strategy Objectives

The Aquatic Conservation Strategy (ACS) focuses on maintaining and restoring ecosystem health at watershed and landscape scales to protect fish habitat and other riparian-dependent resources. The four components of the strategy (key watersheds, riparian reserves, watershed restoration, and watershed analysis) provide the land management agencies the tools to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems.

An evaluation of the conditions within the Eagle Creek Watershed determined compliance of each ACS objective. The following objectives guide land management action on lands administered by the Forest Service and BLM within the range of the northern spotted owl.

Objective #1

Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.

- Riparian vegetation on federal lands in the upper watershed is predominantly in mid-late seral stages. Connectivity of riparian corridors important for riparian dependent species in Upper and Middle Mainstem Subwatersheds is good. Some management in the South Fork and Middle Mainstem exist but generally conditions are good and can be sustained under current management guidelines.

- Some conversion of deciduous to conifer stands exist, especially on BLM lands on the lower North Fork and Delph Creek.

- Under the riparian reserve width recommendations for the Eagle Creek Watershed, the ACS's objective should be met and conditions should improve over time as mid-seral stands move into late seral on federal lands.

- Instream restoration work could restore the instream habitat complexity required for aquatic organisms on the lower North Fork Subwatershed on BLM lands. Management of the relatively few acres of federal lands will have little effect to the overall distribution, diversity, and complexity of watershed and landscape scale features in Delph and North Fork subwatersheds.

Objective #2

Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connection include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

- In general, riparian conditions within Upper Mainstem and South Fork Subwatershed's are spatially and temporally connected providing relatively undisturbed drainage networks and good refugia.

- The North Fork Subwatershed lacks connectivity. Timber harvest and road construction has affected the channel network. Recreational impacts to riparian areas are occurring, primarily along Kitzmiller Road.

- Construction of fish ladders on the lower two falls on Eagle Creek to aid in the return of anadromous fish to the Eagle Creek National Fish Hatchery has increased the range of anadromy along the mainstem. The anadromous fish may be out competing resident fish for habitat that is critical for fulfilling life history requirements.

- Riparian areas have timber harvest, commercial agriculture and residential development in Delph and Lower Eagle Subwatersheds. Chemicals and fertilizers are commonly used and are likely entering the water course. This may be impacting fish directly through contact, or indirectly by effecting aquatic insects which fish eat.

- Kitzmiller and Eagle Fern Road will be continuing to impact the channel's natural course. Restoration opportunities exists within riparian areas to lessen impacts from recreational use.

- Monitoring the effects of the extended range of anadromy would provide information on the effects to the resident fish populations.

- Delph Creek and Lower Mainstem Subwatersheds will continue to be impacted by chemical and fertilizer applications.

Objective #3

Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

- The physical integrity of the aquatic system in Upper Mainstem, South Fork and Middle Mainstem Subwatersheds are stable and could be sustained under current management guidelines.

- Loss of riparian vegetation along the North Fork has decreased the aquatic habitat complexity including: pools, LWD, and spawning gravel. Stream bank erosion and two debris flows on Bear Creek, along with unstable geologic conditions next to North Fork are contributing to sediment deposition in the lower North Fork subwatershed.

- An analysis of potential LWD recruitment within riparian areas revealed that the Lower Eagle and the lower portions of Delph Creek have significant areas of low potential for recruitment. Physical components of the stream are probably out of balance due to the lack of LWD.

- Stream channeling and shade reduction have degraded the physical integrity of Currin creek, the major tributary in the Lower Mainstem subwatershed.

- Management under the ACS will improve the physical integrity of North Fork.

- Full Riparian Reserves widths will improve the physical integrity of the aquatic system to the maximum extent possible on Federal lands within Delph Creek although overall condition of this subwatershed will not improve. Restoration efforts are needed within the lower portions of the North Fork subwatershed to increase habitat complexity are needed on BLM lands.

- Management of the relatively few acres of federal lands under the guidelines of the ACS will have little effect to the physical integrity of Delph and Lower Mainstem Eagle subwatersheds. Consequently, the physical integrity of these subwatersheds will remain out of balance.

Objective #4

Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical and chemical integrity of the system and benefits survival, growth, reproduction and migration of individuals composing aquatic and riparian communities.

- Water temperatures are higher than optimal during most summers in all the subwatersheds with the exception of the South Fork Subwatershed.

- Elevated water temperatures may be natural as elevated stream temperatures flow out of the Wilderness and residential trout populations or corydalis plant community are not adversely affected in the Upper Mainstem Subwatershed.

- Management of the Upper Mainstem and South Fork Subwatersheds under the guidelines of the ACS will not increase the water temperature but may not decrease the naturally elevated water temperatures within the Upper Mainstem.

- Management of the relatively few acres of federal lands under the guidelines of the ACS in Middle Mainstem, North Fork and Delph Creek will have little effect to the water temperatures at the mouth of these subwatersheds. Consequently, elevated water temperatures are adversely affecting aquatic communities in the watershed.

Objective #5

Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate and character of sediment input, storage and transport.

- Limited road construction, timber harvest and surfacing roads on federal lands in the Upper Mainstem and South Fork Subwatershed has resulted in low levels of sediment delivery.

- Risks of natural landslides are high within the Upper Mainstem, South Fork, Middle Mainstem, and North Fork Subwatersheds.

- Management of the Upper Mainstem and South Fork Subwatersheds under the guidelines of the ACS will decrease the sediment delivery from roads, timber harvest and landslides influenced or initiated by management on federal lands. Sediment delivery from management influenced landslides continue to be a risk from non federal lands in the Upper Mainstem and South Fork Subwatersheds.

- Full width riparian reserves with inclusion of unstable or potentially unstable lands will decrease sediment delivery from roads, timber harvest and landslides influenced or initiated by management activities to the maximum extent possible on federal lands in the Middle Mainstem, North Fork and Delph Creek Subwatersheds.

Objective #6

Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient and wood routing. The timing, magnitude, duration and spatial distribution of peak, high and low flows must be protected.

- Peak and base flows remain within the natural range of variation in Upper Mainstem and South Fork Subwatersheds and can be sustained within this range under current management guidelines.

- Increased peak flows exist in Delph Creek. Timber harvest on Bureau of Land Management land would have a minor contribution to the persistence of these increased peak flows due to minimal acres affected.

Objective #7

Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

- This objective is most applicable to the characteristics in the upper portion of the South Fork subwatershed due to the high numbers of wetlands and the presence of a high water table.

- Currently, management activities have not influenced areas to a level that would alter the conditions of the subwatershed. With the application of guidelines under the riparian reserve designation there will be no change.

Objective #8

Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

Objective #9

Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

- Riparian stand structure provides adequate riparian habitat and high levels of potential large woody debris in the Upper Mainstem and South Fork Subwatersheds and will improve under current management guidelines.

- Less than optimal riparian conditions exist in the Middle Mainstem, North Fork and Delph Creek Subwatersheds due to low levels of late seral stands (0-16%) as compared to the range of natural variation (34-78%). Delph Creek has high levels of early seral stands (24%) as compared to the range of natural variation (1-13%).

- Full width riparian reserves will contribute to increased stand structure diversity (late seral conditions) and large woody debris recruitment to the maximum extent possible on federal lands in the Middle Mainstem, North Fork and Delph Creek Subwatersheds.

Table 20. Restoration

Altered Process	Restoration Objective	Restoration Projects	Emphasis Area
Off-site plantations	*To regenerate with the seed source from the appropriate seed zone	*Clearcut without leaving trees and replant within critical habitat requirements	*30-40 year plantations on the Zigzag RD, North Fork Eagle Subwatershed
Upland Alder to conifer conversion	*Convert Alder stands to minimum stocking for conifers; order of species preference: western redcedar, western hemlock, and Douglas-fir	*Underplant or overstory release of conifers	*BLM-commercial forest land
Reduced elk population damage complaints (but around George)	*Increase big game population size and move elk herds up the watershed	*Forage seedlings and road closures	*North Fork and South Fork
Reduced vegetation diversity old growth characteristics	*Increase vegetation species diversity by increasing large trees in with early seral stage *Improve late successional characteristic in mid seral stage stands	*PCT for species diversity and spacing for future large tree growth *CT on mid seral stands for spacing and size	*LSR *LSR
Reduced large trees compound in early and mid seral	*Increase large tree CWD in young stand	*PCT in early seral stands to select for several future large trees *CT in mid seral stand to maintain and increase growth on selected trees	*Matrix early seral *Matrix mid seral
Reduction in channel habitat complexity	*Improve aquatic and riparian habitat function, complexity, and connectivity	*Increase pool and SWD/LWD levels	*BLM Lands and private lands: Currin Creek Bear Creek Little Eagle North Fork
Decreased structure and composition of riparian vegetation	*Restore structure and composition of riparian vegetation *Increase LWD recruitment potential	*Riparian plantings Riparian underplanting	*FS lands in Upper North Fork, BLM land on Lower North Fork, 1st & 2nd order streams on private lands

Altered Process	Restoration Objective	Restoration Projects	Emphasis Area
Introduction of non-native fish species	*Reduce competition & negative interaction between native and non-native fish species	*Work in cooperation w/ODFW & USFWS to minimize interactions of hatchery & native fish *Work with private land owners who stock their ponds to ensure screens prevent emigration of fish	*Lower Eagle
Degraded channel network connection	*Improve fish passage	*Replace culverts or remove and restore road crossings	*North Fork
Decreased base flows	*Maintain base flows within the RNV	*Conifer plantings in riparian areas	*Lower Mainstem
Increased peak flows	*Maintain peak flows within the RNV	*Reduce road crossings by road obliteration	*Lower Mainstem Delph Creek North Fork
Reduced riparian vegetation, reduced water quality due to increased stream temperatures	*Decrease summer temperatures	*Riparian plantings of conifers or shade plants, i.e. willows, redosier dogwood or huckleberries to increase shade	*Upper Mainstem *Middle Mainstem *Lower Mainstem *North Fork *Delph Creek *1st & 2nd order streams on private lands
High% early seral in riparian	Maintain % early seral within RNV	*Educate people to understand benefits of letting riparian buffer grow *Riparian plantings	*Delph Creek & Lower Mainstem

Transportation System

The Northwest Forest Plan identified the primary objective of road management in key watersheds was reduction of existing system and non system roads. In Eagle Creek there are approximately 509 miles of roads. This section outlines access and travel management by discussing priorities for road closures and road restoration to decrease sediment delivery.

The goal of the access and travel management plan for Eagle Creek is to reduce the road effects on peak flows and sediment delivery, and reduce the effects of elk disturbance, while facilitating administrative, commodity and recreational uses on federal lands. Goals were established during Landscape Analysis and Design, and tiered to current access and travel management plans.

Roads to Close

Roads with high sediment delivery (refer to Sediment Delivery Section in Chapter 3).

- Road 4614-180 has actively eroding steep cutbanks. Road obliteration on first 0.7 miles necessary to reestablish vegetation on steep slope.

Roads where elk disturbance needs to be reduced and habitat improvement projects will be implemented on BLM lands. These roads should be gated.

03-05-32.1
03-05-13.1
03-05-13.2
03-05-13.3
03-05-13 .4
03-05-11.1
03-05-11.2
03-05-11.3
03-05-1
03-05-1.1

Roads which are not needed anymore on Forest Service Lands.

