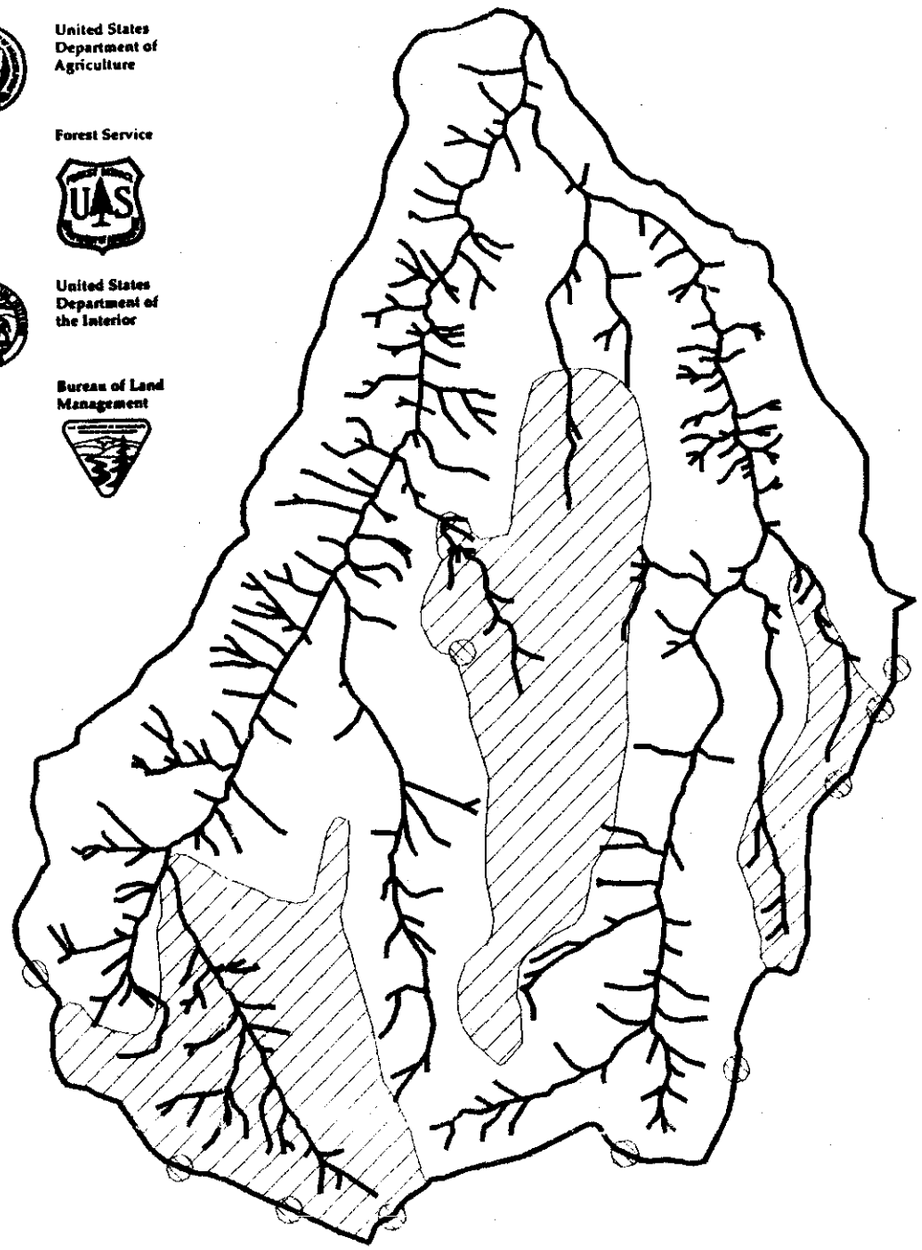
United States Department of Agriculture

Forest Service

United States Department of the Interior

Bureau of Land Management



South Fork Clackamas River WATERSHED ANALYSIS

Final Report
February 1997

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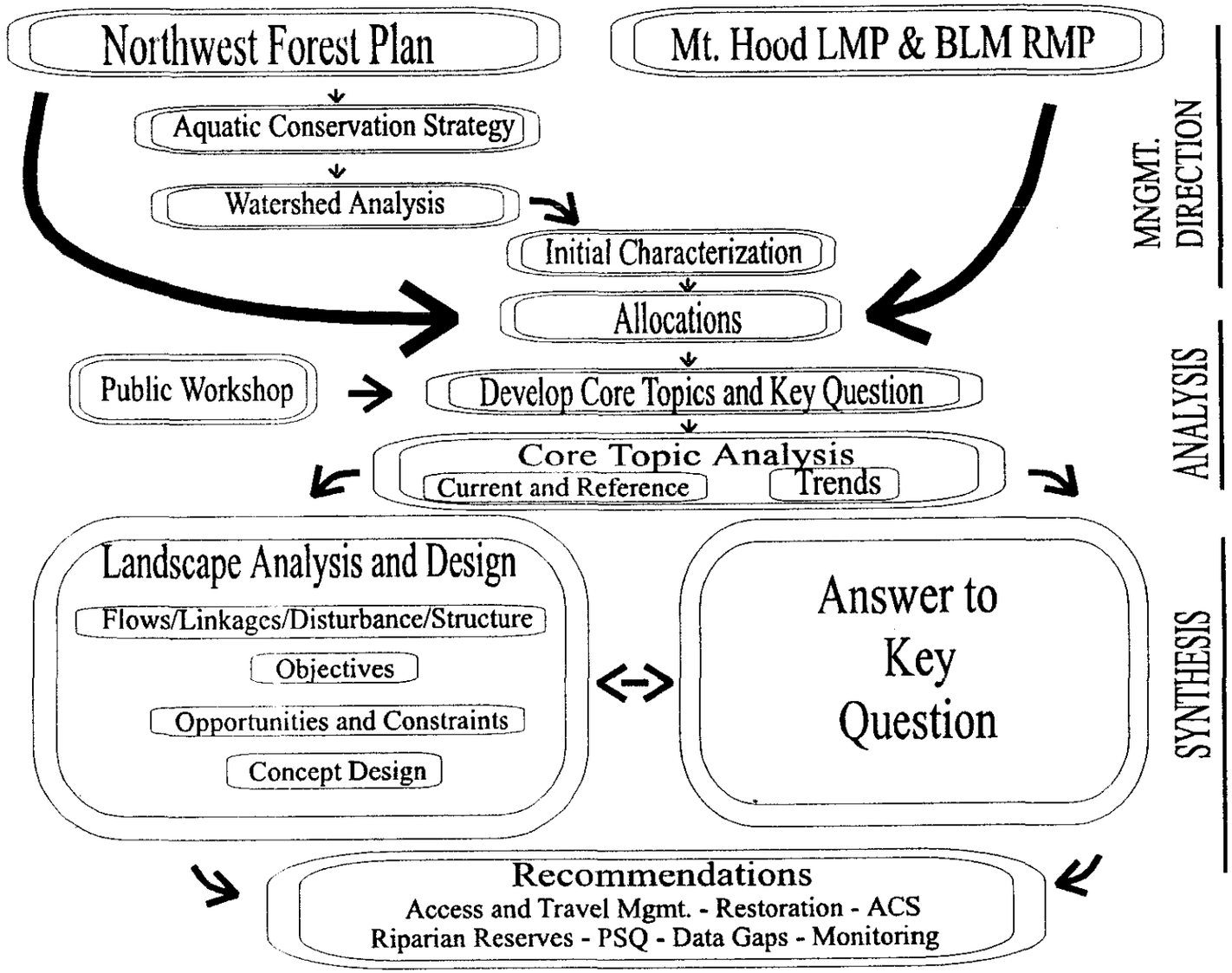
Chapter 1
Introduction



Introduction

Overview of Watershed Analysis

Watershed analysis is a procedure used to characterize the human, aquatic, riparian, and terrestrial features; and conditions, processes, and interactions within a watershed. It provides a systematic way to understand and organize ecosystem information. In so doing, watershed analysis enhances our ability to estimate direct, indirect, and cumulative effects of our past management activities and guide the general type, location, and sequence of appropriate future management activities within a watershed.

"Watershed analysis is not a decision making process. Rather it is a stage setting process."

Watershed analysis is essentially ***ecosystem analysis at the watershed scale***. As one of the principal analyses for implementing the Aquatic Conservation Strategy (ACS) set forth in the Northwest Forest Plan (Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, USDA, USDI, 1994) it provides the watershed context for fishery protection, restoration, and enhancement efforts. The understanding gained through watershed analysis is critical to sustaining the health and productivity of natural resources. Healthy ecological functions are essential to maintain and create current and future social and economic opportunities.

Federal agencies are conducting watershed analyses to shift their focus from species and sites to the ecosystems that support them in order to understand the consequences of management actions before implementation. The watershed scale was selected because every watershed is a well defined land area having a set of unique features, a system of recurring processes, and a collection of dependent plants and animals.

Watershed analysis is not a decision making process. Rather it is a stage setting process. The results of watershed analysis establish the context for subsequent decision making processes, including planning, project development, and regulatory compliance.

The results of watershed analysis can be used to:

* Assist in developing ecologically sustainable programs to produce water, timber, recreation and other commodities.

* Facilitate program and budget development by identifying and setting priorities for social, economic, and ecological needs within and among watersheds.

* Establish a consistent, watershed-wide context for project level National Environmental Policy Act (NEPA) analyses.

* Establish a watershed context for evaluating management activity and project consistency given existing plan objectives.

* Establish a consistent, watershed-wide context for implementing the Endangered Species Act and the Federal Clean Water Act.

Process and Document Organization

The process that was followed for the South Fork Watershed Analysis is shown in Figure 1-1. Each chapter begins with this diagram and highlights the corresponding step in the watershed analysis process. The document is organized around the four primary

steps in the process: core topic analysis, landscape analysis and design, answers to key question, and recommendations.

Chapter 2 presents the analysis of core topic areas, as identified in Ecosystem Analysis at the Watershed Scale: Federal Guide for Watershed Analysis (USDA, USDI 1995). The core topic questions focus the basic analysis of ecological conditions, processes, and interactions at work in the watershed. Current and reference conditions and future trends are examined for each core topic area. The core topics address the major ecological elements that are common to all watersheds. This is the basic analysis that is addressed in every watershed analysis document. Level of detail for each core topic is based on watershed specific issues.

Chapter 3 (Landscape Analysis and Design) and Chapter 4 (Key Question) synthesize information gained in the core topic analysis and integrate it with management direction from the Northwest Forest Plan, Mt. Hood National Forest Land and Resource Management Plan (Mt. Hood Forest Plan), and Bureau of Land Management Resource Management Plan (RMP).

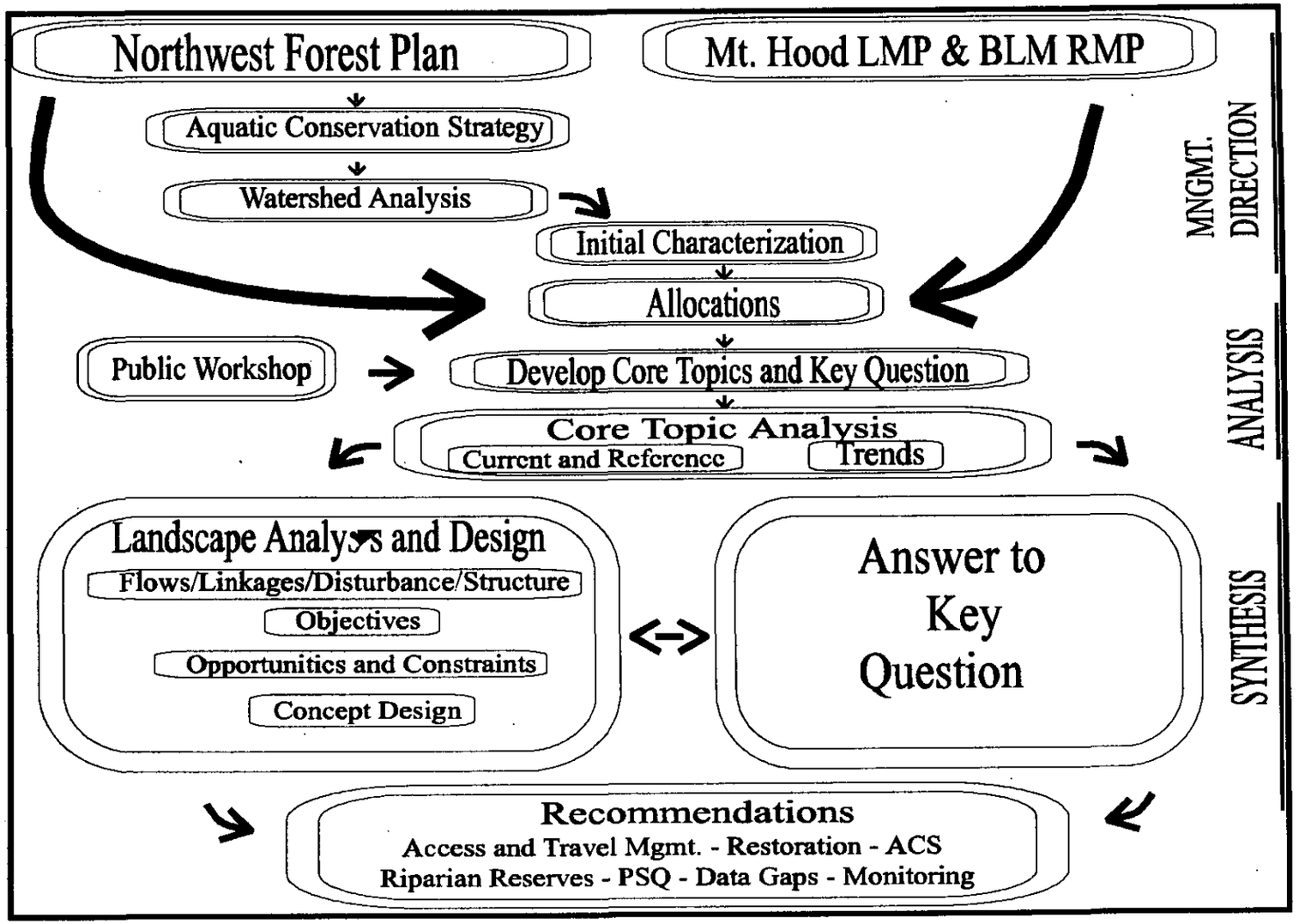
The Landscape Analysis and Design (LAD) process (Diaz and Apostol, 1992) integrates the principles of landscape ecology with forest planning through the conscious design of vegetation and infrastructure patterns based on watershed level desired future conditions, as described in the Northwest Forest Plan, Mt. Hood Forest Plan, and the BLM RMP. The results of watershed analysis are combined with management direction to give a picture of future conditions in the watershed and the ability of the watershed to meet ecological and social objectives.

LAD (Chapter 3) gives a graphic depiction of the vegetation patterns conceptually over the long term (Concept Design) given current conditions, coupled with management direction. Future projects can be evaluated against the Concept Design to see if they help achieve the desired future conditions of the watershed given in the various land management planning documents.

Chapter 4, Key Question, presents the answers to the Key Question. This question was developed around the key issues for the watershed. They are the issues that are of primary concern and are unique to the South Fork watershed. The answer to the Key Question synthesizes and examines interrelationships between the information presented by core topic area in Chapter 2 and LAD (Chapter 3). Recommendations are made to address problems identified in the Key Question.

Chapter 5, Recommendations, summarizes recommendations derived from the Key Question and LAD. The recommended Riparian Reserve system, restoration projects, compliance with the Aquatic Conservation Strategy (ACS), data gaps, and monitoring are all presented in this chapter. There is also an analysis of Probable Sale Quantity (PSQ), examining the amount of timber volume that can be produced in the South Fork watershed. Chapter 5 also contains the Access and Travel Management Plan (ATM), depicting the long term road infrastructure system in the watershed.

Figure 1-1
Process Diagram



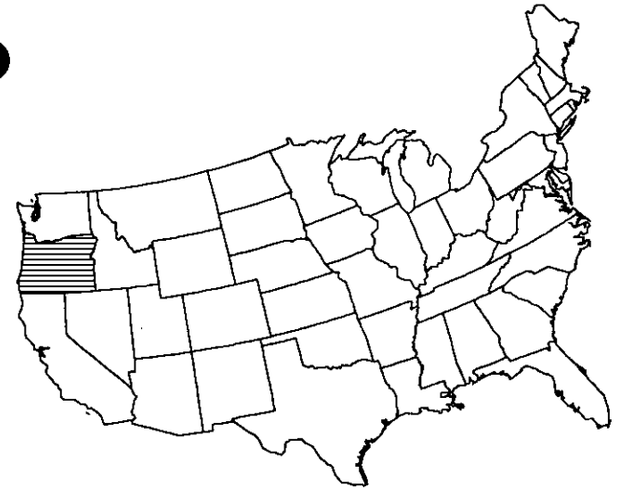
South Fork Clackamas River watershed is located in western Oregon on the west slope of the Cascade Range and is a one hour drive from the Portland Metropolitan area in Clackamas County (Map 1-1). There is a mix of ownership in the watershed (Map 1-2 and Map 1-3) with the majority of the land, (79%) administered by the Mt. Hood National Forest (Clackamas River Ranger Districts). The Bureau of Land Management also administers approximately 18% of the watershed and 3% of the watershed is in private ownership.