Soft Closure - Roads will be left to close by natural processes.

4515120
4515130

4515140
4614180

Closure - Roads will be closed using gate, berm or other device.

4515150
4614130
4614150
4614167
4614170
4614190

Gate

3626105
3626013

Roads that could be converted to trail.

3600355
3626355

Road restoration to decrease sediment delivery

- 4515130 Water flows down road. Check for adequate culvert relief and ditch relief.
- 3626355 Water flows down road. Numerous seeps occur along cutbank. Drainage problems should be improved during conversion from road to trail.
- 4614 Cutbanks delivering sediment. Revegetate five raw 50-300 ft sections beginning Milepost 9 to end of road (most sections past Milepost 10).
- 4614 Three tall, steep cutbanks delivering sediment located east of the 4614167 spur. Consider revegetation with knickknick which has been successfully established on steep cutbanks.
- 3S.5E.56.8 Tall, steep cutbanks delivering sediment located on the switch backs going down to the hatchery. Consider revegetation.

Other roads rated as high sediment delivery were reviewed on all Forest Service land and Road 3S.5E.36.9 on BLM land but restoration was not deemed practical or necessary. The rest of the roads with high sediment delivery on BLM lands should be reviewed for restoration opportunities.

Table 21. Monitoring

Process	Monitoring Objective	Monitoring Parameter	Emphasis Area
Terrestrial			
Stand conversion	Conversion of deciduous to conifers in matrix	Conifer stocking levels	Federal matrix lands
Late seral habitat system	Spotted owl occurrence	Spotted owls	LSR and wilderness
Disturbance	Changes in blowdown, insects and disease infestations	Acres of blowdown or infestation	For infestation, Upper Main and Upper North Fork; for blowdown, mapped high risk areas
Vegetation structure	Assure planning guidelines are met	Amount & distribution of suitable coarse woody debris & snags	All federal lands except wilderness
Habitat use	Assure ODFW herd management objectives are met	Quality & quantity of habitat improvements	Upper areas of South Fork and North Fork
Old growth succession	Determine recruitment of old growth to remove interim matrix old growth management areas	Old growth acres	LSR and wilderness
Aquatic			
Hydrologic condition	Determine base and peak flows	Flow	At hatchery, at Bonnie Lure Bridge, peak flows only in North Fork (crest stage gage)
Water temperature	Compare changes in wilderness versus managed areas	Summer high temperatures	Wilderness South Fork Boundary, Mouth of Mainstem Eagle above confluence w/South Fork, hatchery, mouth of North Fork, Confluence of Eagle & Clackamas River

Process	Monitoring Objective	Monitoring Parameter	Emphasis Area
Fish reproduction	Determine spawning habitat utilization	Spawning surveys	Below hatchery on Mainstem Eagle, North Fork for anadromous, & Upper Mainstem for resident trout
Aquatic habitat	Determine effectiveness of restoration	Habitat complexity	North Fork
Social			
Visual landscape patterns	Assure landscape visual recommendations are met	Landscape patterns fragmented, perforated	From Old Baldy Trail viewshed McGiver Park

Table 22. Data Gaps

Terrestrial

* Similar/compatible vegetation description (i.e. structure, function) on primarily private but also between BLM & FS.
* FS/BLM vegetation data bases need more common ecosystem descriptions, i.e. structure.
* Species of Concern occurrence information is lacking.
* Species of interest (big game) population numbers for management objectives.
* General lack of monitoring information of all species occurrence.
* Snags and coarse woody debris inventory, amounts, location, condition (size, type).
* Detailed special habitats inventory.
* Lack of ground based vegetation information in Salmon-Huckleberry Wilderness and adjacent LSR.

Aquatic

* Pre-settlement stand conditions and type compared to current conditions (deciduous vs. conifer stands).
* Site-specific riparian vegetation structure, condition and type.
* Wildlife use of riparian reserves connectivity habitat.
* Baseflow information.
* Temperature information in the lower part of the watershed.
* Comparison of landslide delivery rates to other sediment sources (i.e. road, timber harvest).
* Spawning utilization of returning hatchery fish and native stocks.
* Level of agricultural and commercial chemical pollutants in lower watershed.
* Stream habitat conditions/capabilities in the lower watershed.
* Unknown culvert passage problems in the watershed.
* Interactions between resident, native and hatchery fish.
* Genetic distinction of cutthroat.
* Distribution and abundance of macro invertebrates.

Social

* Hunter and angling use and location.
* What do people tolerate and/or prefer along trail viewsheds related to timber harvest or vegetation manipulation.
* Trail use levels.
* Contribution of ECNFH to commercial and sport fishing.

Probable Sale Quantity (PSQ)

Scope

PSQ estimations are on a per decade basis on Federal land (Map 4-2). Analysis beyond 40 years is be considered unreliable.

Land Allocations

A good proportion of the PSQ would be expected to come from the Fragmented Design cells (Map 4-2). This area is the least restrictive in attaining the PSQ. The land allocations in terms of timber output restrictions are listed below, starting with the most restrictive:

- Wilderness (no timber outputs)
- LSR
- Riparian Reserves
- Oldgrowth Retention

The Riparian Reserves would overlap other land allocations.

This leaves the area within the fragmented design cell, Matrix lands outside Riparian Reserves for the Connectivity/Diversity block, and areas designed for perforated landscape patterns as the land base for regulated timber outputs. Roadless areas, and B6-Special Emphasis Watershed objectives from the Mt. Hood NF Forest plan would be included in this land base as well.

Assumptions

Assumptions for calculating the PSQ include the following:

- Lands are fully stocked with Douglas-fir as primary species.

- A 150 year rotation is used to meet landscape design, and B6- Special Emphasis Watershed land allocation.
- Five hundred acres out of the 3,040 acres in the perforated design cells will be considered the regenerated equivalent.
- Fifteen percent of the area would be retained in any regenerated stand as directed by the Northwest Forest Plan (see pg C-41 in the ROD).
- The average standing net volume is based on 46 mbf/acre from stand information collected in Eagle Creek watershed.
- Growth rates are based on an average site index of 120 ft, 100 year curve for Douglas-fir. An average growth rate of 4.6 % per decade excluding mortality, and cull was used. This average is based on all successional stages for the western hemlock and Pacific silver fir zones for 150 years. This figure is used as a cross check for sustainability.

Estimated PSQ

The following are the calculations used to determine PSQ based on the assumptions listed above :

2,820	acres designated in Fragmented design cell
170	acres outside Riparian Reserves in the BLM Connectivity/Diversity block
500	acres designated in Perforated design cell for regenerated equivalent
3,490	total acres designated for regulated timber production
-15%	acres green tree retention per President's Forest Plan
3,000	acres adjusted
/150	year rotation to meet landscape design, and B6-Special Emphasis Watershed objectives
x46	mbf/acre average standing volume
926	mbf per year or 9.3 mmbf per decade
+1.0	mmbf per decade for plantation thinning
10.3	Total MMBF per decade on federal lands

Additional volume from Riparian Reserves, LSR, and Oldgrowth retention areas may be possible depending on land allocation objectives, stand conditions, and site disturbances such as insects, disease, or windthrow.

Land Management Plan Recommendations

The Management Direction Section of the Recreation Report in Chapter Three describes the current condition of Roadless areas in South Fork Eagle Creek. Based on these findings, it is recommended the western segment of the roadless area (in the lower South Fork area) be dropped as a roadless area.

Appendices

Appendix A

Glossary

Appendix A - Glossary

Acronyms

ACS	Aquatic Conservation Strategy.
BLM	Bureau of Land Management.
DBH	Diameter at breast height, common measure of tree size.
ELNFH	Eagle Creek National Fish Hatchery.
LAD	Landscape analysis and design.
LSR	Late Successional Reserve. Northwest Forest Plan land allocation.
LWD	Large woody debris - portion of a tree that has fallen or been cut and left on the forest floor or in a stream. Refers to pieces at least 36 inches in diameter and greater than 50 feet in length.
Mt. Hood	Mt. Hood National Forest Land and Resource Management Plan.
FP/LMP	Also called Forest Plan.
ODFW	Oregon Department of Fish and Wildlife.
PIG	Columbia Basin Anadromous Fish Policy and Implementation Guide.
PSQ	Probable sale quantity.
REAP	Regional ecological assessment.
RMP	BLM's Resource Management Plan.
RNV	Range of natural variability.

ROD	Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. Commonly referred to as the Northwest Forest Plan or the President's Forest Plan.
S&G's	Standards and guidelines - the rules and limits governing actions, and the principles specifying the environmental conditions or levels to be achieved and maintained.
SCCA	Species and communities conservation analysis - computer database.
SWD	Small woody debris - refers to pieces at least 24 inches in diameter and greater than 50 feet in length.
T, E & S	Threatened, endangered or sensitive plant and animal species.
TLML	Guild of wildlife species: terrestrial, late seral, capable of aggregating a mosaic of suitable habitat patches, large home range.
USDI	U.S. Department of Interior.
USFS	U.S. Forest Service.
USFWS	U.S. Fish and Wildlife Service.
VQO	Visual Quality Objecties

Appendix B

References

Appendix B
References

Brown , Reade E. et. al. 1985 Management of Wildlife and Fish Habitats in Forests of Wfestern Oregon and Washington USDA and USDI

Cramer, D.P. and Cramer, S.P. 1994. Status and Population Dynamics of Coho Salmon in the Clackamas River. Technical Report. Portland General Electric.

Ecosystem Analysis at the Watershed Scale Version 2.1 Review Draft March 1995.

Federal Agency Guide for Pilot Watershed Analysis. 1994.

Harris, D.D., Hubbard, L.L and L.E. Hubbard. Magnitude and Frequency of Floods in Western Oregon US Geological Survey Open File Report 79-553.

Hicks, B.J., R.L. Beschta, R.D. Harr. 1991. Long-term Changes in Stream-flow Following Logging in Western Oregon and Associated Fisheries Implications. Water Resources Bulletin, American Water Resources Association, Vol. 27, No. 2.

Leonard, A.R., Collins, C.A. 1983. "Ground Water in the Northern Part of Clackamas County, Oregon," USGS Water Resources Department, Ground Water Report Number 29.

Maser , Chris, et. al. 1984. The Seen and Unseen World of the Fallen Tree USDA General Technical Report PNW - 164.

Mellen, Kim, Huff, M, Hagesteadt. 1994 Interpreting Landsacape Patterns: A Vertebrate Habitat Relationships Report. Draft. Unpublished document, USDA Forest Service, Mt . Hood National Forest.

ODFW. 1994 Columbia Region Management for Elk.

Oregon Department of Fish and Wildlife and Washington. 1992. Clackamas river sub-basin fish management plan. Portland Oregon.

Nehlsen, W., Williams, J.E., Litchatowich, J.A. 1991. Pacific Salmon at the Crossroads: Stocks at Risk from California, Idaho, and Washington. Fisheries. 16(2):4-21.

Peck, D.L., Griggs, A.B., Wells, F.G., Brown, R.D., Schlicker, H.G., Dole, H.M. 1964. "Geology of the Central and Northern Parts of the Western Cascade Range in Oregon," USGS Professional Paper 449.

Schlicker, H.G., Finlayson, C.T. 1979. "Geology and Geologic Hazards of Northwestern Clackamas County, Oregon," Oregon Department of Geology and Mineral Industries, Bulletin 99.

Swanson and Grant. 1982. Rates of Soil Erosion by Surface and Mass Erosion Processes in the Willamette NF. Paper prepared for the Willamette NF.

Thomas, J.W.; Forsman, E.D.; lint, J,B. (and others). 1990 A conservation strategy for the northern spotted owl: a report of the Interagency Scientific Committee to address the conservation of the nothern spotted owl. Portland, OR: U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Manaagement, Fish and Wildlife Service, and National Park Service. 427p.

USDA Forest Service. 1990 Land and Resource Management Plan, Mt. Hood National Forest.

USDA Forest Service. 1993. A First Approximation of Ecosystem Health: National Forest System Lands. Pacific Northwest Region. June 1993.

USDA Forest Service. 1994 (unpublished). Fish Creek Watershed Analysis. Mt. Hood National Forest, Gresham, OR.

USDI. 1992 Bart Jonathan et. al. Recovery Plan for the Northern Spotted Owl - Draft.

Washington Forest Practices Board. 1993 Standard Methodology for Conducting Watershed Analysis. Version 2.0. Washington Forest Practices Act Board Manual.

Washington State Forest Practices Board. 1992. Standard Methodology for Conducting Watershed Analysis. 1992.

Wisseman, B. 1994. Benthic Invertebrate Biomonitoring. unpublished report on file a Zigzag Ranger District.

Appendix C

Supporting Documentation

Appendix

Federal Candidate Species

Harlequin Duck

This is a small sea duck that nests along isolated mountain streams. Not much is known about the habitat requirements of this relatively uncommon bird. Extensive studies are underway some 20 to 30 miles south of this area. Fewer than 20 harlequin nests have been located in Oregon to this date. Although much of the habitat appears to be suitable for harlequin ducks no formal surveys have been conducted on this stream. No known sightings have been recorded on the stream.

Wolverine

The wolverine is a rare wonder in the Cascade Mountains. Wolverine are thought to have huge home ranges and therefore could occasionally wander into Eagle Creek drainage. This animal prefers the remoteness of high coniferous forest. Potential habitat occurs in the upper watershed within the Wilderness. Although Mt. Hood National forest has had an ongoing wolverine study the last few years, no sightings have been made in the watershed.

White-Footed Vole

This vole is thought to be a rare rodent that is primarily restricted to riparian vegetation. Recent studies have found it in the upland conifers above riparian and wetland areas. Little is known about the vole's specific habitat needs or population status. There are no known sightings in the Eagle Creek watershed.

Townsend's Big-Eared Bat

This bat feeds on flying insects over forested areas. Caves and cave-like structures in old-growth trees provide roosting sites. Special habitats that provide emergent insects are important habitats for these bats. No roosting areas or hibernacula have been observed in Eagle Creek watershed.

Northern Goshawk

The northern goshawk is believed to nest above 1900' elevation in the Cascades. This large, diurnal avian forest predator nests in large old trees in stands of mature or old-growth forest. Although much of the upper watershed is potential nesting and foraging habitat for goshawks. No nest sites have been identified in Eagle Creek.

Mountain Quail

The mountain quail is a Federal candidate species, although it is thought to be common in most of western Oregon. It prefers brush edge habitat along recent cutover or burned areas.

Cascade Frog

The Cascade frog inhabits streams, bags, and ponds with aquatic vegetation above 2600 feet elevation.

Foothill Yellow-Legged Frog

This frog species is associated with permanent streams that have rocky or gravel bottoms.

Northern Red-Legged Frog

Red-legged frogs prefer ponds and kiw-grauient streams generally at elevations below 2000' elevation.

Spotted Frog

This frog is generally associated with permanent water of ponds and slow moving streams that have soft mud or boggy bottoms. Spotted frogs are rare in western Oregon because of introductions of bull frogs.

Western Pond Turtle

Western pond turtles are found in quiet clear water with emergent rocks or logs. Generally it is found below 2000' elevation in or adjacent to the Willamette Valley. It may have been transplanted into some of the private ponds within the lower Eagle Creek watershed.

Invertebrates

Three species of invertebrates may occur in the watershed (Mt. Hood brachycentrid caddisfly, Cascades apatanian caddisfly, and the Beller's ground beetle). Little is known about these species; most associated with cold clear springs or moist older forests.

EAGLE CREEK WATERSHED ANALYSIS
Unified Database Between the BLM, and the USFS
ARC/INFO VEGETATION DATABASE

FIELD NAME	BLM SOURCE	USFS SOURCE	DESCRIPTION
vegetation-ID	Arc/Info	Arc/Info	Unique polygon identifier
subject	subject	TRIcompt#+veg id	Unique for BLM, not unique for USFS
Ecoclass	Generated	TRI, TSE	Pacific Northwest Ecoclass Codes for Plant Association, R6 Ecol Tech paper 289-87
Structure	Generated	SCCA	Structure field name in SCCA
Strstage	Generated	SCCA, TRI, TSE	Seral Stage:Early, MID, LATE, Non-Veg
Domspecies	FOI/POI	TRI, TSE, SCCA	Dominant overstory species, BLM land, and non-f
Domspbirth	FOI/POI	TRI, TSE, SCCA	Dominant overstory species birthdate
Sdomspec	FOI/POI	TRI, TSE, SCCA	Secondary overstory species
Sddomspbirt	FOI/POI	TRI, TSE, SCCA	Secondary overstory species birthdate
Stockclass	FOI/POI	TRI, TSE, SCCA	Stocking level for tree species
Standsize	FOI/POI	SCCA	Average Stand Diameter Class
Totalcc	Generated	SCCA	Total Canopy Closure (percent of area)
Hwdlvl	Generated	SCCA	Hardwood level class, percent of stand compositi
Owner	FOI/POI	Generated	Landowner
Tenyear	FOI/POI	Generated, TSE	Average stand ten year age class
Cpactcode	Microstorms, Gen	TRI	Harvest prescription for completed project
Actprojid	Microstorms, Gen	TRI	Timber sale name and unit # (not used)
Actprojyr	Microstorms, Gen	TRI	Year project was completed
Site Index	Microstorms, Gen	TSE, TRI	100 yr Douglas-fir site index from TSE only
Site Class	FOI/POI, POI, Ge	TSE, TRI, Generated	Estimated site class if site index is not available

FOI = Forest Operations Inventory (BLM)
POI = Private Operations Inventory (BLM)
TRI = Total Resourc Inventory (USFS)
TSE = Timber Stand Examination (USFS)
SCCA = Species Community and Conservation Assessment (Mt.Hood National Forest)

Table 1 Terrestrial wildlife guilds that are used to identfy different habitat requirement for a variety of wildlife species.

Table 3. Spotted owl habitat acres within the 1.2 mile radius hame range for known sites in or adjacent to Eagle Creek Watershed.

MSNO	LOCATION	SUITABLE	OPTIUM	TOTAL
1616	west W	502	157	659
1617	east w	79	209	288
1622	LSR	525	248	773
4211	north W	39	151	190
4216	outside N	0	0	0
1613	outside E	0	12	12
3482	outside S	2	0	2

Table 4. Threatened, endangered, and sensitive animal species that are either known to occur or may potentially occur on the Eagle Creek Watershed for USFS.

SPECIES	CLASSIFICATION		
	FEDERAL	STATE	REG. FORESTER
Peregrine falcon	E	E	S
N. bald eagle	T	T	S
N. spotted owl	T	T	S
Wolverine	FC2	T	S
Pacific Western big-eared bat	FC2	SC	S
Northwestern pond turtle	FC2	-	S
White-footed vole	FC2	SU	C
Red-legged frog	FC2	SV	S
Cope's giant salamander	-	SU	S
Harlequin duck	FC2	SP	S
Greater Sandhill Crane	-	SV	S
Painted turtle	-	SC	S

Table 5. Special status species (animal) that are known to occur in the area or may potentially occur in the area on BLM lands.

SPECIES	STATUS CATEGORIES		OCCURRENCE
	FEDERAL	STATE	
Peregrine falcon	E	E	C
Bald eagle	T	T	B
N. spotted owl	T	T	A
Wolverine	FC2	T	C
Townsends big-eared bat	FC2	SC	C
White-footed vole	FC2	SU	C
Cascade frog	FC2	SV	C
Foothill yellow-legged frog	FC2	SV	C
N. red-legged frog	FC2	SV	C
Spotted frog	FC2	SC	C
Harlequin duck	FC2	SP	C
Mountain quail	FC2		A
Northern goshawk	FC2	SC	C
Beller's ground beetle	FC2	-	C
Cascades apatanian caddisfly	FC2	-	C
Mt.Hood Brachycentrid caddisfly	FC2	-	C
Western pond turtle	FC2	-	C
Oregon slender salamander	S	SU	C
Cope's Giant Salamander	A	SU	A
Tailed frog	A	SU	C
Great grey owl	A	SV	C
Horned grebe	A	SP	C
N. saw-whet owl	A	-	C
Pileated woodpecker	A	SC	A
Western bluebird	A	SV	C
American marten	A	SC	C
Painted turtle	A	SC	C

1 This list of species is being updated and will be published in the Salem District Resource Management Plan Record of Decision.

2 E = Endangered; T = Threatened; P = Proposed; PE = Proposed Endangered; C2 = Taxa for which information now in the possession of the U.S. Fish and Wildlife Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which conclusive data on biological vulnerability and threat are not currently available to support proposed rules; 3C = Taxa that have proven to be more abundant or widespread than previously believed and/or those that are not subject to any identifiable threat. If further research or changes in habitat indicate a significant decline in any of these taxa, they may be reevaluated for possible inclusion in categories 1 or 2; S = Bureau Sensitive; A = Bureau Assessment.

3 E = Endangered; T = Threatened; SC = Sensitive Critical; SV = Sensitive Vulnerable; SP = Sensitive Peripheral or Naturally Rare.

4 a = Known to occur - breeds within planning area; b = Known to occur - migrates through or into planning area; c = Suspected to occur (historical records, no recent documented sightings).

Table 6. Special Status Plants for Bureau of Land Management that potentially occur in the Eagle Creek Watershed.

SPECIES	STATUS CATEGORY		
	FEDERAL	STATE	STATE DIR
Gorman's aster	FC2	C	BS
Tall bugbane	FC2	C	BS
Cold-water corydalis	FC2	C	BS
Howell's daisy	FC2	C	BS
Pale blue-eyed grass	FC2	C	BS
Oregon sullivantia	FC2	C	BS
Giant polyphore fungus			BS
Tall agoseris			AS
Brewer's reedgrass			AS
Pale sedge			AS
Three-leaf goldthread			AS
Fir clubmoss			AS
Bog clubmoss			AS
Ground cedar			AS
Adder's tongue			AS
Scheuchzeria			AS
Kruhsea			AS
Lesser bladderwort			AS
Columbia watermeal			AS
Tayloria serrata (moss)			AS
Mountain bentgrass			TS
Cascade rockcress			TS
Inland sedge			TS
Smooth-leaved douglasia			TS
Golden alpine d(?)			TS
Dulichium			TS
Yellow willow herb			TS

Cascade daisy			TS
Many-spiked cottongrass			TS
Western wahoo			TS
Branching monig (?)			TS
Loose-flowered bluegrass			TS
Weak bluegrass			TS
Wild cranberry			TS
Blue verbena			TS

Table 7. Vascular plants currently listed as Threatened, Endangered, or Sensitive for Region 6 of the Forest Service, which have potential to be found in the Eagle Creek watershed.