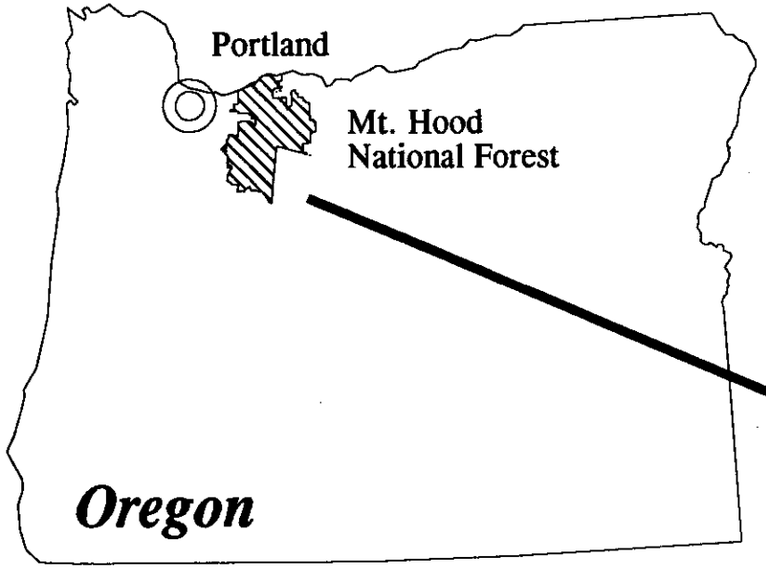
The South Fork Clackamas River watershed is approximately 17,648 acres in size and is one of the smallest watersheds of the Clackamas River drainage. The watershed is oriented north to south and is comprised of two major drainages. The South Fork of the Clackamas River and Memaloose Creek which flow northward to the Clackamas River. Elevations range from 4,485' at South Fork Mountain to 650' at the confluence of the South Fork River with the Clackamas River. The terrain is generally rugged and ranges from steeply incised valley walls to broad, flat ridges. The two main drainages in the watershed are moderately incised in the upper reaches, but canyon-like in the lower reaches. They are separated by a broad, resistant ridge that spans nearly the entire distance of the watershed. The ridge begins at South Fork Mountain in the south and extends roughly to the confluence of the South Fork and Memaloose Creek in the north. During the Quaternary, landsliding in the cirque basins near the headwaters of the watershed has softened many of these slopes and produced gentle but irregular topography marked by closed depressions and disrupted drainages. Three small lakes occur in the headwaters area, Memaloose Lake (5 acres), Helen Lake (2 acres), and Williams Lake with an associated quaking bog ecosystem (35 acres). The river valley of the South Fork River is narrow and steep and a waterfall 0.4 miles from the confluence with the Clackamas limits the passage of anadromous fish. Below the falls, the river is home to winter steelhead, summer steelhead, spring chinook, and coho salmon. Above the falls, resident fish include rainbow and cutthroat trout. Brook trout planted in Memaloose Lake and Williams Lake are now the dominant fish population above the falls in Memaloose Creek. The South Fork River is eligible for designation as a Wild and Scenic River because of its free-flowing nature and the presence of late winter run coho salmon.

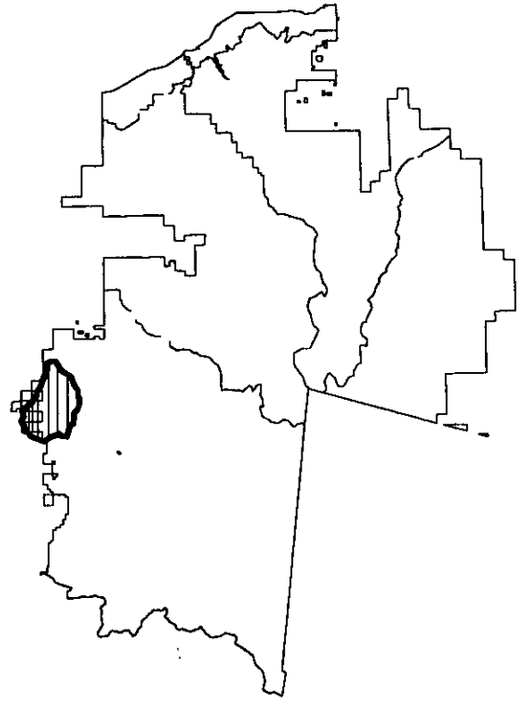
The watershed is relatively unfragmented and is composed of roughly equal amounts of early, mid, and late seral forests. Pacific silver fir forest dominates the watershed with Douglas-fir and western hemlock in the lower elevations along the river and creeks. A smaller amount of mountain hemlock exists in the higher elevations around South Fork Mountain. There are no known resident deer or elk herds but deer and elk do occupy the watershed seasonally. Both pairs and single resident spotted owls occupy the watershed and bald eagles have been sighted. Special habitats found within the watershed include the three lakes, wetlands, rock/talus slopes, cliffs, bogs, and tunnels. Species associated with these habitats include amphibians, raptors, large and small mammals, songbirds, upland birds, and bats. Two special habitats of particular interest in South Fork watershed are Williams Lake and the Oregon City Waterworks. Williams Lake is an excellent example of a Cascadian massive seep-formed lake undergoing peat bog/quaking bog succession. The abandoned tunnels of the Oregon City Waterworks provide roosting sites for several bat species.

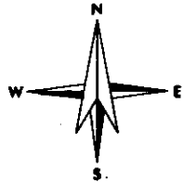
Fire and timber harvest have been the primary landscape pattern forming disturbances in the watershed. The last major fire, the Hillockburn fire, occurred approximately 1910 in the northwest section. Wind and timber harvest has been the major disturbance factor in recent history in the South Fork

VICINITY MAP







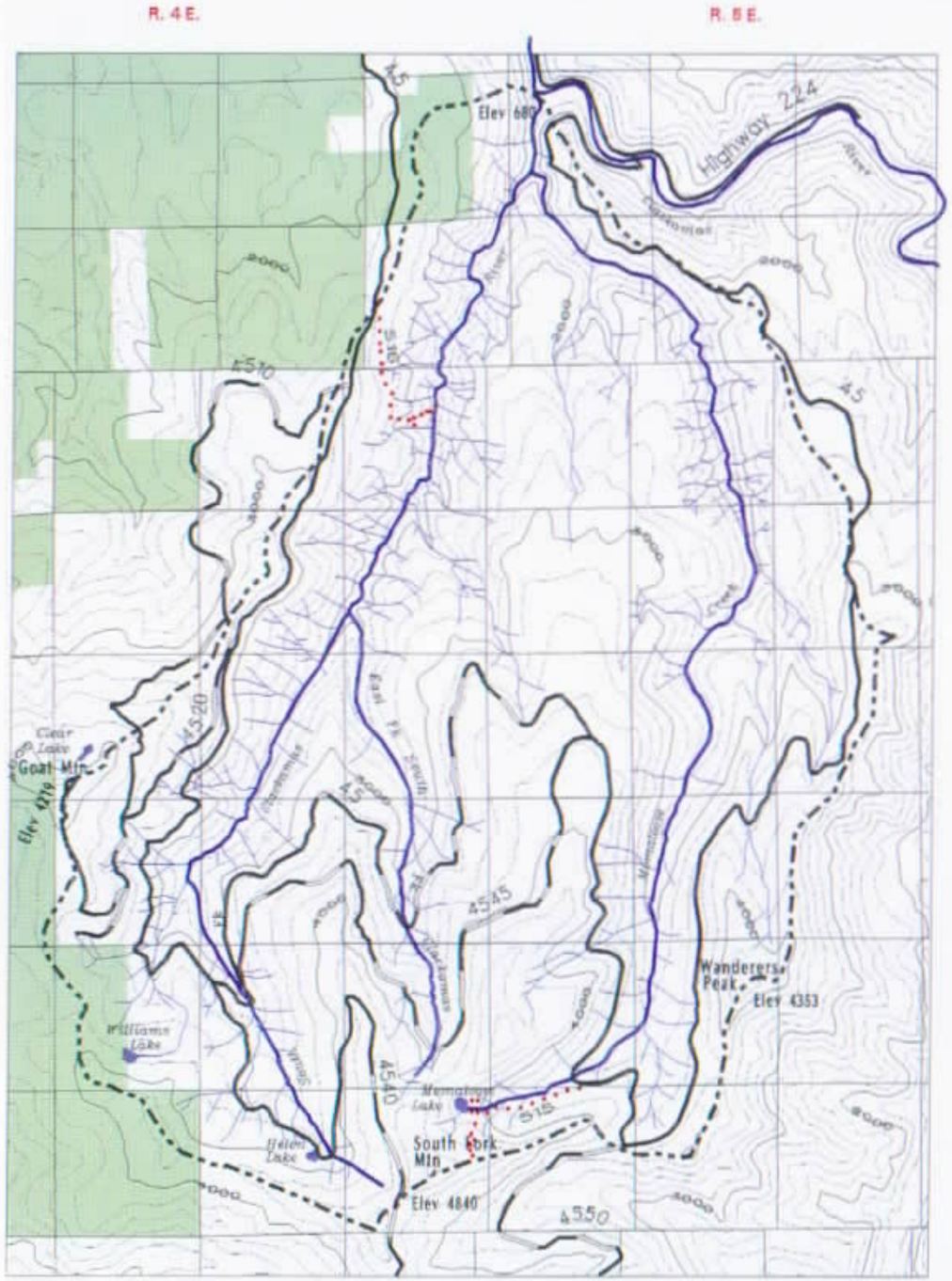


Legend

South Fork
Clackamas River

MAP 1-1

South Fork Clackamas River Watershed



Private Land Ownership

Gravel, Suitable for Passenger

Single Lane Paved

Trail

Watershed Boundary

Contour Interval 200 feet

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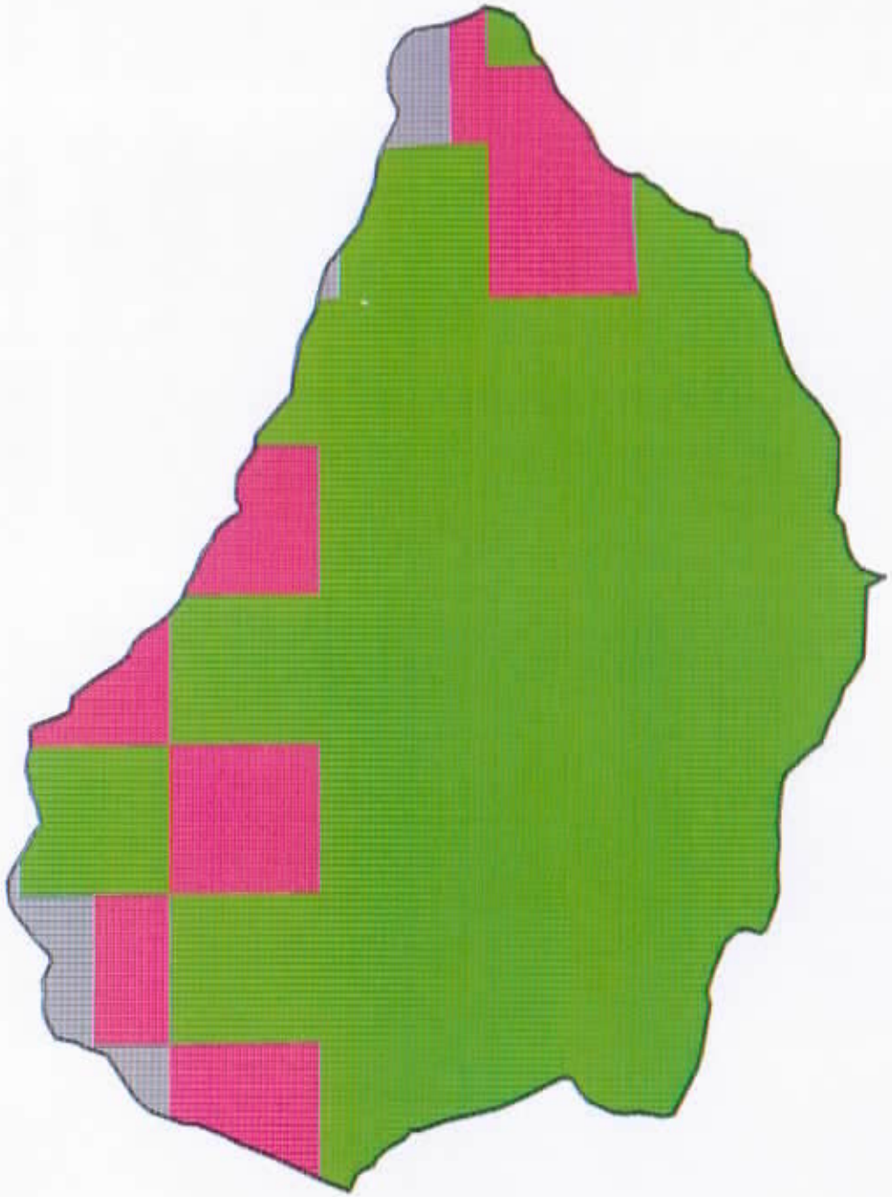
N W E S

Map 1-2

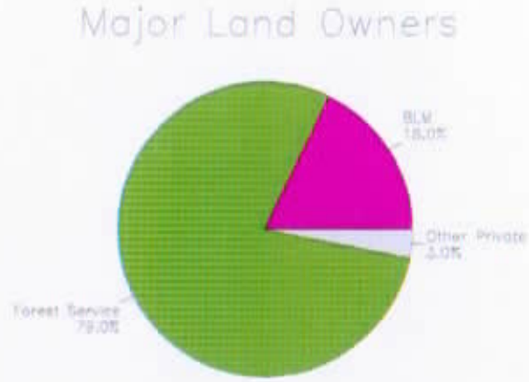
South Fork Clackamas River Watershed

Major Land Ownership



Legend

- BLM
- Forest Service
- Private



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MILES

MAP 1-3

watershed. Past windthrow events have been quite extensive and heavy because of created openings in vulnerable topographic positions. The most vulnerable landforms where windthrow has occurred have been the South Fork Ridge and the upper South Fork subwatershed. Windthrow was first noted in the 1950's when harvesting began on South Fork Ridge and the majority of blowdown salvage occurred during the 1970's and 80's following wind events. Southwest winds during the fall months are the prevalent damaging winds but east and southeast winds during winter months have also contributed to the amount of windthrow in the watershed.

Prehistoric use probably followed the pattern of use in the Clackamas River drainage and was seasonal and short term in nature. Human occupancy of the Western Cascades dates back as far as approximately 9,000 years ago. The South Fork watershed still provides habitat for game, fish, and plants and the ridges and river valley still serve as primary travel routes. Evidence located to date indicates that use occurred throughout the watershed by native people and was not confined to areas in proximity to known prehistoric travel routes. Because of the waterfall limiting anadromous fish passage near the mouth of the South Fork River, prehistoric use is suspected to have been primarily hunting and gathering. Four lithic scatters, three lithic isolates, and one stacked rock feature found in the watershed are a testament to the watershed's long history of human occupation.

Euroamerican settlement of the Clackamas River drainage was limited by the steep, inaccessible terrain until the 1890's. By 1892 four land claims in South Fork watershed were recorded on Government Land Office land surveys. Although the watershed is positioned close to foothill settlements, homesteading was limited even before the establishment of the Oregon National Forest (later to become the current Mt. Hood National Forest) in 1908. Administrative use in the watershed focused on fire control and lookouts and fire guard stations were established on South Fork Mountain and in the Hillockburn area in the 1920's and were used until the 1960's. Little remains of these structures in the landscape today. Trails noted in the earliest historic records of the watershed indicated a system which originated near the mouth of the South Fork River and continued eastward to Dodge and Estacada, with additional trails near the perimeter of the watershed along ridges and around the headwaters of the South Fork and Memaloose Creek. The trail system in the interior of the drainage continued to expand between 1890 and mid 1930's primarily for administrative access. Although the trail system has been reduced to less than three miles currently for recreation access, road mileage has continued to expand for administrative, public, and recreational use. Road 45 is an approximately 50 mile loop road through the watershed and receives some of the highest use in the Clackamas River drainage. Beginning in the mid 1920's, the road was constructed over existing trail on the west side of the watershed in the Hillockburn area. Road 45 continued to expand and by the mid 1930's the road extended past Goat Mountain. By the late 1950's, construction of the road began on the east side of the watershed above Memaloose Creek.

Today the watershed receives high use from the public although no developed recreation facilities currently exist and access to the South Fork River is limited by the steep terrain. Road 45 is a primary recreation feature because it is a loop opportunity road for recreational driving close to the Forest boundary. Other recreation uses in the watershed include hunting, fishing, dispersed camping, hiking, and off-highway-vehicle use. In addition, there is a high incidence of illegal and/or anti-social activities like garbage dumping, under-age partying, and poaching, but the watershed does not have a high incidence of reported assaults, gang activity, or homeless camps.