SPECIES	CLASSIFICATION		
	FEDERAL	STATE	REG. FORESTER
Documented occurrence			
Cold-water corydalis	FC2	C	S
Fir club-moss			S
Suspected occurrence			
Gorman's aster	FC2	C	S
Pale blue-eyed grass	FC2	C	S
Tall bugbane	FC2	C	S
Adder's tongue			S
Lesser bladderwort			S
Tall agoseris			S
Lance-lvd grape-fern			S
Moonwort			S
Mountain grape-fern			S
Pinnate grape-fern			S
Pale sedge			S
Ground ceder			S
Bog club-moss			S
Scheuchzeria			S
Kruhsea			S
Water-meal			S

EAGLE CREEK WATERSHED ANALYSIS

Landslide Analysis

GEOLOGY

The Eagle Creek Watershed is comprised of ten geologic units which were identified during previous work (Peck et al. 1964; Schlicker and Finlayson 1979; Leonard and Collins 1983). The units are briefly described below in their approximate order of occurrence, from youngest to oldest.

Qal ALLUVIUM: Unconsolidated sand, gravel, and cobbles within stream channels and on adjacent terraces; sandy silt up to 10 feet thick overlies gravel on flood plains.

Qls QUATERNARY LANDSLIDE DEPOSITS: Poorly-sorted deposits of slumps and large debris flows and debris slides, and hummocky, fine-grained earthflow deposits.

Qpt PLEISTOCENE TERRACE DEPOSITS: Unconsolidated gravel, cobble, boulder and silty mudflow deposits up to 200 feet thick near the confluence of the Eagle Creek and the Clackamas River. This is the same as unit Qt of Leonard and Collins (1983).

Qpg PLIOCENE-PLEISTOCENE GRAVELS: Weakly indurated, poorly sorted, rounded gravels, cobbles, boulders, and pyroclastic mudflow deposits up to 400 feet thick. Extensive weathering has produced a clayey soil. This is the same as unit Qsw of Leonard and Collins (1983).

Qtb BORING LAVAS: Andesitic and basaltic lava flows with a widely spaced joint pattern; tuff breccia and pyroclastics occur locally; found near Douglass Ridge and Lenhart Butte. This is the same as unit Qtv of Peck and others (1964).

QTa ANDESITE: Andesitic and basaltic intrusions found at the summits of Lenhart and Highland Buttes and Squaw Mountain.

Tpt TROUTDALE FORMATION: Sandstone and conglomerate; indurated beds and lenses of well-sorted sand, gravel, and cobbles with up to 30 percent quartzite clasts; some sands altered to impermeable, high shrink-swell clay. This is the same as unit Tt of Peck (1964) and Tts of Leonard and Collins (1983).

Tsr SANDY RIVER MUDSTONE: Claystone, siltstone, very fine sandstone, and some lapilli tuff; deposited in water, uniform parallel bedding, well-sorted and moderately indurated; exposed adjacent to river channels in the lower portion of the watershed.

Tsa SARDINE FORMATION: Lower unit, andesitic lavas and indurated pyroclastics including abundant tuff breccias, lapilli tuff, and tuff; deeply weathered and found throughout the watershed.

Tsf SARDINE FORMATION: Upper unit, pyroxene andesite lava flows found mostly in the eastern portion of the watershed. Combined with Tsa as mapped by Schlicker and Finlayson (1979).

The geologic units can be grouped into six general categories:
Weak Rock: Tsa, Tsr;
Intermediate Rock: Tsf, Tpt;
Resistant Rock: Qtb, QTa;
Unconsolidated Material: Qpg;
Alluvium: Qal, Qpt;
Quaternary Landslide Deposits: Qls.

GEOMORPHOLOGY

The Eagle Creek Watershed varies substantially in terms of topographic relief and, consequently, landslide potential. In the eastern portion of the watershed, slopes consist of lava flows and slightly indurated volcaniclastic formations, drainages are deeply incised, slope angles may exceed 70 percent, and the landscape is predominantly erosional. In contrast, the landscape of western portion of the watershed is largely depositional, slope angles are modest, and drainages are shallow and may even meander within narrow

floodplains. The fluvial deposits that form much of this part of the watershed have been transported by both Eagle Creek and the Clackamas River.

The watershed has been divided into nine landform types based on their susceptibility to landsliding, which is primarily a function geology, slope angle, and in some cases, drainage density. These landforms are described below. Common slope angles are given for each landform type, but in each case, minor inclusions of slopes with higher or lower angles have been made.

RESISTANT ROCK--STEEP SLOPES (RRSS): Rare in the watershed but occurs locally near Lenhart Butte and west toward Douglass Ridge. Slope angles exceed 50 percent.

RESISTANT AND INTERMEDIATE ROCK--GENTLE SLOPES (RIRGS): Found throughout the central and eastern portions of the watershed. Slope angles range from 0 to 50 percent but are typically less than 30 percent.

INTERMEDIATE ROCK--STEEP SLOPES (IRSS): Found in the central and eastern portions of the watershed but in two different formations. Slope angles exceed 50 percent.

WEAK ROCK--STEEP SLOPES (WRSS): Found throughout the watershed along valley walls of the larger drainages. Slope angles exceed 50 percent.

WEAK ROCK--GENTLE SLOPES (WRGS): Occurs throughout the watershed but mostly in the central portion. Slope angles are less than 50 percent and are usually less than 30 percent.

UNCONSOLIDATED MATERIAL--MODERATE SLOPES (UMMS): Found in the western portion of the watershed. Slope angles typically range from 20 to 50 percent.

UNCONSOLIDATED MATERIAL--GENTLE SLOPES (UMGS): Found mostly in the western portion of the watershed east of Estacada. Slope angles do not exceed 20 percent and are often close to 0 percent.

ALLUVIAL VALLEY BOTTOMS AND TERRACES (AVBT): Occur in the western portion of the watershed. Slope angles seldom exceed 10 percent, with the exception of terrace escarpments, which may exceed 50 percent and range in height from approximately 30 to 100 feet.

*QUATERNARY LANDSLIDE DEPOSITS (QLD): Occur throughout the watershed, typically in areas of greater relief. Slope angles range from near 0 percent to more than 70 percent.

*One may notice that many more Quaternary Landslide Deposits are mapped in the western portion of the watershed than in the eastern portion of the watershed. The explanation for this discrepancy is that the Redland and Estacada quadrangles were mapped by Schlicker and Finlayson (1979) at a greater level of detail than the remainder of the watershed. Field visits by these workers enabled them to identify extensive areas of landslide topography that are not necessarily visible on aerial photographs. Given that the topography is steeper in the eastern portion of the watershed, it is likely that an equivalent or greater number of landslide deposits would be identified here as a result of similar levels of field work.

LANDSLIDE DISCUSSION

The Eagle Creek Watershed consists of steep terrain in the east and flatter terrain in the west. In general, it is not a watershed plagued by instability. Problems are largely limited to the deeply incised drainages in the eastern portion of the watershed, where slope angles exceed 50 and sometimes 70 percent.

The landslide potential and relative sediment delivery rating for the landform types were determined by examining 1967 and 1989 aerial photographs, interpreting an existing hazards map (Schlicker and Finlayson 1979), and by a brief field visit. The results of this work are summarized in the tables below. It is important to note that the ratings found in these tables (i.e., High, Medium, and Low) are based largely on professional judgement and experience with similar landforms and are useful only when making broad, qualitative comparisons between landforms in this watershed; they are, by no means, definitive. If more specific comparisons are required (e.g., comparisons between landforms in other watersheds), a qualified geologist, geotechnical engineer, or geomorphologist should be consulted.

Table I shows the relative landslide potential for each landform type. It essentially represents a landform's propensity for unqualified slope failure. Table II shows the types of mass wasting and erosion processes that

types and not the other sediment transport processes shown in the table. For example, it is valid to conclude from the table that debris flows are less likely to occur on the landform type RRSS than on type WRSS; in contrast, it is not valid to conclude that within landform type RRSS, the occurrence of debris flows is equivalent to that of debris slides and rockfall. Table III lists each landform type and its relative sediment delivery rating for mass wasting. It refers to the probability of sediment reaching a stream as a result of a given landslide. It is worth noting that landslide potential and relative sediment delivery are not necessarily equivalent because of variations in the delivery capability of certain landslides (e.g., debris flow vs. debris slide) and the proximity of the event to streams (drainage density). Table IV summarizes the characteristics and processes associated with each landform.

TABLE I. LANDSLIDE POTENTIAL BY LANDFORM TYPE

Resistant Rock--Steep Slopes	Medium
Intermediate Rock--Steep Slopes	Medium
Weak Rock--Steep Slopes	High
Resistant and Intermediate Rock--Gentle Slopes	Low
Weak Rock--Gentle Slopes	Low
Unconsolidated Material--Moderate Slopes	Medium
Unconsolidated Material--Gentle Slopes	Low
Alluvial Valley Bottoms and Terraces	Low
Quaternary Landslide Deposits	Medium

TABLE II. DOMINANT SEDIMENT TRANSPORT PROCESSES BY LANDFORM TYPE

	Debris Flow	Debris Slide	Earthflow	Slump	Creep	Rockfall	Surface Erosion	Stream Bank Failures
RRSS	M	M	n/a	L	L	M	M	H
IRSS	H	M	n/a	L	L	M	M	H
WRSS	H	H	M	M	M	L	M	H
RIRGS	L	L	n/a	L	L	n/a	L	M
WRGS	L	L	M	M	M	n/a	L	M
UMMS	M	M	M	L	M	n/a	M	M
UMGS	L	L	L	L	L	n/a	L	M
AVBT	L	L	L	L	n/a	n/a	L	M
QLD	M	M	M	M	M	n/a	M	H

TABLE III. RELATIVE SEDIMENT DELIVERY BY LANDFORM TYPE*

Resistant Rock--Steep Slopes	High
Intermediate Rock--Steep Slopes	High
Weak Rock--Steep Slopes	High
Resistant and Intermediate Rock--Gentle Slopes	Low
Weak Rock--Gentle Slopes	Medium
Unconsolidated Material--Moderate Slopes	Medium
Unconsolidated Material--Gentle Slopes	Low
Alluvial Valley Bottoms and Terraces	Low
Quaternary Landslide Deposits	Medium

*Sediment delivery via stream-bank failures is not considered in this table. Rather, it refers only to sediment delivered by debris flows, debris slides, earthflows, slumps, creep, surface erosion and rockfall.

TABLE IV. LANDFORM CHARACTERISTICS AND ASSOCIATED PROCESSES

--Associated Rock Types--

Resistant Rock: light-gray, open-textured olivine basalt, basaltic andesite, and pyroxene andesite, less abundant pyroclastic rocks, also intrusive forms of andesite, basalt, gabbro, and norite.

Intermediate Rock: pyroxene andesite lava flows and indurated pyroclastics, with less common mudflow breccias; sandstone and conglomerate with indurated beds and lenses of well-sorted sand, gravel, and cobbles; may also include altered volcanic glass altered to an impermeable shrink-swell clay.

Weak Rock: pyroxene andesite and less abundant basalt and dacite, abundant mudflow breccia, tuff breccia, and lapilli tuff; also includes siltstone, claystone, and very fine-grained sandstone.

Unconsolidated Material: weakly-indurated, poorly-sorted cobbles and gravels associated with pyroclastic mudflows; extensive weathering of gravels has produced a mottled reddish-brown clayey soil.

Alluvium: unconsolidated sand, gravel, and cobbles, and silty mudflow deposits.

Quaternary Landslide Deposits: unsorted deposits of all particle sizes; identified by hummocky terrain, disrupted drainage patterns, sag ponds, tipped trees, scarps, and cracks.

--Slope-Forming Processes--

Resistant Rock: lava flows, regional uplift, intrusions, fluvial erosion, mass-wasting, surface erosion;

Intermediate Rock: lava flows, regional uplift, fluvial erosion and deposition, mass-wasting, surface erosion;

Weak Rock: lava and pyroclastic debris flows, regional uplift, slack-water deposits, fluvial erosion and deposition, mass-wasting, surface erosion;

Unconsolidated Material: fan-like debris flow deposits, fluvial erosion and deposition, surface erosion;

Alluvium: peak-flow deposits, stream-bank failures, surface erosion;

Quaternary Landslide Deposits: mass-wasting, possible high-magnitude earthquakes, parasitic landsliding, surface erosion.

--Sediment Delivery Mechanisms--

Resistant Rock: stream-bank failures, debris flows, debris slides, surface erosion, creep;

Intermediate Rock: stream-bank failures, debris flows, debris slides, surface erosion, creep;

Weak Rock: stream-bank failures, debris flows, debris slides, slumps, minor earthflows, surface erosion, creep;

Unconsolidated Material: stream-bank failures, slumps, debris flows, debris slides, earthflows, surface erosion;

Alluvium: stream-bank failures, fluvial erosion, surface erosion;

Quaternary Landslide Deposits: stream-bank failures, debris flows, debris slides, slumps, surface erosion, creep.

During the landslide inventory, 57 landslides were identified. Of these, 46 occurred roughly within the period of photo record which dates back to 1967. The 11 remaining landslides are considered to be ancient and are only visible because they are quite large. Of the recent landslides, 40 are debris flows, 3 are rockfall, 2 are debris slides, and 1 is a stream-bank failure. Many of the debris flows appear to be associated with the 1964 100-year storm event. The actual number of debris slides and stream-bank failures is probably much larger than that listed above, but their recognition is largely a function of their size, and smaller events are often concealed by the forest canopy.

Of the 46 recent landslides, 42 are thought to have delivered sediment to the drainage network. If an accurate inventory of stream-bank failures was available, this number would be much higher. Several of the recent landslides are associated with land management practices such as clear-cutting, road-building, and quarrying. This association is based on the position and form a given landslide with respect to the managed site. For example, a debris flow with its headwall located in a clear cut is said to be associated with that clear cut. In some cases, a causal connection appears obvious, though in other it does not. The amount of additional work required to make this determination is somewhat prohibitive in the scope of watershed analysis. In the Eagle Creek Watershed, management practices appear to have influenced or initiated 14 landslides.

Many landslides, particularly debris flows, are associated with the contact between the upper and lower members of the Sardine Formation (Tsf-Tsa contact; typically in the WRSS landform type). The arrangement of a more resistant rock unit overlying a less resistant rock unit is highly conducive to many types of landsliding, including debris flows, debris slides, slumps, rockfall, and even topple. This is especially true when the lower unit is more

unit consists largely of lava flows, while the lower unit, in addition to lava flows, consists of weak pyroclastic rocks such as tuff breccia and lapilli tuff.

In addition to the landslides discussed above, mapping by Schlicker and Finlayson (1979) shows 14 additional landslides and 8 cases of intense stream-bank erosion. A summary of this landslide data and the data discussed above is presented in Table V. Of the landslides identified by Schlicker and Finlayson, 7 are debris slides, 5 are debris flows, and 2 are stream-bank failures. This mapping covers the western-most portion of the watershed, where relief is modest or slight, a fact which helps to explain the smaller number of debris flows they identified. In addition, it is likely that field visits by these workers enabled them to identify small debris slides on the ground, explaining why a vastly higher percentage of the landslides they identified were debris slides compared to the percentage identified in this inventory.

All 8 cases of intense stream-bank erosion occur at the lower portion of the watershed where Eagle Creek transitions from a narrow, constricted channel to a wider floodplain. Above this transition zone, where the river is confined between more resistant rock, most of its available energy is used to deepen its channel. Below the transition zone, most of the river's available energy is spent as it meanders within its own deposits. Within the zone where intense stream-bank erosion occurs, the floodplain is not wide enough to prevent Eagle Creek from cutting laterally into the weak Sandy River Mudstone formation that forms the shallow valley walls. Indeed, as expected, all sites of intense stream-bank erosion are found at the outside edges of meander bends.

TABLE V. LANDSLIDE TYPES AND ASSOCIATIONS

71 landslides identified
- 11 ancient
- 60 recent
  - 45 debris flows
  - 9 debris slides
  - 3 stream-bank failures
  - 3 rockfall

  60

  - 9 associated with clearcuts (0-20 years old)
  - 3 associated with clearcuts and roads
  - 1 associated with clearcuts or quarrying
  - 1 associated with roads
  - 32 not associated with land management practices

  46*

*Total reflects only those landslides identified in this inventory, and not those identified by Schlicker and Finlayson (1979).

Although only 14 of the 46 landslides inventoried here are associated with land management practices, it is important to note that 21 of the landslides identified are located within the Salmon-Huckleberry Wilderness, where typical land management practices do not occur. When these landslides are not considered, the number of landslides associated with land management practices rises from 30 percent to 56 percent. It remains difficult, however, to divine the relationship between landslides and land management practices based on these data alone, primarily because it is not possible to control for certain variables such as the inherent stability of the managed and unmanaged landforms and the effects of the 1964 100-year storm.

Certain geologic conditions within the watershed are inherently unstable and merit special attention during project planning and field investigations. Some of these areas are listed below.

1. Contacts between weak and resistant rock. Changes in permeability at these contacts often result in springs or shallow groundwater tables. Altering the groundwater conditions in these areas can trigger debris slides and debris flows. Important contacts include the following:

   Contacts between weak rock and resistant rock on steep slopes (WRSS-RRSS contacts).

   Contacts between the upper and lower members of the Sardine Formation on steep slopes (IRSS-WRSS contacts).

   Contacts between unconsolidated material and the Troutdale Formation (UM-IR contacts) and contacts between unconsolidated material and the lower unit of the Sardine Formation (UM-WR

Contacts between the Troutdale Formation and the lower member of the Sardine Formation (IR-WR contacts).

2. Around the edges of the intrusions at Squaw Mountain and Lenhart Butte (Ta). The heat from these intrusions may have altered and weakened the adjacent rock making it more prone to mass wasting.

3. Along the margins of dikes and sills. As with intrusions, the heat associated with dike and sill emplacement tends to alter and weaken the adjacent rock making it more prone to mass wasting. Dikes and sills are not shown on the maps.

4. Along stream banks within the RRSS, IRSS, WRSS, and QLD landforms. Slumps, debris slides, and stream-bank failures may occur next to down-cutting or laterally-cutting streams. These types of failures are not usually visible on aerial photographs.

5. On slopes with gradients in excess of 60 percent where shallow soils overlie less permeable materials. Although these conditions may be met on many landforms, they are most common on landform types IRSS and WRSS. These conditions are prone to shallow failures.

6. Along the margins of ancient landslides or earthflows. Changes in groundwater levels near these margins often trigger debris slides, debris flows, and slumps.

7. On scarps of ancient landslides. These areas are steep, have shallow soils, and are prone to debris slides and debris flows. The scarps are not designated on the maps.

8. At the headlands of tributaries with steep gradients. Historically, many such areas have experienced debris flows, and those presently filled or filling with colluvium may fail with the slightest provocation.

9. In the vicinity of fault zones on steep slopes. Increased fracturing and weathering in these areas decreases stability.

There is some overlap among the geologic conditions listed above. The presence of these conditions does not automatically mean that the area is unstable, but it does mean that the area needs to be investigated carefully by an experienced geologist, geotechnical engineer, or geomorphologist during project-level planning.

LIMITS AND ASSUMPTIONS

1. Due to time constraints, only one field visit was made. During this visit, geologic rock types were grouped into weak, intermediate, and resistant categories, but landslides were not verified.

2. Natural rates of landslide occurrence were not determined.

3. Rates of sediment delivery were not calculated.

4. The connection between the 1964 100-year storm event and specific mass wasting events is assumed. It is possible that some of the landslides that appear to be associated with the storm actually occurred slightly earlier or later.

5. The hazard mapping of Schlicker and Finlayson (1979) was taken at face value. No "ground-truthing" of their work was done.

REFERENCES

Leonard, A.R., Collins, C.A., 1983: "Ground Water in the Northern Part of Clackamas County, Oregon," USGS Water Resources Department, Ground Water Report Number 29.

Peck, D.L., Griggs, A.B., Wells, F.G., Brown, R.D., Schlicker, H.G., Dole, H.M., 1964: "Geology of the Central and Northern Parts of the Western Cascade Range in Oregon," USGS Professional Paper 449.

Schlicker, H.G., Finlayson, C.T., 1979: "Geology and Geologic Hazards of Northwestern Clackamas County, Oregon," Oregon Department of Geology and Mineral Industries, Bulletin 99.

Eagle.4.pre

Eagle Creek Watershed Analysis Ruth Tracy

Hydrologic Change Peak Flow Module

1. The historical flood frequency for Eagle Creek and its subwatersheds were calculated using the equations in Magnitude and Frequency of Floods in Western Oregon by D.D. Harris, Larry L. Hubbard and Lawrence E. Hubbard, 1979 (Table 1).

2. Precipitation intensity for Eagle Creek watershed were estimated using the Log Pearson II analysis on precipitation data collected at Three Linx from 1931-1992. The following return period storms were estimated from this analysis.

Return Period (years)	Normal Storm Intensity (inches)	Unusual Storm Intensity (inches)
2	2.7	2.9
5	3.3	3.5
10	3.6	3.9
25	4.0	4.4
50	4.3	4.8
100	4.6	5.1

3. Average snow accumulation was estimated using the average snow accumulation data from 1985-1993 at Peavine Ridge Soil Conservation Service SNOTEL site. This station is located at elevation of 3500 ft. The average snow accumulation was 14.8 inches and the maximum snow accumulation was 23.0 inches. Due to the limited number of years of data at this station, the average and extreme estimations may not be accurate.