Of significant importance in South Fork watershed was the construction of the Oregon City Waterworks. A typhoid epidemic in 1913 in nearby Oregon City caused the city to find alternative water supply to be

pumped, filtered water from the Willamette River. In January 1915, Oregon City Council purchased rights to build a water line from the mouth of the South Fork River to Oregon City. West Linn joined with Oregon City and the two cities shared the construction costs, maintenance, and water. The two cities formed the South Fork Water Commission in March, 1915, and construction of the "mountain line" was completed by October, 1915. The Commission and the Oregon National Forest entered a Cooperative Agreement for watershed protection to ensure water quality in 1916.

The mountain line was shut down in 1985 for various reasons. The old water line required major upkeep and maintenance, and was only able to carry 2.2 million gallons/day compared to 3 million gallons/day when initially constructed. In addition, the South Fork Water Board (SFWB) had received various extensions from the Environmental Protection Agency (EPA) regarding the need for water filtration to meet Safe Drinking Water Act (SDWA) requirements for turbidity at the time. The SDWA required that turbidity in an unfiltered water supply be less than 5 NTU's 95 percent of the time (Sparling, SFWB).

Prior to the decision to shut down the mountain line, the EPA told the SFWB they would either have to install a water filtration system or abandon their South Fork Clackamas River water source. The SFWB considered routing the mountain water line to their existing water treatment plant on river mile 1.5 of the Clackamas River, but decided against this due to the water line capacity and maintenance problems. The SFWB has no future plans to use the South Fork Clackamas River as a municipal water supply and is currently trying to transfer their existing water rights in the South Fork Clackamas River to their point of diversion just upstream from the mouth of the Clackamas River. Although all the buildings at the Oregon City Waterworks have been removed, the old tunnel and miscellaneous structures still remain.

MANAGEMENT DIRECTION AND LAND ALLOCATIONS

The Mt. Hood National Forest Land and Resource Management Plan (Mt. Hood Forest Plan) of 1991 and the Bureau of Land Management (BLM) Resource Management Plan/Final Environmental Impact Statement (RMP/FEIS), both amended by the Northwest Forest Plan of 1994, provides management direction for federal lands within the South Fork Clackamas River watershed.

The Northwest Forest Plan Record of Decision (ROD, page 12) has specific direction about amending existing land management plans for both National Forests and BLM. The ROD direction supersedes Forest Plan allocations that are in conflict with, or are less restrictive than management direction in the Northwest Forest Plan.

Table 1-1 displays each of the Mt. Food Forest Plan and BLM's RMP land allocations, along with the acreage. The groups of land allocation are intended to lump similar management direction to allow comparison between the two plans (refer to Map 1-4). Overlapping land allocations are present in both plans. For instance, General Riparian and Trail Viewshed (refer to Map 2-16) overlays the Timber Emphasis allocation.

Table 1-1. South Fork Clackamas River Watershed Land Allocation Acreage from the Mt. Hood Forest Plan, *BLM RMP and the Northwest Forest Plan.*

Mt. Hood Forest Plan	Acres	Northwest Forest Plan	Acres
B5 - Pileated Woodpecker /Pine Marten C1 - Timber Emphasis	1,207 12,222	BLM Matrix Forest Service Matrix	1,613 5,869
B7 - General Riparian A9 - Key Site Riparian	68	FS &BLM Riparian Reserves	4,923
B1 - Wild & Scenic River	27	LSR (mapped and unmapped)	6,607
B8 - Earthflow	42		
B12 - Backcountry Lake	482		
BLM Williams Lake	98		

*B7 General Riparian is an unmapped Mt. Hood Forest Plan land allocation, and may be superseded by the Northwest Forest Plan Riparian Reserve direction. Many allocations overlap and the sum acres may be misleading.

Mt. Hood Forest Plan

A9: Key Site Riparian

Goal: Maintain or enhance habitat and hydrologic conditions of selected riparian areas, notable for their exceptional diversity, high natural quality and key role in providing for the continued production of riparian dependent resource values. Note that this allocation overlaps with the B12 Backcountry Lake allocation, one of the B5 Pine Martin/Pileated Woodpecker Habitat Areas, and a Late Successional Reserve.

B5: Pileated Woodpecker/Pine Marten Habitat Area

Goal: Provide Forestwide mature or old growth forest habitat blocks of sufficient quality, quantity, and distribution to sustain viable populations of pine marten and pileated woodpecker. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices. Of the three B5 allocations in the watershed, two overlap with the Late Successional Reserves and one overlays the Matrix allocation.

B7: General Riparian Area

Goal: Achieve and maintain riparian and aquatic habitat conditions for the sustained, long term production of fish, selected wildlife and plant species, and high quality water for the full spectrum of the forest's riparian and aquatic areas. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices. This is a watershed-wide allocation and is not mapped.

B1: Wild and Scenic River

Goal: Protect and enhance the resource values for which a river (Clackamas River) was designated into the Wild and Scenic Rivers System.

B2: Scenic Viewshed

Goal: Provide attractive, visually appealing forest scenery with a wide variety of natural appearing landscape features. Utilize vegetation management activities to create and maintain a long term desired landscape character.

Eligible Wild and Scenic Rivers

The South Fork Clackamas River is eligible for designation by Congress as a Wild and Scenic river. Management activities should be designed to protect the free flowing nature and outstandingly remarkable values until the river is designated or released from consideration. The one-half mile wide eligible river corridor extends from the mouth of the river to the confluence of the South Fork River with the East Fork. In addition, the State of Oregon has designated the South Fork Clackamas River a State Scenic Waterway. The State Scenic Waterways Act requires that the State Land Board approve any alteration of the bed and/or bank of the scenic river or wetlands within the scenic waterway, regardless of the amount of material involved.

Trail Viewshed

Goal: Maintain the scenic quality with a diversity of tree and shrub species of various sizes and ages, distributed in natural appearing patterns. Natural appearing openings may occur to enhance views to landscape features.

B8: Earthflow

Goal: Maintain hydrologic and physical balance to prevent reactivation or acceleration of large, slow moving earthflow areas. Allow for the management and utilization of forest resources through the use of special management practices.

B12: Backcountry Lakes

Goal: Protect or enhance the recreation, fish and wildlife, or scenic values of designated lakes. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices.

C1: Timber Emphasis

Goal: Provide lumber, wood fiber, and other products on a regulated basis, based on the capability and suitability of the land. A secondary goal is to enhance other resource uses and values that are compatible with timber production such as deer and elk habitat..

Bureau of Land Management - Resource Management Plan

General Forest Management Area (GFMA)

Goal: The primary objectives of the GFMA are to manage for timber production while providing for long term site productivity, forest health, cavity nester habitat, and biological legacies. Emphasis would be placed on the use of intensive forest management practices and investments to maintain a high level of sustainable timber production.

Fragile/Nonsuitable for Timber Production

Goal: The primary objective is to provide for protection of fragile sites due to steepness, high watertable, rocky soils, or non-forest areas while contributing to meeting other ecosystem goals such as late-successional habitat, aquatic resources, and special habitats. This is an administrative withdrawl which overlays the General Forest Management Area allocation.

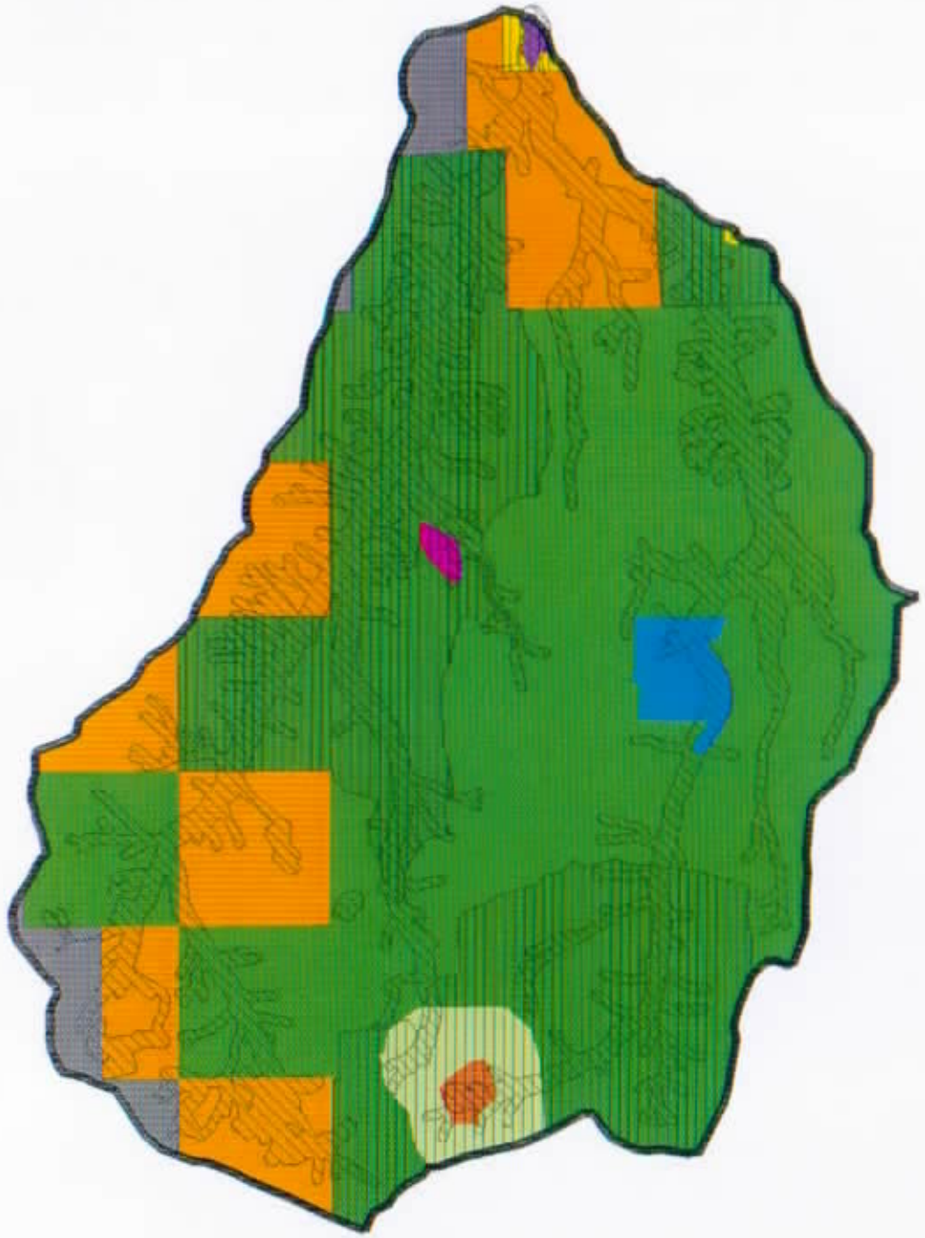
Northwest Forest Plan

Riparian Reserves

Goal: Achieve and maintain riparian and aquatic habitat conditions for the sustained, long term production of fish, selected wildlife and plant species, and high quality water for the full spectrum of the forest's riparian and aquatic areas. A secondary goal

South Fork Clackamas River Watershed

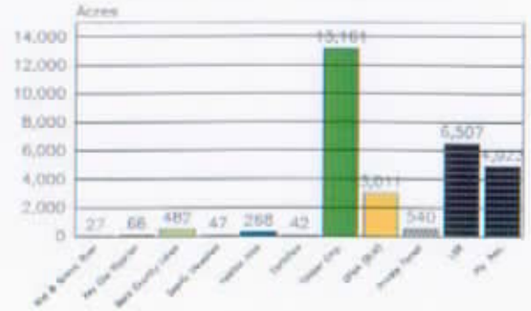
Land Use Allocations



Legend

- Wild & Scenic River
- Key Site Riparian Area
- Back Country Lakes
- Scenic Viewshed
- Pileated Woodpecker Pine Marten Habitat Area
- Earthflow
- Timber Emphasis
- General Forest Management Area (BLM)
- Private Forest Land
- Late Successional Reserve
- Riparian Reserves

Land Use Allocations



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MAP 1-4

is to provide habitat connection for late-successional species and dispersal habitat for other terrestrial species.

Matrix

Goal: Provide lumber, wood fiber, and other products on a regulated basis, based on the capability and suitability of the land. The intent is to retain some late seral habitat components (minimum 15%) to facilitate species flow. A secondary goal is to function as connectivity between Late-Successional Reserves (LSR) and to provide habitat for a variety of organisms associated with both late-successional and younger forests. This definition of Matrix is different from the landscape ecology definition of matrix.

Late Successional Reserves

Goal: The objective of the Late Successional Reserves is to maintain a functional, interactive, late successional and old-growth ecosystem. They are designed to serve as habitat for late successional and old growth related species including the norther spotted owl. In addition, one hundred acres of the best northern spotted owl habitat will be retained as close to the nest site or owl activity center as possible for all known spotted owl activity centers located on federal lands in the matrix. Only one 100 acre LSR is located in the South Fork watershed and is not illustrated on the allocations map.

CORE TOPICS AND KEY QUESTION

The primary issues in the South Fork watershed have been divided into two main areas. The first being those that focus the basic analysis of ecological conditions, processes, and interactions at work in the watershed — the Core Topics. This is the basic analysis that is addressed in all watershed analyses and addresses the major elements and their relationships in the watershed. The second are those issues that are unique to the South Fork watershed, those that are key drivers of the system — the Key Question.

Core Topic Questions

Aquatic

Erosion Processes

What erosion processes are dominant within the watershed? Where have they occurred or are they likely to occur?

Hydrology

What are the dominant hydrologic characteristics (total discharge, peak flows, minimum flows) and other notable hydrologic features and processes in the watershed?

Stream Channel

What are the basic stream morphological characteristics and the general sediment transport and deposition processes in the watershed?

Water Quality

What beneficial uses dependent on aquatic resources occur in the watershed?

Aquatic Species and Habitats

What is the relative abundance and distribution of aquatic species that are important in the watershed? What is the distribution and character of their habitats?

Terrestrial

Vegetation

What is the array and landscape pattern of plant communities and seral stages in the watershed? What processes caused these patterns?

Species and Habitats

What is the relative abundance and distribution of terrestrial species of concern that are important in the watershed? What is the distribution and character of their habitats?

Social

Human Uses

What are the major human uses and where do they occur in the watershed?

Current and reference condition, and trends and causal relationships will be examined for each of the core topic areas (Chapter 2).

Key Question

This question was developed around the key issues for the watershed. It is the issue that is of primary concern, unique to the South Fork watershed.

Given the watershed's tendency for blowdown, what timber harvest pattern and silvicultural treatments would best retain structural components for future stands (15% in matrix) and prevent blowdown of the Late Successional Reserves and Riparian Reserves?

The answer to this Key Question is presented in Chapter 4.