4. The storm temperature for each precipitation zone were approximated using maximum daily temperatures at Three Linx between November and April on days which had two or more inches of rain. There were 380 observations within the 32 years of daily observations available. The normal storm temperature was the maximum daily temperature that was exceeded 50% of the time and the unusual storm temperature was the maximum daily temperature that was exceeded only 15% of the time. The following storm temperatures were estimated for the 0-2399 foot precipitation zone from the frequency analysis. The other two precipitation zones were approximated using the constant of 3.5 ° F increase with 1,000 feet increase in elevation and estimating for the mean elevation of the precipitation zone.

Precipitation Zone (feet)	Normal Storm Temperature (° F)	Unusual Storm Temperature (° F)
0000-2399	45.0	50.0
2400-4799	36.6	41.6
4800-6000	32.4	37.4

5. The average and unusual storm wind speed was approximated using average daily wind speed at the Wanderers Peak RAWS station between November and April. There were 887 observations within the 5 years of data. The average storm wind speed was considered the wind speed that was exceeded 50% of the time and the unusual storm wind speed was considered the wind speed that was exceeded 15% of the time. The wind speed of the average storm in Eagle Creek is 5 miles per hour and 13 miles per hour for the unusual storm.

6. Flood frequency analysis adjusted for land management activities were accomplished using the method outlined in the Washington State Department of Natural Resources' Conducting Watershed Analysis Manual. Neither of the two subwatersheds within the transient snow zone response to rain-on-snow zone have been affected by management activities (Tables 2 and 3).

Eagle Creek Watershed

	Recurrence Interval - Flow (cfs)					
	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Eagle Creek Watershed	3697	5675	6987	8797	10234	11716
Subwatersheds						
Lower Mainstem (subwatershed contribution)	731	1101	1355	1707	1985	2273
North Fork	1343	2038	2509	3159	3675	4207
Delph Creek	649	976	1202	1514	1761	2016
Middle Mainstem (at confluence w/ Delph Cr.)	1890	2844	3502	4410	5130	5873
Middle Mainstem (subwatershed contribution)	480	719	885	1115	1297	1485
South Fork	431	646	795	1001	1164	1333
Upper Mainstem	979	1480	1822	2294	2668	3055

Eagle Creek Watershed Analysis by Ruth Tracy, Hydrologist 26-Jun-95

South Fork		Water Available		Flow (cfs) from WAR			Flow (cfs)	
Recurren Interval	Storm Intensity	Fully Forested	Existing Condition	Fully Forested	Existing Condition	Percent Increase	USGS Predicted	Existing Condition
2	Average	3.6	3.7	995	1050	6	431	455
2	Unusual	4.7	4.8	1356	1403	3	431	446
5	Average	4.3	4.3	1381	1381	0	646	646
5	Unusual	5.4	5.5	1681	1727	3	646	664
10	Average	4.6	4.6	1546	1546	0	795	795
10	Unusual	5.9	5.9	1913	1913	0	795	795
25	Average	5.1	5.1	1822	1822	0	1001	1001
25	Unusual	6.4	6.5	2145	2191	2	1001	1023
50	Average	5.4	5.4	1987	1987	0	1164	1164
50	Unusual	6.9	6.9	2377	2377	0	1164	1164
100	Average	5.7	5.7	2153	2153	0	1333	1333
100	Unusual	7.2	7.3	2516	2562	2	1333	1358

Eagle Creek Watershed Analysis by Ruth Tracy, Hydrologist 26-Jun-95

Upper Mainstem		Water Available Runoff		Flow (cfs) from WAR			Flow (cfs)	
Recurrence Interval	Storm Intensity	Fully Forested	Existing Condition	Fully Forested	Existing Condition	Percent Increase	USGS Predicted	Existing Condition
2	Average	3.6	3.6	2278	2278	0	979	979
2	Unusual	4.7	4.7	3108	3108	0	979	979
5	Average	4.3	4.3	3165	3165	0	1480	1480
5	Unusual	5.4	5.4	3855	3855	0	1480	1480
10	Average	4.6	4.6	3546	3546	0	1822	1822
10	Unusual	5.9	5.9	4389	4389	0	1822	1822
25	Average	5.1	5.1	4180	4180	0	2294	2294
25	Unusual	6.4	6.4	4923	4923	0	2294	2294
50	Average	5.4	5.4	4560	4560	0	2668	2668
50	Unusual	6.9	6.9	5456	5456	0	2668	2668
100	Average	5.7	5.7	4941	4941	0	3055	3055
100	Unusual	7.2	7.2	5777	5777	0	3055	3055

Eagle Creek Watershed Analysis by Ruth Tracy, Hydrologist 26-Jun-95

Sediment Erosion Module

Sediment delivery to streams from roads, timber harvest and agriculture activity were estimated using the method outlined in Washington State Department of Natural Resources' Conducting Watershed Analysis Manual. This module estimated sediment erosion from earth disturbing activities using erodibility ratings based on soil information (slope and K factor) and contributing factors such as timber harvest, broadcast burning, or scarification for site preparation. Sediment delivery was then estimated from areas that were within 200 feet of a stream.

In this module, sediment erosion from roads were predicted from erosion rates based on parent material, the area the road occupies and the protection provided by cover materials such as cut and fill vegetation or surface type which reduce the exposure of soil to rainfall and traffic wear. Sediment delivery from roads was considered 100% from road segments that directly drain into a stream via a ditch and 10% from road segments with culvert outflow that is less than 200 feet from a stream.

ARC/INFO was used to determine areas that were within 300 feet of streams and had recent timber harvest (1990-1994) or are commercial agriculture lands. Vegetative recovery was assumed for timber harvest units that were harvested prior to 1990 (5 years). Land units coded as small agriculture or small woodlot were considered full vegetated in the analysis due to the lack of information to determine vegetative ground cover conditions.

Similarly, ARC/INFO was used to determine which roads intersected with streams and which roads were within 300 feet of a stream but were not intersecting. In the Eagle Creek Watershed, sediment transport via overland flow from culvert out flow was considered to deliver sediment to streams if the road was within 300 feet of the stream. This increase in distance of sediment delivery is based on local knowledge of the watershed. All roads were considered to have fully vegetated cut and fill slopes due to the lack of information on actual conditions. Road segments within this watershed had varying levels of attribute information due to the three different sources (Forest Service, Bureau of Land Management, and Clackamas County). Therefore only the road surface type was used as a factor for protection cover from exposure to rainfall and traffic wear.

The basic erosion rates were used to estimate sediment erosion from recent timber harvest and active agriculture activity along with the roads due to the lack of soil information (K-factor) on all areas within the watershed to determined soil erosion rates for the timber harvest and agricultural activity. A benefit of the departure from the DNR module is sediment delivery rates from roads and timber harvest and agricultural activity are more comparable. The Guide for Predicting Sediment Yield form Forested Drainage Basins (USDA, 1981) describes methods for computation of the basic erosion rates.

Results from this module have not been validated on the Mt. Hood National Forest, although the module is based on current scientific understanding of forest management and watershed processes. Results should be used to compare among subwatersheds and among watersheds if similar ARC/INFO queries and assumptions have been made. Results also provide the relative delivery of sediment from roads, timber harvest and other earth disturbing activities.

The results are considered an increase in sediment delivery over natural rates since natural rates for forested lands are considered low (Swanson and Grant 1982).

Sediment delivery rates were estimated by subwatershed. Absolute sediment delivery quantities for both road segments and areas with either recent timber harvest or commercial agricultural activities were categorized into high, moderate or low (Tables 1 and 2). Areas of high sediment delivery were then mapped to show the locations of the road segments or areas with high sediment delivery. The roads segments designated as high sediment delivery on Federal Lands were reviewed to assess the need for restoration.

Table 1. Road Lengths Delivering High vs. Mod-Low Rates of Sediment to Streams

Subwatershed	Rating	Sediment Delivered		Road Length Delivering	
		Tons/year	%	Miles	%
Lower Mainstem	high	16.1	36	6.8	31
	mod-low	29.2	64	15.0	65
North Fork	high	34.7	31	1.9	4
	mod-low	68.3	66	39.1	90
Delph Creek	high	24.9	35	10.1	34
	mod-low	37.2	59	17.2	60
Middle Mainstem	high	10.1	34	3.5	24
	mod-low	20.0	66	11.0	71
Upper Mainstem	high	0.8	32	0.5	31
	mod-low	1.7	67	1.1	56
South Fork	high	1.0	12	0.8	10
	mod-low	7.4	87	7.0	88

Table 2. Recent Timber Harvest and Commercial Agriculture Activity Delivering High vs. Moderate or Low Rates of Sediment to Streams

Subwatershed	Rating	Sediment Delivered		Area Delivering	
		Tons/year	%	Acres	%
Lower Mainstem	high	518.9	65	571	65
	mod-low	281.6	35	313	35
North Fork	high	342.6	48	398	47
	mod-low	377.6	52	451	53
Delph Creek	high	524.4	71	511	71
	mod-low	210.4	29	211	29
Middle Mainstem	high	186.6	74	162	68
	mod-low	65.2	26	75	32
Upper Mainstem	high	0.0	0	0	0
	mod-low	4.3	100	5	100
South Fork	high	0.0	0	0	0
	mod-low	22.9	100	40	100

ASSLwd

Large Woody Debris Recruitment (LWD)

Assumptions for the LWD recruitment model can be found in the Washington Forest Practice Board (1993) (WFPB). In addition to the assumptions provided, the following was taken in to account for the application of the model during the LWD recruitment analysis for the Eagle Creek Watershed.

-LWD recruitment analysis included data which was within the entire riparian reserve buffers, rather than within 66 feet of the stream as called for in the Washington Forest Practice Board. Therefore, LWD recruitment potential for this analysis estimates LWD within the entire riparian reserves.

-Dominant tree species definitions were determined by using Eagle Creek Watershed Analysis's vegetation databases layer field (hardwood level) HWDLVL. The data base was queried as follows: hardwood level < three = conifer dominated, hardwood level > six but < 10 = hardwood dominated, and hardwood level > two but < seven = mixed.

-Tree size classifications were determined by using Eagle Creeks Watershed Analysis's vegetation databases layer field SIZECLASS.

-Seral stages rather than tree age was used in the WFPB model. All EARLY SERAL stage was classified as YOUNG, MID-SERAL stage as SMALL, and LATE SERAL as LARGE.

-Density was determined by using Eagle Creeks WA vegetation databases layer field STOCKCLASS.

- Density is sparse if less than 70% of the ground is exposed. Otherwise, it is dense.

-STOCKCLASS data fields used included: 0, 1, 2 = sparse, 3 = dense.

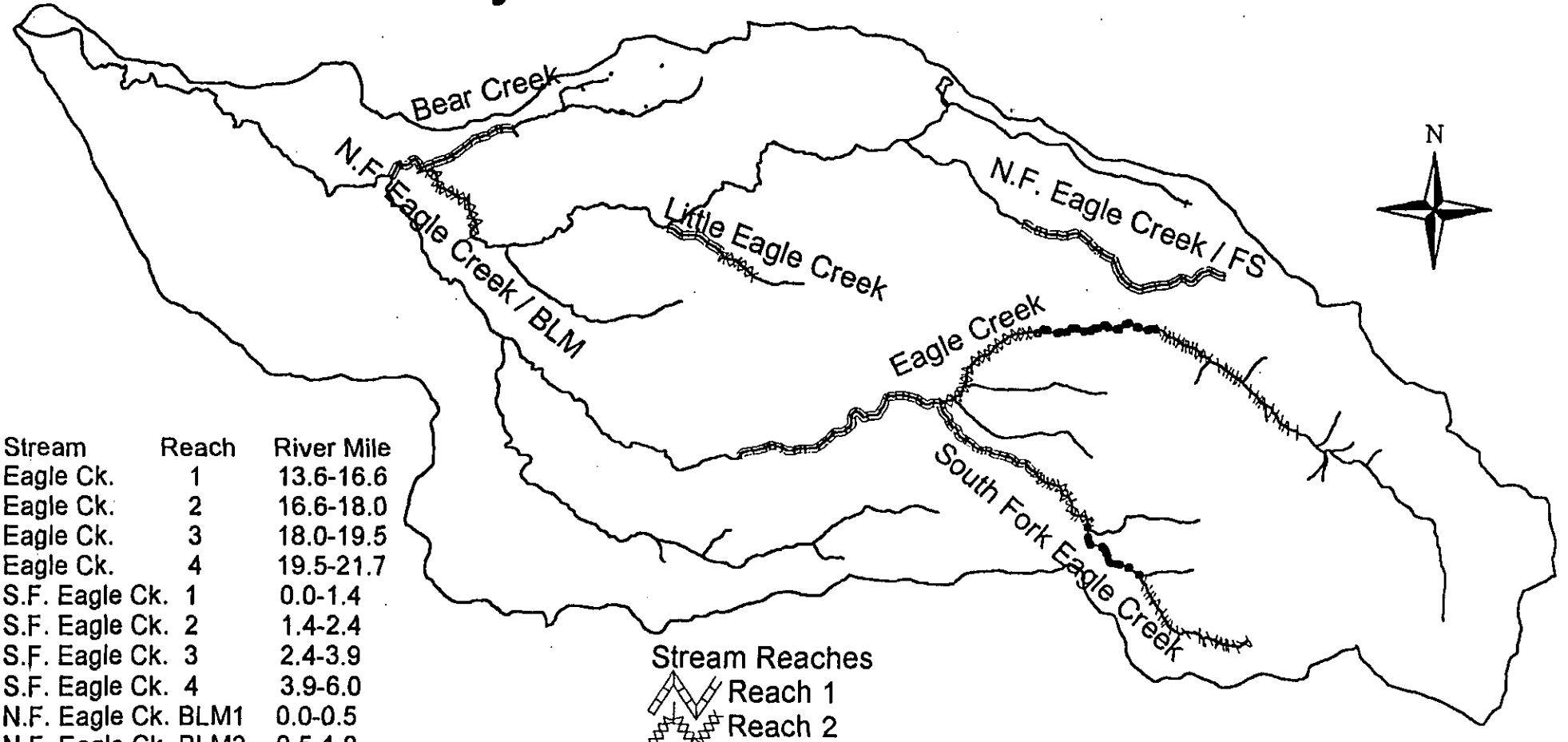
This information was then combined to form the following table to assign high, medium, and low large woody debris recruitment potential.

Table 3. Riparian LWD Recruitment Potential and Seral Stage

Dominant Tree Type	Seral Stage and Density					
	Young		Small		Large	
	Sparse	Dense	Sparse	Dense	Sparse	Dense
Conifer	L	M	M	H	M	H
Mixed	L	L	L	H	M	H
Hardwood	L	L	L	M	L	M

Eagle Creek Watershed

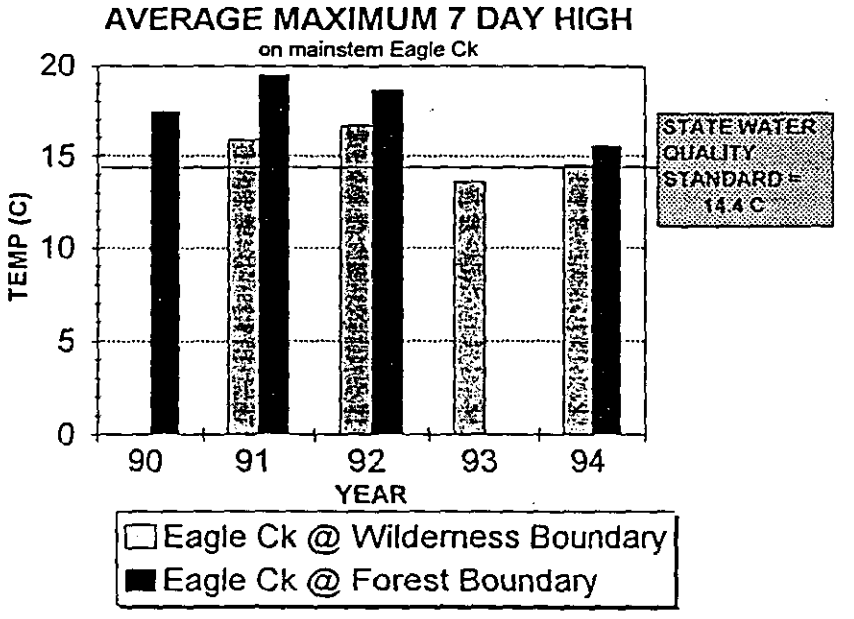
Surveyed Stream Reaches

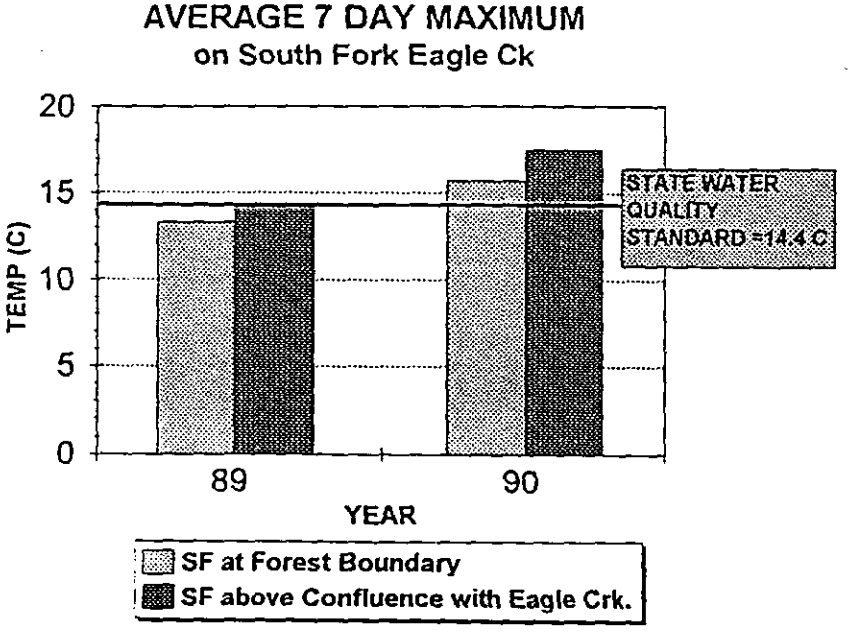


Stream	Reach	River Mile
Eagle Ck.	1	13.6-16.6
Eagle Ck.	2	16.6-18.0
Eagle Ck.	3	18.0-19.5
Eagle Ck.	4	19.5-21.7
S.F. Eagle Ck.	1	0.0-1.4
S.F. Eagle Ck.	2	1.4-2.4
S.F. Eagle Ck.	3	2.4-3.9
S.F. Eagle Ck.	4	3.9-6.0
N.F. Eagle Ck.	BLM1	0.0-0.5
N.F. Eagle Ck.	BLM2	0.5-1.8
N.F. Eagle Ck.	FS1	9.0-12.0
Bear Ck.	1	0.0-1.0
Little Eagle	1	0.0-0.5
Little Eagle	2	0.5-1.2

MAP A-1

temporal


AVERAGE MAXIMUM 7 DAY HIGH
on mainstem Eagle Ck
20
15
10
5
0
TEMP (C)
90
91
92
93
94
YEAR
STATE WATER QUALITY STANDARD = 14.4 C
Eagle Ck @ Wilderness Boundary
Eagle Ck @ Forest Boundary


AVERAGE 7 DAY MAXIMUM
on South Fork Eagle Ck
20
15
10
5
0
TEMP (C)
89
90
YEAR
STATE WATER QUALITY STANDARD =14.4 C
SF at Forest Boundary
SF above Confluence with Eagle Crk.

(4)

ASSRNV

Range of Natural Variability (RNV) Estimates of Stream Habitat Attributes

Method Summary:
Stream survey data was collected from several Ranger Districts within the Williamette Basin. Region 6 stream survey protocals were used for all streams on which data was collected. Data from streams used for this analysis included only streams in unmanaged or wilderness areas. The data was grouped by stream order. Box and Whisker Plots were developed to provide an estimate of the RNV for the following stream attributes: large woody debris (LWD), small wooody debris (SWD), primary pools, and total pools.

Limitations:
1. Channel geomorphic type (ie Rosgen channel classification sytem) was not available with the surveys supplied. Therefore, stream order was used to best group like systems.

2. Sample sizes were small for comparison purposes. Sample size of 2nd order streams were = 10, 3rd order = 15, 4th order = 17.

3. Different stream surveyors were collecting data.

4. There was no plant association (ie Western Hemlock zone, Pacific Silver zone) available to further group like systems.

5. Although streams which were used for comparison were either unmanaged or wilderness streams, fire history was not evaluated. Some of these streams may have had either natural or human ignited fires. Further, it is impossible to determine whether or not fire suppression may have had an indirect impact by suppressing natural fires leading to an unatural buildup of woody material and understory.

delphiL

FISH RELEASED WITHIN THE EAGLE CREEK WATERSHED

(source: Doug Dysart, Eagle Creek National Fish Hatchery Manager)

Release site:Delph Creek Fish Hatchery

WINTER STEELHEAD

Release Year	Fry	Pre-Smolt	Smolt
1948	0	43,830	0

FALL CHINOOK

Release Year	Fry	Pre-smolt	Smolt
1945	0	0	184,224
1946	0	0	0
1947	0	0	0
1948	0	0	0
1949	0	0	769,470
1950	0	0	612,675
1951	0	0	295,135
1952	0	0	406,610
1953	0	0	363,885
1954	0	0	195,165
TOTALS	**0**	**0**	**2,827,164**

Spring Chinook

Release Year	Fry	Pre-smolt	Smolt
1943	0	0	56,770
1944	0	0	0
1945	0	0	21,985
1946	0	0	0
1947	0	0	0
1948	0	0	9,110
1949	0	0	58,290
1950	0	0	12,400
1951	0	0	134,260
1952	0	0	52,070
1953	0	0	32,255
1954	0	0	20,655
TOTALS	**0**	**0**	**397,795**

COHO SALMON

Release Year	Fry	Pre-smolt	Smolt
1948	0	43,830	0

FISH RELEASED WITHIN THE EAGLE CREEK WATERSHED

(Source: Clackamas River Subbasin Fish Management Plan)

EARLY RUN COHO Bear Creek

Release Year	Fry	Pre-Smolt	Smolt	Adult
1983	37,600	0	0	0
1984	0	31,031	0	0
1985	0	30,652	0	0
1987	0	30,080	0	0
TOTALS	37,600	91,763	0	0