PUBLIC WORKSHOP

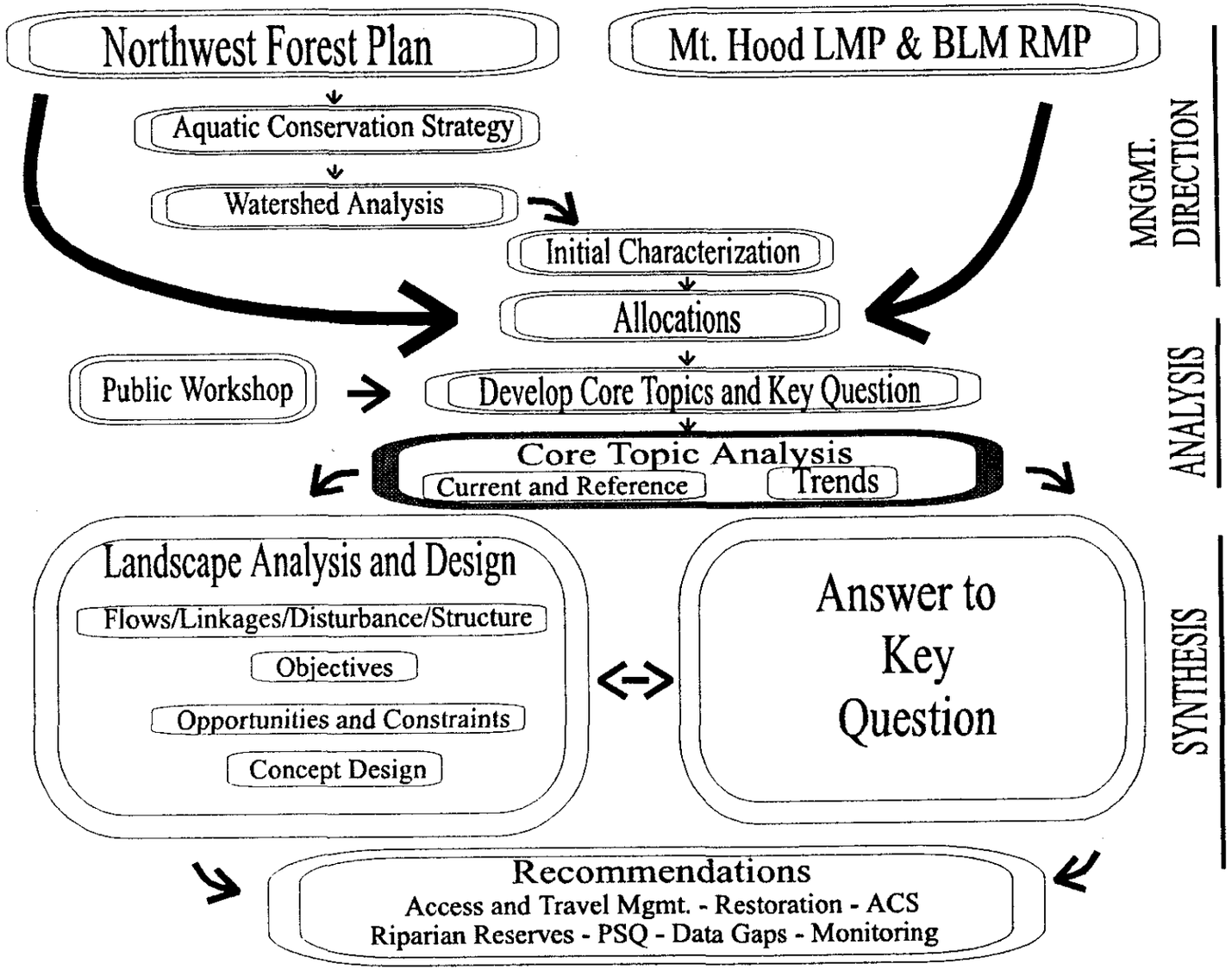
A public meeting was held on Friday, May 29 at the Estacada Senior Center. The topic of concern was the South Fork watershed analysis and the objective was to capture the questions and suggestions of those citizens present. Most are long time residents of the area who are quite familiar with the watershed. Some have been recreating or working in the watershed for years. Their concerns and knowledge covered a wide range of topics but among the most popular were species sighting information, roads, fishing, and special uses. The following is a summary of their comments, concerns, suggestions, and interesting facts about the watershed:

- Many years ago Memaloose Creek was a good cutthroat stream. Now very few cutthroat are found there - only brook trout.
- Anadromous fish barrier at the mouth of the South Fork River.
- Popular watershed for hunters.
- Coyotes and mink spotted near the South Fork River.
- Fisher spotted near Memaloose Creek.
- Trail 516 is overgrown and could be a potential project.
- Pretty pools and waterfalls in South Fork River.
- Brook trout spawning in Memaloose Lake in 1979.
- Helen Lake is really shallow and possibly eutrophic.
- Concern about closing roads in the watershed and throughout the Clackamas River drainage. Would like all roads to stay open for public access and salvage opportunities. Do not close roads without provable benefits.
- Popular watershed for Christmas tree harvest.
- Portland astronomy club uses Goat Mountain area for star watching.
- Steep, difficult access down to the lower South Fork River and Memaloose Creek for fishing.
- Road 45-180 is the only roaded access to the upper South Fork River.

The following is a list of those present at the meeting along with their given cities of residence:

Dan Guttridge, Estacada
Norman Goetz, Portland
Avis Rana, Oregon City
John Shoop, Estacada
Cole Gardiner, Portland
Gary Guttridge, Estacada
Joe E. Evans, Oregon City
Susan Hadson, Oregon City
Rod Klawitter, Estacada
Gordon McGhee, Clackamas
Douglas W. Smith, Estacada
Noel Hamel, Estacada
Jerry Myra, Oregon City
Chuck Steahly, Corbett
John Clark, Eagle Creek
Jon Clark, Eagle Creek
Leroy Layton, Estacada
Dan Herrick, Silverton

Chapter 2
Core Topic Analysis



Current and Reference Condition

A. Erosion Processes

Geology

The South Fork of the Clackamas River drains from South Fork Mountain and empties into the Clackamas River at Big Cliff. The watershed is oriented north to south and, at 17,647 acres, is the second smallest watershed that drains into the Clackamas River and one of the smallest watersheds in the Mt. Hood National Forest. Watersheds bordering the South Fork include Fish Creek to the southeast, the Molalla River tributaries to the southwest, the Clear Creek Fork to the northwest, and the Lower Clackamas River to the northeast.

The watershed is comprised of two major drainages, Memaloose Creek and the South Fork of the Clackamas River. A major tributary of Memaloose Creek is Cultus Creek, and the main tributary of South Fork is the East Fork. The Memaloose and the South Fork converge 0.55 miles before draining into the main stem of the Clackamas River. South Fork Mountain, which separates the Memaloose and South Fork drainages, is the highest peak in the watershed at 4485 feet. The lowest point is 650 feet, which is located at the confluence of the South Fork with the Clackamas River. In just under eight miles the elevation of the watershed changes 3735 feet, yielding a loss of approximately 460 feet per mile. This is significant and highlights the ruggedness of the watershed. The two major drainages are moderately incised in the upper reaches, but canyon-like in the lower reaches. They are separated by a broad, resistant ridge (South Fork Ridge) that spans nearly the entire distance of the watershed, beginning at South Fork Mountain in the south and extending roughly to the confluence of the South Fork and Memaloose Creek in the north.

Glaciation, landsliding, and fluvial processes have been the primary landform sculptors of the South Fork watershed. Acting in concert throughout the Quaternary, these processes have changed the topographic expression of the landscape. Glaciers moving through narrow valleys have left these valleywalls over-steepened, saturated, and unconfined. In turn, landsliding, particularly in cirque basins near the headwaters of the watershed, has softened many of these slopes and produced gentle but irregular topography marked by closed depressions and disrupted drainages. Although glaciation and landsliding are comparatively infrequent events, their influence on the watershed may equal that of fluvial processes, which, although functioning continuously, accomplish the majority of their work during brief periods of peak flow.

Geologic Units

The geologic mapping was compiled by the Geotechnical Division of the Mt. Hood National Forest. A geologic map produced by Hammond and others (1982) was the principal source, along with personal communication with Dave Sherrod of the U.S. Geological Survey. A detailed geologic mapping of the southwestern portion of the watershed has not yet been published. As a result, some geologic units in this area are inferred by extending contacts along appropriate slope breaks and from communication with Dave Sherrod, geologist with the U.S. Geological Survey.

The South Fork Clackamas River watershed is composed of ten geologic units. Three are surficial units and seven are bedrock units. These units are briefly described below in their approximate order of occurrence, from youngest to oldest.

Surficial Units

Qal — Alluvium: Unconsolidated gravel, sand, and silt deposits that have been eroded from bedrock throughout the watershed. Mapped in one area at the South Fork's confluence with the main stem Clackamas River. Deposited over the last two million years.

Qls — Landslide deposit: Large, poorly-sorted

deposits consisting of boulder to silt size material. Four landslides are mapped in the lower portion of the Memaloose Creek drainage. The other three landslides, mapped in the South Fork sub-watershed, are found at Williams Lake, Helen Lake, and Oscar Creek. These three landslides are larger in area than the four in the Memaloose sub-watershed. However, all seven landslides appear to be related to the weak geologic contact between QTb and Tr. These landslides have occurred in the last 10,000 years and their relationship to glaciation is discussed below.

Qyt Younger till deposits: Unsorted compact deposits of mostly gray clay to boulder size detritus distributed by glacial meltwater streams. These deposits have been mapped in the headwaters of Memaloose Creek and the East Fork of the South Fork of the Clackamas River. These deposits are between 20,000 to 12,500 years old.

Bedrock units

Qib Intrusive basaltic andesite: Dark-gray, fine to medium grained rock. Formed as a small volcanic plug or dike. Found above 4000 feet on Goat Mountain in the central western portion of the watershed. Intruded surrounding bedrock in the last two million years.

Qtb Olivine basaltic andesite: Dark-gray, blocky to platy jointed olivine bearing basaltic andesite lava flows. These flows are often separated by either reddened scoria, fluvial volcaniclastic deposits, or tephra deposits. Commonly, this unit is deeply dissected and found capping ridge crests. These lava flows are 4.2 million years and younger.

Tr Rhododendron formation: Nearly-horizontal lying, interbedded weak pyroclastic/mud flow deposits with usually thinner, resistant lava flows. Numerous thin basalt dikes (not shown on map) cut through this unit, altering and further weakening the rock along the dike contacts. Deposited between 12 and 4 million years ago.

Columbia river basalt group

Wanapum basalt formation

Tyfs Frenchman springs member: Dark-gray, columnar, fine grained basaltic lava flows with rare plagioclase crystals. Distinguished by normal polarity magnetization. Lies stratigraphically above the other members of the Columbia River Basalt Formation present in this drainage. The vantage horizon (a sedimentary interbed) separates the Frenchman Springs member from the High MgO Grande Ronde member. Approximately 15 million years old.

Grande ronde basalt formation

Tygr3 High mgo basalt member: Dark-gray, blocky to highly fractured, very fine grained basaltic lava flows. Distinguished by reverse polarity magnetization. Lies stratigraphically between the Frenchman Springs and Low MgO Grande Ronde member. Approximately between 16 and 15 million years old.

Tygr2 Low mgo basalt member: Dark-gray, blocky to highly fractured, fine grained basaltic lava flow with rare plagioclase crystals. Distinguished by reverse polarization and paleosols separating the lava flows that make up this member. This flow stratigraphically lies between the High MgO Grande Ronde member and the Prineville Type member. Between 18 and 16 million years old.

Typv Prineville type member: Dark-gray, columnar to blocky, fine grained basaltic lava flow. Distinguished by its smaller flow top vesicular zone of less than 15 feet. The bottom of these flows are not seen in this drainage, but the lava flow is overlain by the Low MgO Grande Ronde member. Between 25 and 18 million years old.

These geologic units can be divided into six general categories:
Alluvium: Qal
Landslides: Qls
Glacial Valley Floor: Qyt
Weak Rock: Tr
Resistant Rock: Qib and QTb
Layered Resistant Rock: Tyfs, Tygr2, Tygr3, and Typv

Landform types

The watershed has been divided into ten landform types (Map 2-1) based primarily on slope angle, drainage density, and susceptibility to landsliding of the
geologic unit. These landform are described below.

Qal Alluvium deposits: Found in an isolated deposit at the South Fork's confluence with the Clackamas River. These types of deposits have a slope range from 0-20 percent slope, but usually it is between 0-10 percent.

Qls landslide deposits: Seven landslides have been mapped in the South Fork of the Clackamas River watershed. Four are located in the Memaloose Creek drainage toward the lower part of the drainage. Two are found in the South Fork headwaters and one is found around Oscar Creek, a main tributary to the South Fork. The landslides appear to be associated with contacts between weak and resistant rocks. The slopes range from 0-50 percent, but they generally are between 10-35 percent.

GVF Glacial valley floor: A small glacial deposit is located in the headwaters of the East Fork of the South Fork of the Clackamas River. A large glacial deposit has been mapped from Memaloose Lake to approximately one half mile below Oasis Creek's confluence with Memaloose Creek. The headwaters of the South Fork watershed display many bowl-shaped features. The bowl-shaped features in the watershed are oriented to the north which is the most conducive position for a year-round snow pack. For these reasons, it is likely that the headwaters of the South Fork sub-watershed were glaciated at one time, but landslides post-dating the last glaciation have covered the glacial deposits that were once there. The slopes of the glacial valley floors range from 0-40 percent, but they are usually between 10-25 percent.

WRGS Weak rock-gentle slopes: Primarily found along the upper reaches of the streams and on the lips of the broad ridges that separate sub-drainages in this watershed. The slopes range from 0-30 percent.

WRMS weak rock-moderate slopes: Concentrated in the mid-slope position adjacent to the main drainages and its higher order tributaries. Most of the moderate slopes are found in the upper two thirds of the watershed. The slopes range from 31-50 percent.

WRSS Weak rock-steep slopes: Found adjacent to the South Fork and Memaloose streams. Is primarily concentrated in the lower third of the watershed where the most severe stream down cutting has occurred. The slopes generally exceed 50 percent.

RRGS Resistant rock-gentle slopes: This landform type is often found on the broad ridges that separate drainages, but most notably the extensive broad ridge that divides the Memaloose and South Fork drainages. The slopes range from 0-20 percent.

RRMS Resistant rock-moderate slopes: Primarily located around the headwaters of streams and in the mid- to upper-slope positions adjacent to drainages. The slopes range from 21-50 percent.

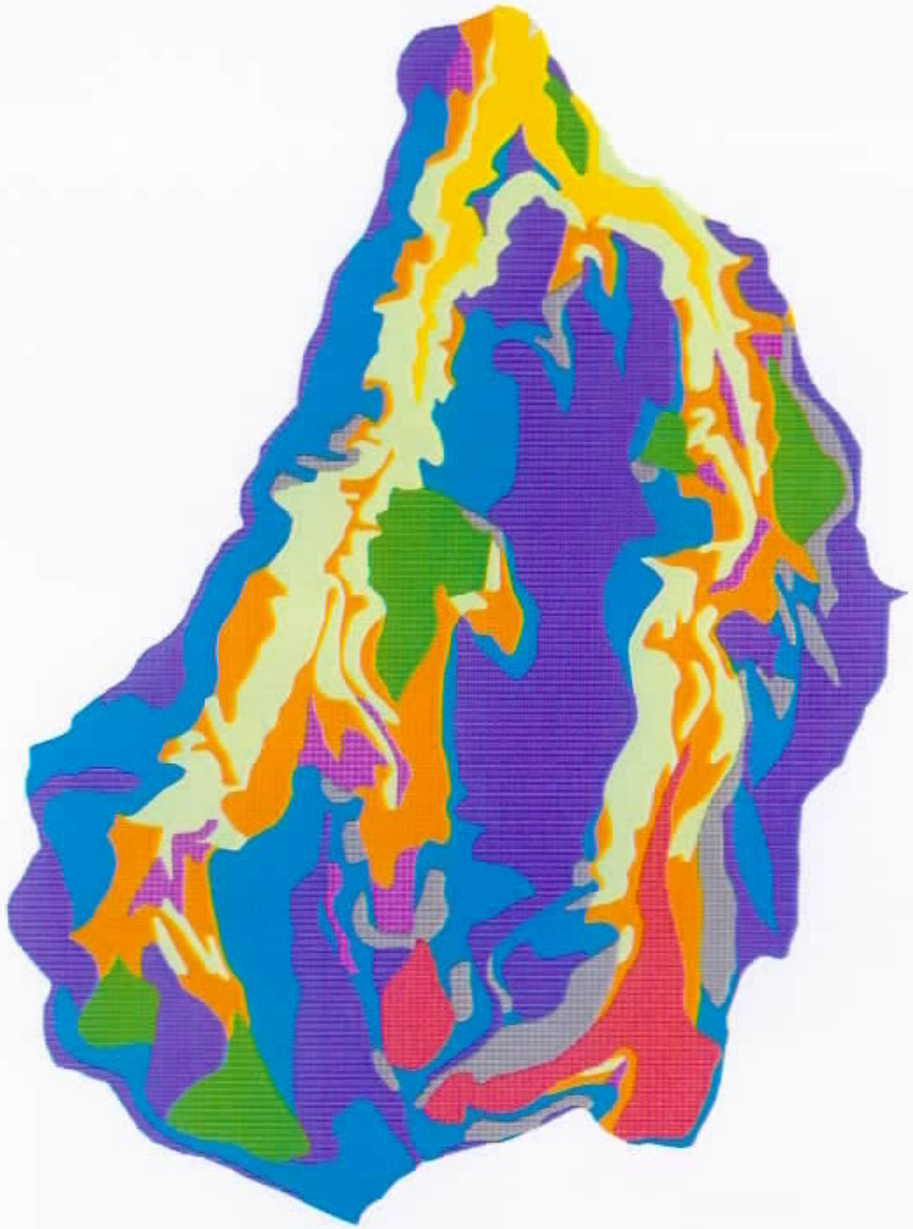
RRSS Resistant rock-steep slopes: This landform type is found sporadically in both of the major drainages. However, the highest concentration of resistant rock with steep slopes is in the headwall position of tributaries and around the glacial eroded headwaters of Memaloose and

South Fork drainages. The slopes often exceed 50 percent.

LRRSS Layered resistant rock-steep slopes:
Exclusively composed of the Columbia River Basalt Group that exists in the lower portions of the watershed. This landform type reaches approximately 2.5 miles up both the South Fork and Memaloose drainages. The slopes generally exceed 50 percent.

Landslides

The landslide potential and relative sediment delivery rating for the landform types were determined by examining selected aerial photographs and by field-checking particular landslides in adjacent watersheds. The results of this work are summarized in the tables below. Table 2-1 and table 2-1a refers to the potential of a generic landslide type to occur within a given landform type. Table 2-2 shows the types of mass wasting and erosion processes that are likely to occur on a particular landform. Table 2-3 and table 2-3a lists each landform type and its relative sediment delivery rating for mass wasting. It is important to note that landslide potential and relative sediment delivery are not necessarily equivalent due to variations in delivery capability and proximity to streams.



South Fork Clackamas River Watershed

Landform Type

Legend

- Alluvium
- Glacial Valley Floor
- Layered Resistant Rock Steep Slopes
- Landslide Deposit
- Resistant Rock - Gentle Slopes
- Resistant Rock - Moderate Slopes
- Resistant Rock - Steep Slopes
- Weak Rock - Gentle Slopes
- Weak Rock - Moderate Slopes
- Weak Rock - Steep Slopes

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MILES

N W E S

MAP 2-1

Table 2-1. Relative landslide potential by landform type

LANDFORM TYPE	SYMBOL	RATING	ACRES
Alluvium	AL	L	4
Quaternary Landside Deposit	Qls	H	1137
Glacial Valley Floor	GVF	L	874
Weak Rock - Gentle Slopes	WRGS	M	456
Weak Rock - Moderate Slopes	WRMS	H	2403
Weak Rock - Steep Slopes	WRSS	H	2382
Resistant Rock - Gentle Slopes	RRGS	L	4775
Resistant Rock - Moderate Slopes	RRMS	M	4035
Resistant Rock - Steep Slopes	RRSS	H	1006
Layered Resistant Rock - Steep Slopes	LRRSS	H	575

NOTE: rating scale is H = high, M = moderate, L = low, N/A = not applicable

Table 2-1a. Total Relative Landslide Potential

RATING	ACRES	PERCENT
High	7503	43
Moderate	4491	25
Low	5653	32

Table 2-2. Dominant sediment transport processes by landform type

	Debris Flow	Debris Slide	Earth-flow	Slump	Creep	Rock-Fall	Surface Erosion	Stream Bank Failures	Inner Gorge Failures
QAL	N/A	N/A	N/A	L	N/A	N/A	H	H	N/A
QLS	M	H	H	M	M	N/A	M	H	H
GVF	N/A	L	L	M	M	L	M	H	L
WRGS	L	L	M	L	L	N/A	M	M	N/A
WRMS	M	M	H	M	M	N/A	M	H	M
WRSS	H	H	M	M	M	H	H	H	H
RRGS	L	L	N/A	L	L	N/A	L	L	N/A
RRMS	M	M	N/A	M	L	L	M	M	M
RRSS	H	H	N/A	L	L	H	M	H	H
LRRSS	H	H	N/A	L	L	H	M	H	H

NOTE: rating scale is H = high, M = moderate, L = low, N/A = not applicable

Table 2-3. Relative sediment delivery by landform type

LANDFORM TYPE	SYMBOL	RATING	ACRES
Alluvium	AL	H	4
Quaternary Landside Deposit	Qls	H	1137
Glacial Valley Floor	GVF	M	874
Weak Rock - Gentle Slopes	WRGS	L	456
Weak Rock - Moderate Slopes	WRMS	H	2403
Weak Rock - Steep Slopes	WRSS	H	2382
Resistant Rock - Gentle Slopes	RRGS	L	4775
Resistant Rock - Moderate Slopes	RRMS	M	4035
Resistant Rock - Steep Slopes	RRSS	H	1006
Layered Resistant Rock - Steep Slopes	LRRSS	H	575

NOTE: rating scale is H = high, M = moderate, L = low, N/A = not applicable

Table 2-3a. Total relative sediment delivery

RATING	ACRES	PERCENT
High	7507	43
Moderate	4909	27
Low	5231	**30**

Landslide discussion

As with many watersheds in the Cascade Mountains, the occurrence of landslides in the South Fork of the Clackamas Watershed is highly dependent upon steep slopes, abundant precipitation, and the presence of weak rock formations. This combination commonly occurs on side slopes adjacent to the major drainages. The inventoried landslides typically have two things in common. First, the initiation point of the landslides is often near the contact of weak and resistant rock (QTb-Tr). Second, they tend to occur on the edges of ancient landslide deposits, where a variety of conditions may conspire to reduce stability. For example, the margins of ancient landslides are often over-steepened, excessively wet, and comprised of disturbed, and therefore weak soils.

Seven Quaternary landslide deposits were mapped in the watershed. The landslides that produced these large deposits were initiated under different climatic and hydrologic conditions from those that exist today. They occurred during periods of glacial retreat when valley walls were over-steepened, saturated, and unconfined. Moreover, since these conditions persisted for hundreds or perhaps thousands of years, it is thought that large-magnitude earthquakes may have played a role in triggering the large-scale landslides. In addition, the landslides typically occurred where unaltered flows of Pliocene-age basaltic andesite (QTb) overlie clay-rich tuffaceous rocks of Miocene age (Tr). This highly-jointed overlying rock rapidly transmits water to the cohesive rock unit below, destabilizing the slope by causing pore-water pressure to rise. This arrangement of geologic units, resistant rock over weak rock, has been recognized as a problematic combination by numerous authors because it is prone to large-scale slope failure.

Although most of the landslide deposits are currently inactive, simply by their predisposition toward instability they continue to play an important role in a variety of sediment transport and delivery processes. Those areas of the deposits that remain active (i.e., earthflows) are even more important because they effectively transport sediment to a position where it can be easily delivered to a stream via stream-bank failures, debris slides, or surface erosion. Unfortunately, the extent of active earthflows in this watershed has not been studied and is not entirely clear.

In areas where slopes are formed of resistant rock or mantled with till, soils tend to be shallow and granular, conditions which favor debris slides and debris flows rather than slumps and earthflows. However, in many of the areas where these conditions are met, slope gradients are often gentle, and landsliding of any kind is unlikely. Such is the case on the wide, north to south-trending ridge that divides the watershed into east and west drainages.

During the landslide inventory, 17 landslides were identified (Table 2-4). Of these, 11 are debris flows and 6 are debris slides. Separating these landslides by land use indicates that 4 are associated with roads, 11 with clearcuts, and 2 appear to be associated with mature forest land. The majority of these slides are unvegetated and several appear to have delivered sediment to nearby streams. It is possible that more landslides, other than the ones' identified, are associated with land management impacts. It is important to note, however, that these are merely associations; the actual causes of the landslides are not certain.

Table 2-4. Landslide types and associations

Type	Occurrence
Debris Flows	11
Debris Slides	6
Total	17
Associated w/ roads	4
Associated w/ Clearcuts	11
Associated w/ Mature Forest	2
Total	17

Additional comments and observations

Although debris flows and debris slides were the leading inventoried landslide types, stream-bank failures probably remain the most common type of landslide in the area. The reason stream-bank failures are vastly under-represented in the landslide inventory is, of course, because they tend to be small and are often concealed by riparian vegetation. They are, therefore, difficult to detect on aerial photographs at a scale of 1:12,000. A rough estimate indicates that stream-bank failures producing more than 50 cubic yards of debris can be concealed from air photo observation by the riparian canopy. This estimate was made based on field observations of stream-bank failures not visible on aerial photographs. Moreover, the deposit, usually a key in recognition, is generally carried away within a few days by the stream. In addition, while debris flows and debris slides tend to have return intervals of a few years, stream-bank failures occur almost continuously. Stream-bank failures probably account for a majority of the sediment delivered to streams by landslides.

Colluvial hollows are often sites of small-scale but repeated landsliding since they act like receptacles for debris. As a hollow fills, its stability decreases, as does, therefore, the amount of water needed to trigger a landslide. When the landslide occurs and the hollow is flushed, it returns to more stable conditions. However, if the source of debris has not been depleted, the hollow will start to fill again. Colluvial hollows are often found along steep valley walls and are often visible from roads at the crest of the cut-slope, and appear as a V- or U-shaped notch.

Many colluvial hollows are simply hanging tributary channels that have not kept pace with the down-cutting of the main stem. Such channels may collect debris introduced by headward erosion or deposited by stream-bank failures. Episodes of peak flow associated with large storms or rain-on-snow events typically mobilize this debris in either of two ways. If a debris flow is triggered at the headwaters of the tributary, it may collide with and mobilize the channel debris as it passes. In the absence of a debris flow, peak flow volumes must be sufficiently large to entrain the channel debris as a hyperconcentrated flood or possibly a debris flow. Ephemeral streams maybe particularly disposed to failure by debris flow because they act as a repository for debris of all kinds when their channels are dry. Under such conditions, the debris may be quite stable, but when the channel again carries water, these seasonal deposits may be mobilized. For two related and equally important reasons, concave slopes are often more prone to landsliding than planar or convex slopes. In general, surface water and groundwater will flow in a direction normal to the contours of a slope. When the slope is concave (i.e., having the shape of an inner gorge), the result is for water to be directed inward, and gather along the longitudinal axis of the inner gorge. Consequently, these locations are more susceptible to abrupt increases in pore pressure, which naturally have a destabilizing effect on the slope. Where slopes are convex or planar, the result is for water to be directed outward or simply straight down the slope, and increased pore pressures are more easily dissipated. In addition, concave slopes and inner gorges often indicate the presence of colluvial hollows, which, as discussed above, are predisposed to slope failure.

Landslides occurring within the lower reaches of the South Fork watershed have a high probability of delivering sediment because of the canyon-like shape of the valley. This is particularly true where streams are deeply entrenched. Similarly, failures occurring in colluvial hollows and inner gorges have a high probability of delivering sediment to streams. Care should be taken when conducting land management activities in these areas.

The 1964 Flood does not appear to have affected mass wasting in this watershed as severely as it did in neighboring watersheds, particularly the Salmon River Watershed to the north. Part of the reason for this may involve either the path of the storm or the amount of snow present in the watershed. It is also possible that the watershed was, to some degree, topographically isolated from the storm, which seems to have impacted east-west oriented drainages more severely than north-south oriented drainages (Waananen et al. 1971).

Certain geologic conditions within the watershed are

inherently unstable and merit special attention during field investigations. Some of these areas are listed below.

1. Contacts between weak (Tr) and resistant rock (QTb). Changes inpermeability 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.

2. Contacts within layered resistant rock (Tyfs, Tygr2, Tygr3, and Typv). Changes in permeability of the lava flows at these contacts often result in springs or shallow groundwater tables. Paleosols can also perch water at the contacts of these lava flows. A change in the groundwater conditions in these areas can trigger debris slides and debris flows.

3. Around the edges of intrusions (Qib). The heat from these intrusions has often altered and weakened the adjacent rock making it more prone to mass wasting.

4. Along the margins of dikes and sills. Similarly to 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.

5. Along stream banks within the landforms WRSS and WRMS, or similar landforms. Slumps, debris slides, and stream-bank failures may occur next to down-cutting or laterally-cutting streams. These failures are not usually visible on aerial photographs.

6. 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 RRSS, WRSS, and LRRSS. These conditions are prone to shallow failures.

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

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

9. 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 upon the slightest provocation.

10. In the inner gorge locations of any steeply-sloping landform. These areas may be sites of colluvial hollows and higher than typical groundwater levels.

11. In the vicinity of fault zones. Increased fracturing, weathering, and often the presence of water in these areas decreases the stability. These zones are not shown on the maps.

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.

Limitations and Assumptions

1. Rates of sediment delivery were not calculated.

2. Natural rates of landslide occurrence were not determined.

3. Certain geologic contacts were inferred.

4. A causal relationship between land management practices and landslide occurrence could not be determined due to the nature of the analysis, a lack of field work, and the inability to control for certain factors such as the distribution of landforms and the types and locations of permissible management activities. This causal relationship, however, is well documented in the scientific literature (O'Loughlin 1974; Swanson and Dyrness 1975; Gresswell et al. 1979; Amaranthus et al. 1985; Wolfe and Williams 1986; Neely and Rice 1990; Sidle 1992).

Overall Soil Productivity

In this watershed there are 8,360 acres of soil types that possess moderate to high site productivity (as measured by Douglas-fir site class). Predominantly only moderately productive, they are rocky, cool, and not very deep. These soil types occur on benches, sideslopes, and ridges throughout the upper drainage. The Soil Productivity Ratings are as follows:

Low = site class < 4,
Moderate = site class 3-4,
High = site class > 3

Low = 1,659 ac
Low to Moderate = 7,615 ac
Moderate = 7,339 ac
Moderate to High = 1,022 ac

Approximately 9,274 acres of soil types in the drainage exhibit low relative productivity. They are potentially screen 4 (Determination of Land Not Suitable for Timber Production, Doust et al, 1984) soil types. This means that natural regeneration of these soil types may not adequately stock a young stand (USFS, R-6 stocking standards) within 5 years after complete removal of an overstory stand by human or natural causes. Most of these soil types are very shallow and rocky, existing on steep sideslopes and ridgetops interspersed with talus and rubble at all elevations.

Soil Erosion Potentials

Erosion potential of soils in the watershed is predominantly moderate. This is due to the abundance of medium and coarse textured soil types of moderate depth and rapid infiltration rates. However, where these soil types exist on slopes greater than 30%, they become very susceptible to erosion.

On slopes greater than 30%, Vegetation is key in providing protective cover for highly erosive soils. The Mt. Hood Forest Plan specifies target protective ground cover percentages for erosive soil types in an effort to safeguard them from accelerated erosion that could affect forest productivity, water quality, and aquatic habitat.

Soil Erosion Potentials

Low	= 5,791 ac
Moderate	= 9,258 ac
High	= 2,594 ac

Info Gap: The condition of soil resources in the watershed has not been assessed. It is known that forest management activities ranging from timber harvest to recreational development, and wildfire, have affected soil resources on many acres to some degree. But to what extent is unknown and can be considered an information gap in this watershed analysis effort.

Sensitive Soil Types

Sensitive soils are those which have inherent properties (physical, biological, and chemical characteristics) that make them susceptible to detrimental soil impacts such as, but not limited to, compaction, accelerated erosion, and displacement. These disturbances have the potential to directly decrease forest productivity. The importance of identifying sensitive soil types is to alert forest managers where to exercise additional caution when implementing management activities on them.

Soil types considered sensitive, along with the characteristics which make them so, are listed in the attached tables. Twenty percent (3,531 ac.) of the watershed area is mantled with sensitive soil types. They are distributed primarily in the lower reaches of the watershed, existing on steep, rocky slopes, and stream-bank sideslopes at elevations below 2600'. Most of the sensitive soils in the watershed are the "miscellaneous land types as described in Soil Resource Inventory (table 2-5). (SRI) The remainder are soils derived from pyroclastic or igneous parent materials(table 2-5a and table 2-5b).

Table 2-5 Miscellaneous Sensitive Soil Types

Miscellaneous Soil Types	
SRI Map Units	Limitations Driving Sensitivity
5	pyroclastic rock outcrop
5-329	predominantly pyroclastic rock outcrop with glacial till
6	talus slope
6-13	rubble/felsenmeer and talus
12	wetr talus
13	felsenmeer slopes
13-6	felsenmeer and talus/rubble
13-12	felsenmeer and wet talus
15	steep, unstable, stream bank adjacent

Table 2-5a Soil Types from Pyroclastic Rock

Soil Types Originating from Pyroclastic Rock Parent Materials	
SRI Map Units	Limitations Driving Sensitivity
113	steep, unstable slopes, shallow, high erosion potential, droughty

Table 2-5b Soil Types from Igneous Rock

Soil Types Originating from Igneous Rock Parent Materials	
SRI Map Units	Limitations Driving Sensitivity
200	steep, unstable slopes, high erosion potential, shallow
200-7	same as soil type 200 but interspersed with igneous rock outcrops
201	steep, unstable slopes, high erosion potential, shallow, droughty, south aspect
201-7	same as soil type 201 but interspersed with igneous rock outcrops

Land management activities on sensitive soil types should strive to limit detrimental soil impacts. Standards and Guidelines from the Mt. Hood Forest Plan and Best Management Practices (BMP's) for all activities on sensitive soils should be identified prior to project implementation to prevent and minimize negative impacts to site productivity (direct effects), water resources (indirect effects), and existing detrimental soil conditions (cumulative effects). Appropriate BMP's for sensitive/fragile soils on BLM administered lands are discussed in Appendix C of BLM's Resource Management Plan (RMP, 1995).

Sediment Delivery from Roads and Timber Harvest

The South Fork watershed has been divided into four subwatersheds, ranging in size from 2,331 acres to 7311 acres (Map 2-2). The sediment delivery and hydrologic function analyzes were stratified at the subwatershed level.

Historically, sediment delivery from roads and timber harvest was more episodic than continual with high levels of delivery occurring during periods following recent large scale fires and floods. Causal agents for the sediment delivery were rain-on-snow events, floods or landslides. Currently, roads and timber harvest units also contribute to sediment delivery in South Fork.

Methodology for estimating sediment delivery from roads and timber harvest to streams closely follows methods for evaluating surface erosion from hillslopes and roads described in the *Standard Methodology for Conducting Watershed Analysis* (Washington Forest Practices Board 1993). The objectives of the methodology as applied to South Fork are:

* To evaluate and document the relative potential for sediment delivery from roads and timber harvest.

* Evaluate consistency with the Aquatic Conservation

Strategy Objectives (ACS).

* To prioritize activities and locations for restoration.

Natural or undisturbed rates of erosion for the landform types within the South Fork watershed are unknown. Swanson and Grant (1982) estimate average surface erosion rates for forested areas as .007 tons/acre/year. Therefore, surface erosion and sediment delivery estimated in the methodology used here is considered to be an increase due to recent management activities. Total vegetative recovery for surface erosion is assumed after five years for harvest units and road obliteration and revegetation.