EARLY RUN COHO Grabenheim Creek

Release Year	Fry	Pre-Smolt	Smolt	Adult
1983	0	0	0	0
1987	0	30,040	0	0
TOTALS	0	30,040	0	0

EARLY RUN COHO Delph Creek

Release Year	Fry	Pre-Smolt	Smolt	Adult
1962	0	87,000	0	0
1981	188,200	0	0	0
1983	111,625	0	0	0
1985	0	51,986	0	0
1986	0	0	0	100
1986	0	85,425	0	0
1987	0	68,400	0	0
1986	0	16,080	0	0
TOTALS	299,825	308,891	0	100

EARLY RUN COHO Trout Creek

Release Year	Fry	Pre-Smolt	Smolt	Adult
1983	24,675	0	0	0
1984	0	24,640	0	0
1985	0	30,294	0	0
1987	0	30,080	0	0
TOTALS	24,675	85,014	0	0

EARLY RUN COHO Eagle Creek

Release Year	Fry	Pre-Smolt	Smolt	Adult
1958	0	410,000	0	0
1959	0	0	80,717	0
1960	0	0	282,604	0
1961	0	0	1,169,804	0
1962	0	0	600,000	0
1963	0	0	599,479	0
1964	0	0	455,660	0
1964	0	653,867	0	0
1966	0	0	695,377	0
1967	0	1,038,515	0	0
1968	0	0	1,443,200	0
1969	0	0	736,000	0
1970	0	0	1,148,852	0
1970	184,092	0	0	0
1971	0	0	1,452,366	0
1971	0	207,500	0	0
1971	549,000	0	0	0
1972	0	0	1,750,271	0
1972	798,606	0	0	0
1973	0	0	1,119,296	0
1973	1,126,587	0	0	0
1974	0	0	2,000	0
1974	0	0	1,093,070	0
1975	0	250,000	0	0
1975	0	0	1,320,155	0
1976	0	0	1,053,613	0
1977	0	0	1,505,959	0
1978	0	0	1,267,044	0
1979	0	0	1,201,840	0
1980	0	0	1,574,171	0
1981	0	0	939,811	0
1982	0	0	929,274	0
1983	0	0	573,512	0
1984	0	0	1,030,354	0
1985	0	129,360	0	0
1985	0	0	1,022,505	0
1986	0	0	782,372	0
1987	0	0	805,821	0
1988	0	226,093	0	0
1988	0	0	1,006,329	0

EARLY RUN COHO Eagle Creek (cont.)

1989	0	0	1,053,162	0
1990	0	0	1,012,793	0
1991	0	0	1,196,823	0
1992	0	0	1,087,346	0
1993	0	0	1,060,888	0
1994	0	0	980,327	0
1995	0	0	988,000	0
TOTALS	2,658,285	2,915,335	35,020,795	0

EARLY RUN COHO Little Eagle Creek

Release Year	Fry	Pre-Smolt	Smolt	Adult
1983	24,675	0	0	0
1987	0	39,900	0	0
TOTALS	24,675	39,900	0	0

EARLY RUN COHO North Fork of Eagle Creek

Release Year	Fry	Pre-Smolt	Smolt	Adult
1961	0	100,875	0	0
1962	0	100,036	0	0
1981	61,655	0	0	0
1983	172,526	0	0	0
1984	0	81,200	0	0
1984	0	11,935	0	0
1985	0	93,198	0	0
1985	0	15,326	0	0
1986	0	10,050	0	0
1960	0	0	75,874	0
1963	0	96,450	0	0
1964	0	0	99,587	0
1986	0	90,450	0	0
1987	0	82,460	0	0
1987	0	9,964	0	0
TOTALS	234,181	691,944	175,461	0

TOTAL COHO RELEASED

Fry	Pre-Smolt	Smolt	Adult
3,279,241	4,162,887	35,020,995	100

Echinel

FISH RELEASED WITHIN THE EAGLE CREEK WATERSHED

(source: Doug Dysart, Eagle Creek National Fish Hatchery Manager)

FALL CHINOOK: Released at Eagle Creek National Fish Hatchery

Release Year	Fry	Pre-smolt	Smolt
1957	0	0	1,757,482
1958	0	0	1,738,258
1959	3,084,145	0	2,601,066
1960	1,012,607	0	2,890,274
1961	0	0	2,193,611
1962	0	0	0
1963	0	0	2,435,531
TOTALS	**4,096,752**	**0**	**13,616,222**

Spchnk 8

FISH RELEASED WITHIN THE EAGLE CREEK WATERSHED

(source: Clackamas River Subasin Fish Management Plan)

SPRING CHINOOK Eagle Creek

Release Year	Fry	Pre-smolt	Smolt
1959	0	604,910	0
1960	0	749,100	0
1961	0	533,372	0
1962	0	108,945	0
1963	0	882,963	0
1964	0	1,108,825	0
1964	0	99,300	0
1964	0	3,013	0
1964	0	2,458,783	0
1966	0	1,386,951	0
1967	0	1,813,431	0
1968	0	1,404,000	0
1969	0	1,157,613	0
1970	0	0	620,853
1970	0	0	14,122
1970	0	0	15,400
1971	0	460,150	0
1972	0	0	75,388
1973	0	0	953,232
1973	0	0	857
1974	0	0	552,510
1975	0	0	289,710
1975	0	0	316,860
1976	0	0	848,650
1977	0	0	251,943

SPRING CHINOOK Eagle Creek

Release Year	Fry	Pre-Smolt	Smolt
1977	0	0	377,392
1977	0	0	465,247
1977	0	0	9,652
1978	0	0	782,473
1979	0	0	421,327
1980	0	0	402,144
1981	0	0	940,647
1981	0	61,830	0
1981	0	158,960	0
1981	0	31,461	0
1982	0	0	518,204
1982	0	0	71,420
1983	0	0	540,308
1983	0	66,370	0
1983	0	0	179,315
1984	0	0	455,570
1983	0	0	207,859
1985	0	0	1,276
1985	0	0	411,191
1985	0	0	221,047
1986	0	0	255,052
1986	0	0	221,628
1986	52,773	0	0
1987	0	0	207,845
1987	0	0	309,102
1990	352,238	0	0
1991	556,214	0	0
TOTALS	961,225	318,621	6,156,060

stlhdrel

Table —
WINTER STEELHEAD RELEASED WITHIN THE EAGLE CREEK WATERSHED Release site:Eagle Creek National Fish Hatchery.

Release Year	Fry	Pre-smolts	Smolts
1959	0	0	39,747
1960	0	0	293,120
1961	0	0	147,300
1962	0	0	231,264
1963	0	0	151364 (ECNFH) 102,200 (NFEagle)
1964	0	52,665	265,629
1965	0	0	72,280
1966	0	0	213,233
1967	0	0	228,285
1968	0	0	264,500
1969	272,000	0	341,353
1970	442,000	372,000	204,520
1971	0	0	138,408
1972	17,295	0	316,623
1973	211,329	0	204,820
1974	0	0	234,750
1975	13,312	0	96,890
1976	0	0	119,382
1977	0	0	95,843
1978	0	0	112,920
1979	0	0	165,914
1980	0	127,053	165,841
1981	0	0	148,900

1982	0	0	100,796
1983	0	0	111,388
1984	0	0	99,758
1985	0	0	153,740
1986	0	0	156,144
1987	0	0	169,412
1988	0	0	155,422
1989	0	74,546	148,800
1990	0	0	169,325
1991	0	0	167,040
1992	0	0	150,844
1993	0	0	188,106
1994	0	0	195,633
1995	0	0	157,464
TOTALS	**955,936**	**626,264**	**6,376,758**

trout rel 4

Table --Rainbow Trout Released within the Eagle Creek Watershed

Release Year	Total Number Released at Eagle Fern Park in mainstem of Eagle Creek	Total Number Released at BLM campground in North Fork of Eagle Creek
1948	5,000	0
1949	3,000	0
1950	7,969	0
1951	3,952	0
1952	5,901	0
1953	7,353	0
1954	7,991	0
1955	6,047	0
1956	5,181	0
1957	4,195	0
1958	7,648	0
1959	5,003	0
1960	5,001	0
1961	0	0
1962	3,996	0
1963	4,145	0
1964	2,996	0
1965	3,002	0
1966	3,007	2,506
1967	3,004	2,001
1968	3,003	1,499
1969	2,503	2,077

1970	3,002	2,002
1971	3,000	1,499
1972	3,251	1,252
1973	3,000	1,500
1974	3,003	1,504
1975	3,005	1,502
1976	3,004	1,506
1977	3,003	1,501
1978	3,005	1,504
1979	3,000	1,500
1980	3,003	1,504
1981	3,060	1,500
1982	3,000	1,497
1983	3,004	1,512
1984	2,989	1,509
1985	2,999	1,499
1986	2,994	1,499
1987	3,026	1,504
1988	3,002	1,502
1989	3,009	1,495
1990	3,025	1,495
1991	3,005	1,456
1992	2,998	1,500
1993	2,983	1,493
1994	3,007	1,504
1995	0	0
TOTAL:	175,274	45,822

Appendix D

Acknowledgements

Appendix D
Participants

Core Team

Cindy Froyd, Forest Service, German Paleo Botanist
Tracii Hickman, Forest Service, Team Leader
Wayne Logan, Bureau of Land Management, Wildlife Biologist
Ruth Tracy, Forest Service, Physical Processes Ecologist
Deborah Urich, Forest Service, Aquatic Ecologist
Ron Wanek, Forest Service, GIS Analyst
Leo Yanez, Forest Service, Terrestrial Ecologist

Key Personnel

Bruce Ahrendt, Bureau of Land Management, GIS Analyst
Pat Greene, Forest Service, Landscape Architect
Randy Gould, Bureau of Land Management, Associate Team Leader

Acknowledgements

John Berry, Forest Service, District Ranger
Tom DeRoo, Forest Service, Geologist
Lucy Wold, Forest Service, Fish Biologist
Cyndi Baker, Forest Service, Fish Biologist
Dan Shively, Forest Service, Fish Biologist
Mark Koski, Bureau of Land Management, GIS Analyst
Rich Hagestedt, Forest Service, GIS Analyst
Sue Helgeson, Forest Service, Fish Biologist
Dave Roberts, BLM, Fish Biologist
Pat Keely, ODFW Fish Biologist
Jay Massey, ODFW Fish Biologist
Doug Dysart, Eagle Creek National Fish Hatchery Manager
Dan Newberry, Forest Service, Hydrologist
Salmon River Watershed Analysis Team
Bob Johnson, Forest Service, Silviculture
Jamie Bradbury, Forest Service, GIS Analyst
John Davis, Forest Service, Silviculture
Keith Conaway, Forest Service, Forestry Technician
Mary Bernard, Forest Service, Fish Biologist
Joyce Johnson, Forest Service, GIS Specialist
Terry Beahan, Forest Service, Forester
Denise LA, Volunteer
Shelly Butler, Forest Service, Silviculture
Ed Hendrix, Longview Fiber, Forester
Darrell Foster, BLM Cruiser
Wayne Barney, BLM, GIS Specialist
Jeanne Rice, Forest Service, Stewards
Craig Edberg, Forest Service, Stewards