Data limitations necessitated some alteration of analysis methodology from that described by the Washington Forest Practices Board. These departures retain the logic and assumptions of the original methodology. 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 or BLM administered lands. 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.

The modeled potential sediment delivery from roads and timber harvest units, by subwatershed are summarized in Table 2-6. Map 2-3 shows the road segments and harvest units with the highest potential to deliver sediment to streams.

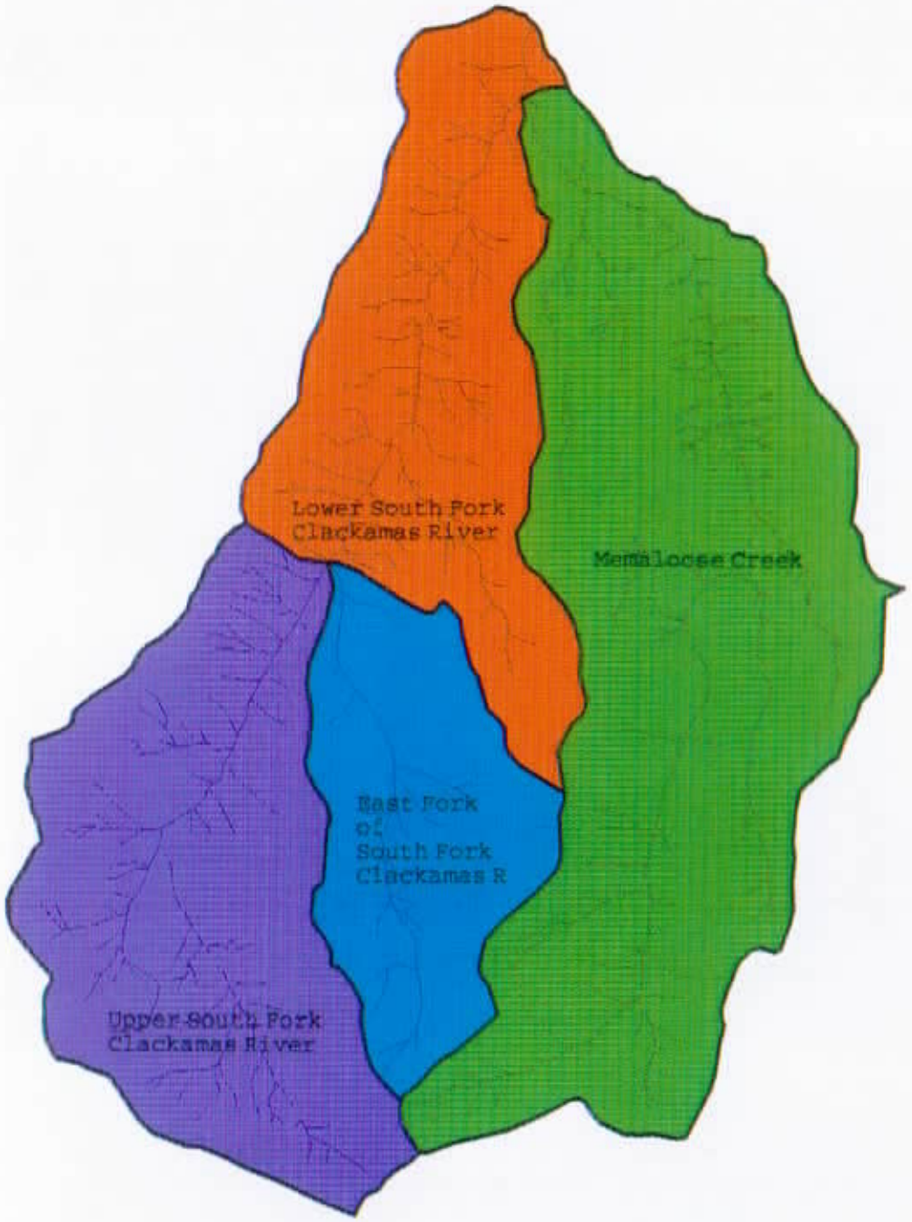
Roads

Roads may 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 outflow. (Table 2-6.)

The assessment of erosion from roads focuses on the three main factors associated with the road prism: cutslopes, fillslope, and road surface. Sediment from roads was predicted using erosion rates based on landform type, area of the road, and road surface type. Of the potential sediment, 100% was assumed to be directly delivered to the stream for road segments within 300 feet of a road/stream crossing. Road segments within 200 feet of a stream running parallel to, but not crossing the stream, were assumed to deliver 10% of the potential sediment to the stream through overland flow.

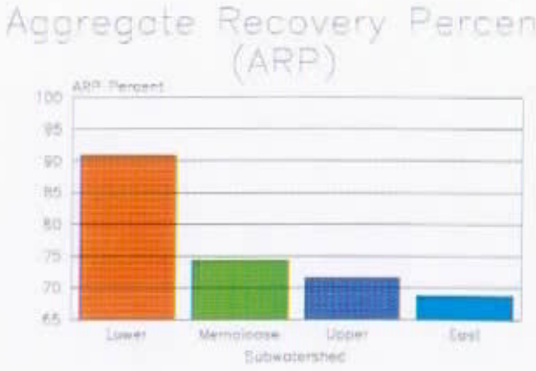
Sixty-nine percent of the potential sediment delivery from roads occurs in the Upper South Fork Clackamas subwatershed. Approximately 14 miles of the 96 miles of road in the South Fork have the likelihood of delivering sediment to streams.

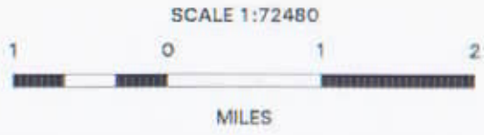
South Fork Clackamas River Watershed



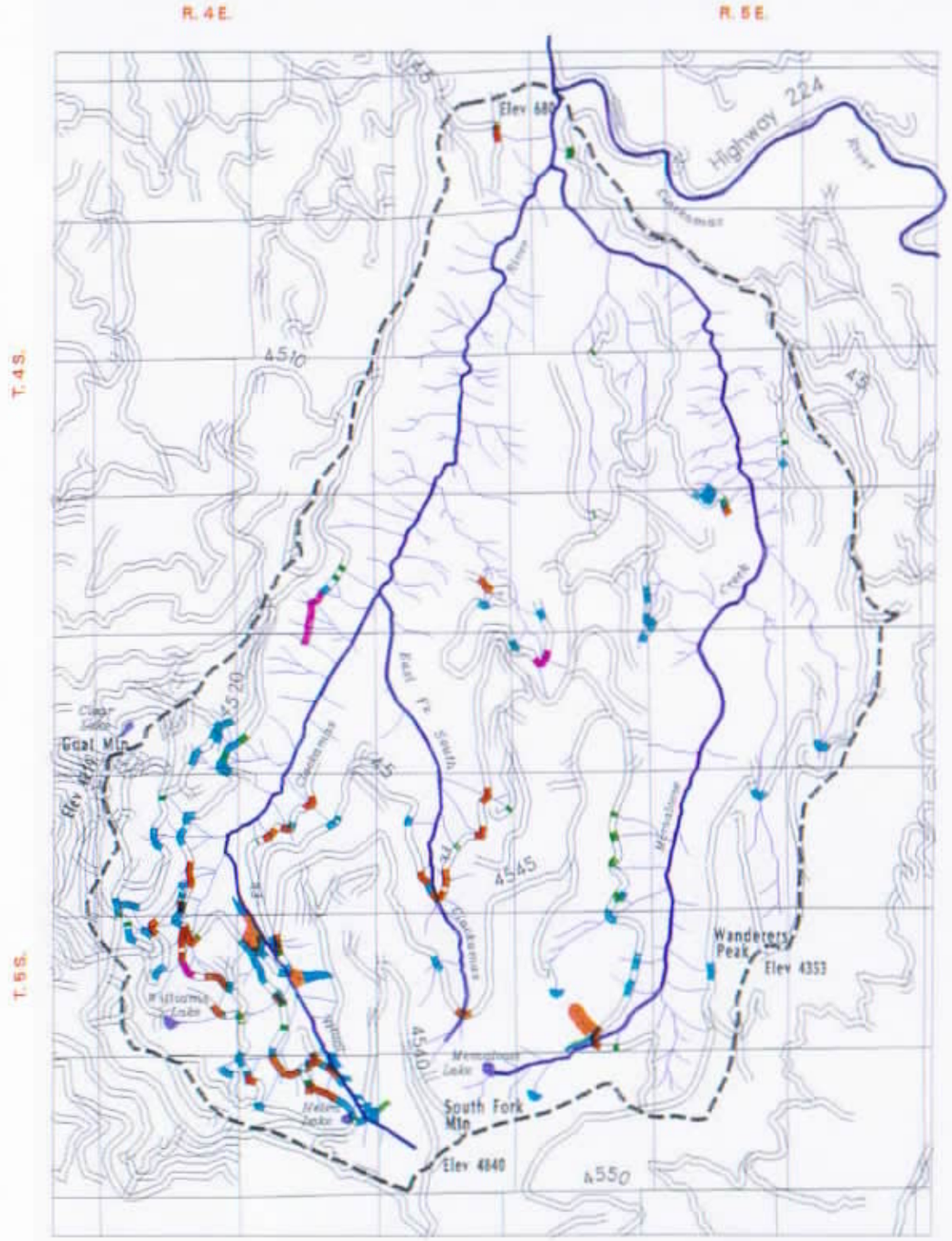
Legend

- East Fork of South Fork Clackamas River
- Lower South Fork Clackamas River
- Memaloose Creek
- Upper South Fork Clackamas River
- Streams





MAP 2-2



South Fork Clackamas River Watershed

Modeled Sediment Delivery From Roads and Harvest Activities

Legend

Road Sediment	Harvest Sediment
Extreme	High
High	Low
Low	Moderate
Moderate	

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N W E S

MAP 2-3

Table 2-6. Potential sediment delivery from roads and timber harvest units.

SOUTH FORK CLACKAMAS RIVER	ROADS				TIMBER HARVEST				TOTAL	
	Sediment Delivered		Road Length Delivering Sediment		Sediment Delivered		Area Delivering Sediment		Sediment Delivered From Roads & Harvest	
		% of Road		% of Road		% of Harvest	Harvest Area	% of Harvest		% of Total
Subwatershed	Tons/yr.	Sediment	Miles	Length	Tons/yr	Sediment	Acres	Acres	Tons/yr.	Sediment
East Fork of South Fork Clackamas	3.30	12%	1.15	8%		0%		0%	3.30	3%
Lower South Fork Clackamas	2.60	10%	0.98	7%		0%		0%	2.60	2%
Memaloose Creek	2.26	9%	2.61	20%	43.10	41%	7.42	39%	45.36	35%
Upper South Fork Clackamas	18.3	69%	8.79	65%	60.92	59%	40.1	61%	79.22	60%
Watershed Total	50.77	100%	21.01	100%	210.66	100%	258.9	100%	309.67	100%

"Approximately 60% of the total potential sediment delivery from roads and timber harvest occurs in the Upper South Fork Clackamas subwatershed."

Timber Harvest

Areas harvested within the last five years that are within 300 feet of a stream were considered to have potential to deliver sediment to streams. Thinning units were not included in the model. The model looked at area of the harvest unit and landform type erosion rate.

Fifty-nine percent of the potential sediment delivery from harvest units occurs in the Upper South Fork Clackamas subwatershed. The model predicts no potential sediment delivery from harvest units in the Lower South Fork Clackamas and East Fork of South fork subwatersheds.

Approximately 60% of the total potential sediment delivery from roads and timber harvest occurs in the Upper South Fork Clackamas subwatershed. The next highest subwatershed, for total potential sediment delivery, is Memaloose Creek with 35%.

B. Hydrology

Table 2-7 displays several watershed parameters influencing hydrologic processes within each of the subwatersheds in the South Fork drainage. Parameters examined include road density, drainage density, channel network expansion, and hydrologic recovery.

"A 50-100 year flood event recently occurred in the Clackamas River subbasin, in February 1996. Portions of the subbasin received extensive flood damage. Very little damage occurred in the South Fork watershed."

Peak Flows

Peak flows are critical to watershed function. The relatively frequent peak flows (2-year to 25-year return period) are referred to as "channel forming" or "channel maintenance" flows, responsible for shaping the general character of stream channels, adjacent riparian areas, and associated habitats. The relatively infrequent (50-year to 100-year) peak flows are floods which generally transport and redistribute large quantities of sediment and debris, often causing damage to road infrastructure and dramatic changes to aquatic and riparian habitats.

A 50-100 year flood event recently occurred in the Clackamas River subbasin, in February 1996. Portions of the subbasin received extensive flood damage. Very little damage occurred in the South Fork watershed.

Transient Snow Zone

Flood events in the South Fork Clackamas River are similar to other documented floods in the Cascades. These peak flow events occur during the rainy season following a rapid and substantial depletion of snowpack during a prolonged rain-on-snow period in the "transient snow zone" (a zone of significant snowpack accumulation). This was demonstrated during the February 1996 flood event. Approximately 76% of the South Fork watershed is within the normally occurring transient snow zone.

Created Opening

Research elsewhere in the Cascades has shown that more snow accumulates in openings than under forest canopies and that during rain-on-snow events the runoffs from these areas are more rapid. Timber harvest activities (particularly clearcuts) and other created openings (roads, windthrow areas, fires, etc.) are areas of increased snow accumulation. Rapid runoff from these areas increases the magnitude of peak flows during rain-on-snow events, which can result in channel scour, down cutting, or widening of the stream channel.

Currently, 3,267 acres (19%) of the South Fork watershed are clearcut areas that have not yet developed a closed forest canopy. All acres are found on federal land within the watershed. There are 96 miles of road in the watershed, for a total road density of 3.37 miles/mile^2 (Table 2-7). The highest road densities occur in the Upper South Fork Clackamas (5.94 mi/mi^2) and East Fork of South Fork Clackamas (3.24 mi/mi^2) subwatersheds, both of which are primarily on public lands.

Table 2-7. Watershed Parameters Affecting South Fork Clackamas River Hydrologic Processes.

	Total	Total	Total Road	Road Density	Total Stream	Drainage Density	Stream Crossings	Channel Expansion		Hydro Recovery ARP
								Low Est.	High Est.	
SUBWATERSHED NAME	(Acres)	(Sq. Mi)	(Miles)	(Mi/Sq. Mi)	(Miles)	(Mi.Sq/Mi)	(#)	(%)	(%)	(%)
East Fork of South Fork Clackamas	2331	3.64	11.78	3.40	8.20	2.25	7	3.3%	8.0%	68.7%
Lower South Fork Clackamas	3608	5.64	11.45	2.36	22.35	3.96	4	0.7%	1.7%	90.9%
Memaloose Creek	7311	11.42	31.46	2.86	37.49	3.28	12	1.2%	3.0%	74.3%
Upper South Fork Clackamas	4397	6.87	40.8	7.21	24.94	3.63	61	9.3%	23.2%	71.6%
Total	17647	27.57	95.49	3.91	92.98	3.37	84	3.4%	8.6%	76.3%

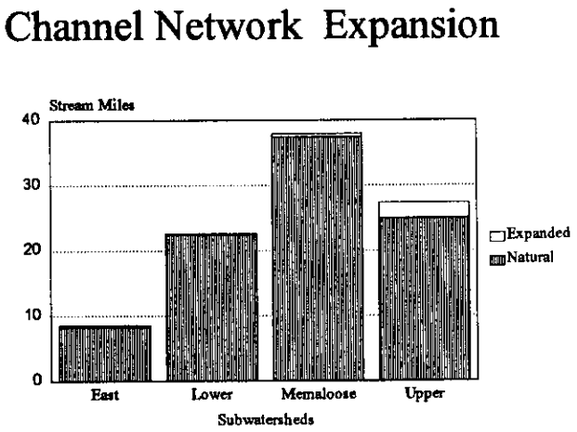
The potential channel network expansion attributed to roads was calculated at a distance spacing of 200 to 500 between ditch relief culverts, adding an additional 400 to 1000 feet to lengths of affected streams.

Channel Network Expansion

Road surfaces and cut slopes are essentially impermeable to rainfall and snowmelt. They intercept shallow subsurface flow and concentrate surface runoff. Road ditches function as extensions of intermittent streams, increasing overall drainage density and transporting water more rapidly than natural processes. Increased road densities result in more water being delivered to streams within a shorter time frame, potentially affecting the magnitude of smaller peak flows.

The potential channel network expansion attributable to roads was calculated by estimating the length of road directly accessing streams, and adding that value to the length of affected streams. Since the exact spacing of ditch relief culverts could not be determined for each road in each subwatershed, a "best case" scenario (200 foot spacing) and a "worst case" scenario (500 foot spacing) were analyzed (Table 2-7). The lower values appear to be realistic for most roads and watersheds, based on field observations and common construction practices. Channel networks appear to have expanded 3.4% overall, with subwatershed values ranging from 0.7% (Lower South Fork Clackamas) to 9.3% (Upper South Fork Clackamas) (Figure 2-1). Lower South Fork Clackamas, and Upper South Fork Clackamas subwatersheds have the greatest percentage of channel network expansion.

Figure 2-1. Channel Network Expansion Related to Roads.



Aggregate Recovery Percentage (ARP)

The effects of management activities on hydrologic function and hydrologic recovery were assessed using the Aggregate Recovery Percentage (ARP) methodology. The ARP model examines the effect of harvested openings and roads on hydrologic recovery.

The Mt. Hood National Forest Land and Resource Management Plan identified an ARP value "threshold" of 65% for the South Fork watershed. This means that at least 65% of the watershed should be in a hydrologically recovered condition (defined as coniferous forest with at least 70% crown closure and an average diameter of at least 8 inches). ARP values of less than 65% suggest a very high likelihood of increased magnitude and frequency of peak flows associated with rain-on-snow events and potential subsequent channel degradation. The concept of a single absolute "threshold" has been called into question by recent research. While no absolute thresholds exist in the real world, subwatersheds with lower ARP values are considered at greater risk for damaging peak flows.

ARP values of the four subwatersheds in South Fork range from 69% (East Fork of South Fork Clackamas) to 91% (Lower South Fork Clackamas) (Table 2-7). All subwatersheds are currently above the Mt. Hood Forest Plan standards. East Fork of South Fork Clackamas, the subwatershed with the lowest ARP value, is predominantly on Federal land . Considering the small amount of damage that occurred on federal lands in the watershed during the recent flood event, it appears that South Fork is in a hydrologically recovered condition and that the Forest Plan thresholds are valid.

Base Flow

Base flow is critical to watershed health during times of little or no precipitation, providing habitat for fish and other aquatic organisms, sustaining habitat for riparian plants and animals, and maintaining cover and travel corridors for wildlife. Decreases in base flows are a concern to the watershed because of reduction in effective habitat for aquatic organisms; and the possible decrease in water quality, i.e., increased water temperatures, decreased dissolved oxygen levels, and increased algal and pathogen populations.

Limited information exists on base flows in the South Fork watershed. However, because Oregon City and West Linn diverted water from the Lower South Fork Clackamas subwatershed during the years 1915 through the early 1980's, it is assumed that the base flows were down from the historic levels during this period. Currently South Fork watershed base flow should be approaching the historic levels due to increased ARP values, decrease in harvest activities during the recent years and because the diversion of water has stopped.

"Today the Riparian Reserves in the South Fork watershed are composed of 30 percent early seral, 25 percent mid seral and 44 percent late seral stands."

C. Stream Channel

Riparian and Aquatic Habitat Conditions

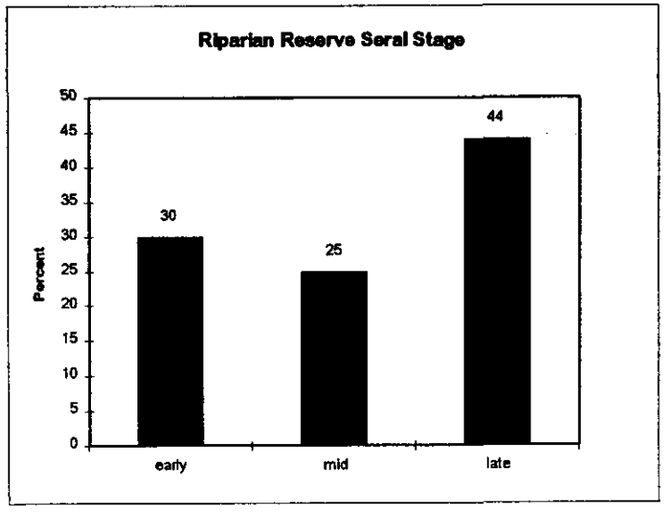
The South Fork watershed is composed of four subwatersheds: Lower, Upper, East and Memaloose (Map 2-2).

The South Fork watershed has two main drainages the South Fork Clackamas River and Memaloose Creek. They are characterized by V-shaped canyons with steep side slopes ranging from 30-60 percent. The first couple miles of both streams flow through a narrow canyon with deep gorges and waterfalls. Because of these steep slopes, and the weak and resistant rock formations of the lower drainage (Map 2-1) landslides are possible with a high probability of sediment delivery to streams. Ancient landslides in the headwaters of South Fork Clackamas have produced numerous wetlands through landform processes. The headwaters of Memaloose have been formed by glaciation.

Today the Riparian Reserves in the South Fork

watershed are composed of 30 percent early seral, 25 percent mid seral and 44 percent late seral stands (Figure 2-2). The Range of Natural Variability (RNV) was determined during the REAP analysis (USDA, 1993) for Riparian Reserves. The RNV for early seral is 5-15 percent and late seral is 35-80 percent. Currently the early seral stage is outside the RNV due to a history of timber harvest, road building and extensive windthrow. This is especially true in the Upper and East subwatersheds (Map 2-4). The projected large woody debris (LWD) recruitment potential in the South Fork watershed within the Riparian Reserves is related to seral stage for each subwatershed. Low potential recruitment areas are associated with early seral stands and high potential recruitment areas are late seral stands.

Figure 2-2 Riparian Reserve Seral Stage



South Fork Clackamas River

The entire riparian area along the mainstem South Fork in the Lower subwatershed lies within the LSR and is virtually undisturbed with the exception of a road built to access the South Fork Waterworks. These Riparian Reserves consist of late seral stands of Douglas fir, western hemlock and western red cedar (Map 2-4). Recruitment potential for LWD and stream shade are excellent. These Riparian Reserves will continue to improve aquatic habitat within the LSR.

The Upper and East subwatersheds of South Fork and Oscar Creek of the Lower subwatershed have been impacted from past timber harvest and road building activities. These subwatersheds have also been influenced by wind patterns. Windthrow frequently occurs in the fall with southwest winds and saturated soils. The east and southeast winds during the winter also contribute to windthrow. Timber harvest and road building activities have resulted in windthrow along streams within Riparian Reserves. Consequently many perennial and intermittent streams lack the necessary stream shading and LWD recruitment potential. Current riparian vegetation average less than 100 feet wide consisting of mainly early seral stands and hardwoods (Map 2-4).

Anadromous fish are limited to the lower 0.4 miles of South Fork Clackamas River by a 70 foot barrier falls. Steelhead, coho and possibly spring chinook, occupy this section for spawning. Because of its location just above the reservoir, this area could be an important area for restoration activities to enhance habitat diversity, creating rearing and overwintering habitat for coho and steelhead.

A restoration project was completed on the South Fork Clackamas River at river mile 7.0 - 7.5 within the Upper subwatershed (USDA, 1990). This effort targeted habitat for resident trout populations in the upper reach of South Fork which has been heavily impacted by timber harvest activities. A helicopter placed LWD and boulders into the stream to increase habitat diversity for the resident trout.

Sediment concerns from roads are mainly in the Upper subwatershed. Portions of roads 4530, 45, 4540, 4540-120, 4540-130 and 45-140, and 45-200 near Oscar Creek in the Lower subwatershed are potentially sediment producers to South Fork Clackamas River and Oscar Creek because of their location within the Riparian Reserves (Map 2-3).

Memaloose Creek

Memaloose Creek subwatershed has been impacted from past timber harvest and road building activities. Windthrow from mainly east winds has occurred within the subwatershed but not as extensive as in South Fork drainage. Buffer strips which at one time were intact, now have either blown down into the channel or are very sparse or nonexistent. Many of

the perennial and intermittent streams lack the necessary stream shading and LWD recruitment potential due to harvest near creeks and subsequent windthrow. Tributaries with extensive areas of blowdown are the headwaters of Cultus and Elbow Creeks. Approximately one-half of the Riparian Reserve vegetation along the mainstem Memaloose Creek is in late seral stands (Map 2-4).

The headwaters of Memaloose Creek are within an LSR. An A9 Key Site Riparian land allocation is located around Memaloose Lake, the headwaters of Memaloose Creek. This allocation is completely within the Riparian Reserve network (Map 1-4).

Sediment concerns from roads are mainly located on portions of roads 45-220 and 45 where it crosses Memaloose Creek. These areas are potential sediment producers to Elbow and Memaloose Creeks because of their location within the Riparian Reserves (Map 2-3).

Large Woody Debris and Pools

Current habitat conditions are measured by large woody debris (LWD), small woody debris (SWD), and primary and total pools per mile. Large woody debris is delivered and removed into the stream channels by natural processes and human activities. Natural processes include windthrow, landslides, floods, fire and the natural tendency of wood to migrate downstream. Human activities such as timber harvest, road construction, and instream LWD removal affect the presence of large wood in the stream. Large wood influences channel morphology by affecting the longitudinal profile, pool formation, channel pattern, complexity, cover, stream velocity and nutrient storage. Pools provide important habitat for adult salmonids during spawning migrations, baseflow thermal refugia, and protective cover. In addition, pools provide important rearing and overwintering habitat for juvenile steelhead, salmon, resident fish, and amphibians.

Beyer and Miller, (1990) and Bucknum, (1995) conducted stream surveys for the South Fork Clackamas River and Memaloose Creek respectively. Table 2-8 shows information on pool and woody debris frequency. All reaches of South Fork Clackamas River and Memaloose Creek are below the Mt. Hood Forest Plan standards for primary pools (pools greater than 3 feet deep) and the Columbia River Policy Implementation Guide (PIG) for total pools. This suggests that some of the reaches within the streams may lack adequate organic input for structure such as large wood to help create pools. Pools per mile are highly variable and are also dependent on gradient, confinement, substrate and stream width.

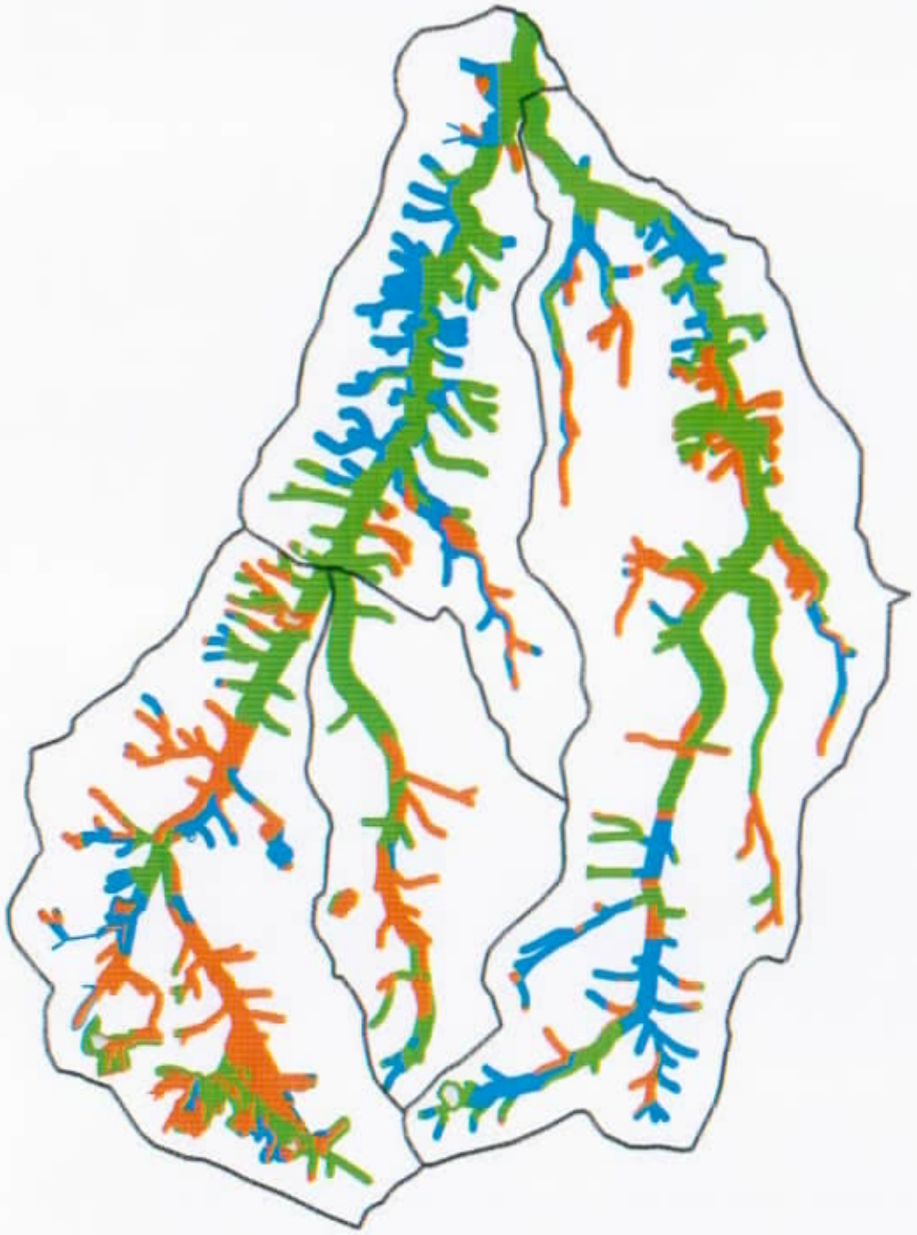
Both reaches of South Fork Clackamas River meet the Mt. Hood Forest Plan standards for LWD. The amount of LWD in reach 1 located in the Lower subwatershed, may reflect the relatively undisturbed, late seral stand conditions of the Riparian Reserve. Reach 2, in the Upper subwatershed may reflect the addition of LWD from windthrow of riparian buffers blown down into the stream. Also, the Upper subwatershed lacks future recruitment potential for LWD because of the early and mid seral stands.

All reaches of Memaloose Creek are below the Mt. Hood Forest Plan standards for LWD. This may be due to timber harvest activities within the Riparian Reserves. The mid and early seral stands do not provide recruitment potential. This can result in the reduction of aquatic habitat quality and affect the natural stream channel functions such as pool formation, regulation of bedload movement, and nutrient routing.

"Anadromous fish are limited to the lower 0.4 miles of South Fork Clackamas River by a 70 foot barrier falls."

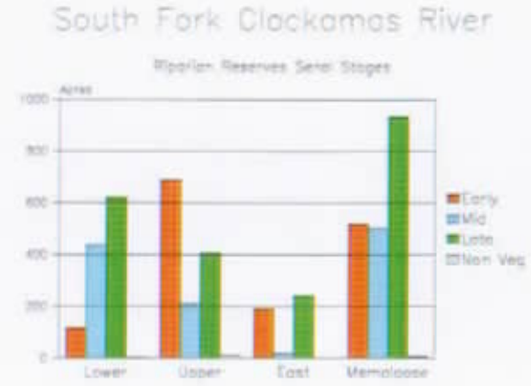
South Fork Clackamas River Watershed

Riparian Reserve with Seral Stages



Legend

- Early (30%)
- Late (44%)
- Mid (25%)
- Non Forest



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MILES

MAP 2-4

Table 2-8 Comparison of existing pool and LWD conditions in the South Fork Watershed with the Mt. Hood Forest Plan (LMP) and Columbia River Policy Implementation Guide (PIG) standards

Stream	Reach #	River Mile	Primary Pools		Total Pools		LWD/ Mile	SWD/ Mile	LMP std*
			Pools /Mile	LMP std	Pools/ Mile	PIG std			
S. Fork Clackamas	R1	0.0-4.5	8.4	42.9/mi	10	26/mi	36.7	71.9	106/mi
	R2	4.5-9.0	3.4	84.6/mi	10.3	56/mi	30.7	84.8	106/mi
Memaloose	R1	0.0-1.1	25.2	53.3/mi	44.7	47/mi	4.1	34.9	106/mi
	R2	1.1-5.4	9.3	65.7/mi	30	47/mi	17.2	20.7	106/mi
	R3	5.4-6.7	0.8	83.8/mi	19.7	56/mi	6.8	11.3	106/mi
	R4	6.7-7.5	0	176/mi	16	96/mi	1.1	12.8	106/mi
	R5	7.5-7.9	2.0	220/mi	32.7	56/mi	0	0	106/mi

*20% should be LWD> or = to 36 inches and 50 feet in length
80% should be SWD> or = to 24 inches and 50 feet in length.

D. Water Quality

Recreational use of dispersed recreation sites has the greatest potential to affect water quality in the South Fork watershed. Human fecal material could enter the streams from dispersed sites. The effects of biological contamination is unknown due to a lack of water quality monitoring.

Temperature

Stream temperatures are affected by direct solar radiation which depends on the quality and quantity of shade, vegetative and / or topographic. Natural disturbances such as landslides, windthrow, and fire, and human activities such as timber harvest and road building have the potential to influence stream temperature by altering stream side vegetation and channel form. The health and productivity of fish and other aquatic organisms are directly related to stream temperature. Water temperatures in streams can vary daily, seasonally, and spatially.

Limited stream temperature data is available for the South Fork Watershed. Low flow summer stream temperatures were measured with continuous recorders during 1991, and 1992, between the months of June and September (data on file at Clackamas River Ranger Districts). The two sites monitored were located at the mouth of South Fork Clackamas

River in 1992 and the confluence of South Fork Clackamas River and the East Fork of the South Fork Clackamas River in 1991. The seven day maximum stream temperature for the mouth of South Fork Clackamas was 18.8 degrees Celsius which is within the RNV for the Clackamas River subbasin 14.5 - 20.0 degrees Celsius (REAP, USDA, 1993). The upper site exceeded the RNV at 21.3 degrees Celsius. Both sites exceeded the state water quality standard of 17.8 degrees Celsius for the 7 day average high.

All of South Fork's subwatersheds have been influenced to some degree by wind patterns. The wind in the Upper subwatershed has resulted in major blowdown along streams in the Riparian Reserves associated with harvest activities and road building. Consequently many perennial streams and intermittent streams lack the necessary shading to maintain cool stream temperatures during summer months. Other factors possibly influencing stream temperatures may be the general hydrology of the area, the limited number of springs producing cold water sources and lower stream flows. Stream temperatures at the mouth of the South Fork and the general aspect of the stream are similar to Fish Creek (See Fish Creek Watershed Analysis). With the limited stream data available for the watershed and the potential for elevated stream temperatures, the South Fork watershed may need additional monitoring.

Macro-Invertebrates

Aquatic macro-invertebrate sampling was conducted at the mouth of the South Fork Clackamas River and Memaloose Creek in 1991. This type of sampling can provide important baseline information to help evaluate watershed condition and water quality. Data analysis was done using a modified Environmental Protection Agency (EPA) Rapid Bio-assessment Protocol (Aquatic Biology Associates, 1991).

The 1991 results indicate that both South Fork and Memaloose Creek have taxa typical of Western Cascade streams. However, they both contain higher percentages of tolerable taxa than intolerable taxa, which can indicate poor habitat quality due to increased stream temperatures, increased canopy openings, and/or fine sediment accumulation. This may relate to the watersheds past history of windthrow and harvest activities along Riparian Reserves. The dominant functional feeding group is the collector/gatherers which can indicate a possible impairment or limitation in the stream habitat. An indicator of good water quality is a stream with high percentages of shredders and scrapers. Both South Fork and Memaloose Creek have a low percentage of shredders which can indicate insufficient input of organic matter into the stream and/or limited stream retention capabilities such as logs and boulders to maintain the organic material in the channel. Memaloose Creek's low percentage of scrapers could be an indicator of sediment sources delivery from such as roads, unstable ground or management activities.

Turbidity

Turbidity is an optical measure of water clarity and is also an indicator of the amount and type of material contained in the water. Municipal water suppliers are required to monitor turbidity to ensure compliance with the Safe Drinking Water Act (SDWA). In the early 1980's, the SDWA required that, for an unfiltered water supply, turbidity be less than 5 NTU's 95 percent of the time (Sparling, South Fork Water Board (SFWB)).

The SFWB monitored turbidity daily at their diversion sites on Memaloose Creek and the South Fork Clackamas River from 1970 until 1984. The SFWB turbidity monitoring indicated that water at the diversions on the South Fork Clackamas River (about 1.5 miles from mouth) and Memaloose Creek (about 0.5 miles from mouth) did not occasionally meet the stringent SDWA turbidity requirements for an unfiltered water supply during certain peak runoff months. This is not unusual, since instream turbidities in many wildland watersheds can routinely exceed 5 NTU's during storm runoff periods. Storm-related turbidities at the diversion on Memaloose Creek were usually lower than storm-related turbidities for corresponding days at the diversion on the South Fork Clackamas River. No other turbidity data is available for the South Fork Clackamas River. The primary sources of turbidity in

the watershed is expected to be a combination of surface erosion from roads on both public and private lands, and stream bank failures.

E. Aquatic Species and Habitats

Fish Distribution

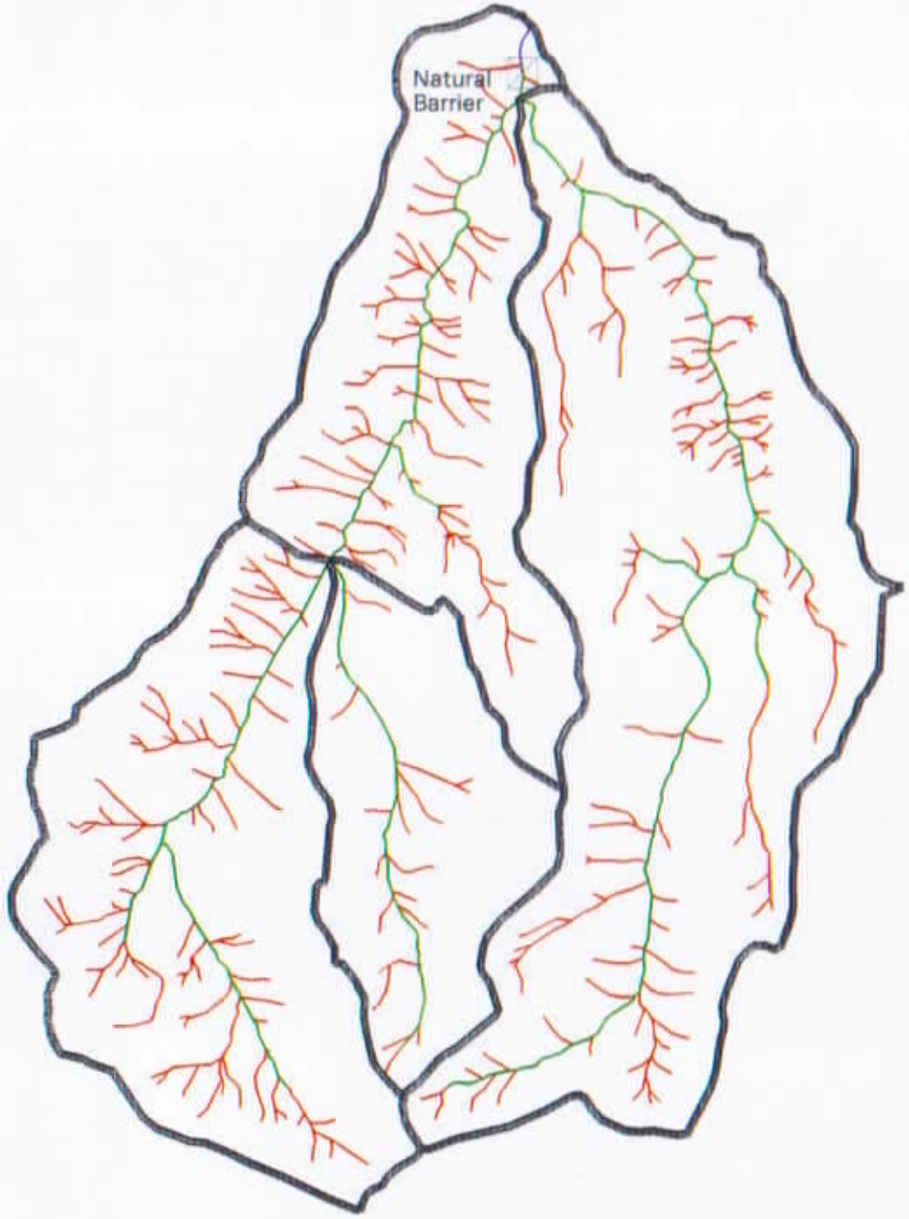
Fish present in the South Fork watershed consist of late and early run coho salmon, summer and winter steelhead, spring chinook, resident rainbow trout and resident cutthroat trout. Other fish occupying the watershed are large scale suckers, sculpin, and longnose dace.

A 70 foot falls on the South Fork Clackamas River at river mile 0.4 is a migration barrier for anadromous fish. The anadromous portion of South Fork is all on Forest Service administered land. Native populations of cutthroat and rainbow trout occupy both the South Fork and Memaloose Creeks as well as major tributaries such as the East Fork of the South Fork, Oscar Creek, Elbow Creek and Cultus Creek. The South Fork watershed consists of 0.4 miles of anadromous streams, 24 miles of resident fish bearing streams and 69 miles of non-fish bearing streams (Map 2-5).

Little historical information exists on the distribution and population of fish which occupy the South Fork and Memaloose drainages. However estimates of historic numbers of anadromous fish have been made for the entire Clackamas River Subbasin (ODFW, 1992). Table 2-9 displays status of fish species and stocks above North Fork Dam. Native winter steelhead which was proposed for listing under the Endangered Species Act by the National Marine Fisheries Service and late run coho are declining. Commercial and recreational harvest, coexistence of hatchery stocks, reduced habitat quality, and the effects of hydroelectric facilities have contributed to the decline of these stocks.

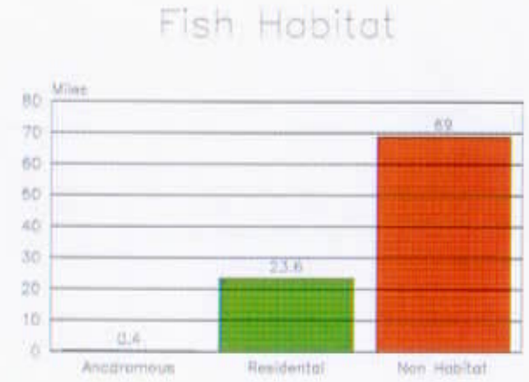
South Fork Clackamas River Watershed

Fish Habitat and Barriers



Legend

- Anadromous
- Non Habitat
- Resident



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MAP 2-5

Table 2-9. Fish species and stock status

Common Name	Scientific Name	Stock Origin	Status
coho salmon	*Oncorhynchus kisutch*	early run - H	increasing
		late run - W	declining
spring chinook salmon	*Oncorhynchus tshawytsha*	W/H	increasing
winter steelhead	*Oncorhynchus mykiss*	H	declining
		W	declining
summer steelhead	*Oncorhynchus mykiss*	H	stable
cutthroat trout	*Oncorhynchus clarki*	W	unknown
rainbow trout	*Oncorhynchus mykiss*	W	unknown
brook trout	*Salvelinus confluentus*	H	unknown
sculpin	*Cottus sp.*	W	unknown
large scale sucker	*Catostomus macrocheilus*	W	unknown
longnose dace	*Rhinichthys cataractae*	W	unknown

H - Hatchery W-Wild

Anadromous Fish

Steelhead

In 1991, Nelhsen, et. al., identified the Clackamas River native late run winter steelhead as being at a "moderate" risk of extinction. The Oregon Department of Fish and Wildlife (ODFW) recognizes the late run winter steelhead as a "stock of concern". In 1994 all native stocks of steelhead from Alaska to southern California were petitioned for listing under the Endangered Species Act. In August of 1996 the National Marine Fisheries Service proposed listing the Lower Columbia River steelhead which includes the Clackamas River as "threatened" under the Endangered Species Act (ESA) (Federal Register, 1996). Winter steelhead are known to spawn throughout most of the Clackamas Subbasin but South Fork is not considered a primary spawning location, though juvenile steelhead were observed during the 1990 (Beyer and Miller, 1990) stream survey.

Coho

The South Fork Clackamas River has been designated eligible to become a Wild and Scenic River. Its eligibility was based on fisheries values being outstandingly remarkable due to the presence of late run winter coho below the barrier falls at river mile 0.4. The late run coho salmon is recognized as the last self sustaining wild run of coho salmon in the lower Columbia River (Cramer and Cramer, 1994). One year class has declined 95% in two generations.

In 1991 Nehlsen, et. al., designated the Clackamas River native late run coho as at "moderate" risk of extinction. This stock is also listed as "sensitive" on both the state Sensitive Species List (ODFW,1992) and the Regional Forester's Sensitive Species List. Hatchery origin early run coho also occupy the South Fork.

Coho prefer streams that have low water velocities, low gradient, side channels and woody debris for habitat complexity. Because of its riffle dominated habitat, the South Fork is not a preferred stream for coho, but a spawning survey in 1992 determined the presence of late run coho spawning activity (USDA, 1992). Because of the lack of rearing and over-wintering habitat it is likely that the fry move into the mainstem Clackamas to find adequate rearing habitat.

Spring Chinook

Historically the Clackamas River was considered one of the largest producers of spring chinook salmon (ODFW,1992). In the mid 1800's commercial harvest in the Columbia river for chinook drastically reduced the indigenous stocks from the Clackamas River. Today the spring chinook run in the Clackamas consists of both native and hatchery fish. It is believed by local fisheries biologists that historic native spring chinook in the wild have interbred with hatchery strays and that little if any wild genes are left in the gene pool (Shively, personnel communication). The South Fork is a minor contributor to the Clackamas River for the production of spring chinook.

Resident Fish

Rainbow and Cutthroat Trout

Resident rainbow and cutthroat trout populations are present in the South Fork Clackamas River and Memaloose Creek, including major tributaries. Additional sampling is needed to determine the upper limits of these resident trout due to natural or man-made barriers or lack of base flow. Oregon Department of Fish and Wildlife stock the mainstem Clackamas River with hatchery rainbows. These fish are blocked from entering the upper reaches of the watershed by the barrier falls at river mile 0.4.

"Brook trout are exotic fish that have been introduced into the South Fork watershed through stocking that has taken place in Memaloose and Williams Lakes."

Brook Trout

Brook trout are exotic fish that have been introduced into the South Fork watershed through stocking that has taken place in Memaloose and Williams Lakes. They have escaped from Memaloose lake through the tributary outlet into Memaloose Creek. Because these fish are exotic to the region they pose a threat to the native populations of cutthroat and rainbow trout that occupy Memaloose Creek through competition for available food and habitat. Brook trout are now the dominant fish population above the falls in Memaloose Creek. The population is probably stable but monitoring may be necessary. Brook trout have been caught throughout Memaloose Creek. It is not known whether the brook trout in Williams Lake have escaped into the mainstem South Fork Clackamas River.

Other Fish

Large scale suckers, sculpin and longnose dace are known to occupy the South Fork watershed.

Lakes

The South Fork watershed consists of three main lakes: Memaloose, Williams and Helen Lakes. All these lakes except Helen support recreational fishing and are currently stocked by the state with brook trout. During the 1980's rainbow and cutthroat were stocked.

Trends

Aquatic

The condition of Riparian Reserves should improve with the designation of LSR's within the watershed. Riparian Reserves outside LSR's will continue to be influenced by wind patterns and increasing risk of windthrow through management of adjacent matrix lands. The Conceptual Landscape Design recommends the development of windfirm Riparian Reserve stands through second growth thinnings, silvicultural prescriptions, harvest design and mitigation measures which should help maintain and support the habitat quality of the Riparian Reserves.

Sediment delivery into streams should decrease with the implementation of the Aquatic Conservation Strategy (ACS) and the designation of Riparian Reserves including unstable and potentially unstable lands.

The effects of roads on aquatic resources will be reduced as restoration activities occur such as road obliteration, erosion control and road stabilization to reduce sediment delivery to streams.

The recovery of at risk fish stocks, especially the late run coho salmon and late run winter steelhead, will continue to depend on high quality habitat in the lower 0.4 miles of South Fork Clackamas River.

Brook trout may continue to expand their distribution within Memaloose Creek through competition for available food and habitat.

It is expected that the functional feeding group composition should improve from collector/gatherers back to shredders as stream retention capabilities are increased by large woody debris and boulders that help maintain the organic material in the channel. Scrapers will also increase as sedimentation levels decrease due to restoration activities occurring with the implementation of the ACS.

Recommendations

- Fish habitat restoration should concentrate on increasing instream LWD through short and long term recruitment particularly in the Upper and East subwatersheds and Memaloose and Oscar Creeks. This is accomplished through placement of instream structures, silvicultural thinnings to promote late seral structure and windfirmness, and planting of western redcedar.

- Roads within the South Fork watershed should be managed to reduce sediment effects and expansion of stream channel networks on riparian and aquatic habitat functions. Emphasis should be given to roads in the East and Upper subwatersheds (See Access and Travel Management).

- Address ACS objectives in proposed harvest activities (including salvage) of windthrow trees in Riparian Reserve.

Current and Reference Condition

A. Vegetation

Landscape Structure

Map 2-6 is a landscape structure map which displays the current condition of the South Fork watershed. The structural elements of the South Fork landscape are divided into six broad categories:

- Matrix (landscape ecology definition)
- Hardwood patches
- Immature forest patches
- Wetland patches
- Aquatic patches
- Rock patches.

The "matrix" within the South Fork watershed, based on the criteria of relative area, connectivity, and control over landscape dynamics (Forman and Godron 1986, Diaz and Apostol 1992), is defined as mature forest, a combination of large and small sawtimber. The matrix is composed of three different structural classes: large conifer, closed small sawtimber, and open small sawtimber. Immature forest patch structural classes include grass/forb/shrub, open sapling pole, and closed sapling pole stands.

Other patch types identified within the South Fork watershed are considered "special habitats" (see Map 2-7), these include hardwood patches (both mixed red alder/conifer stands and stands of pure red alder (*Alnus rubra*), wetland patches (Shrub dominated meadows), three aquatic patches (Three small backcountry lakes), and rock patches (rock outcrops and talus slopes). These areas contribute to species and habitat diversity within the watershed for animals, vascular plants, and also lichens, mosses, and fungi.

South Fork has few special habitats compared to other watersheds in the Clackamas subbasin. There are eighteen shrub/wet meadows identified in the watershed, the largest of which is 40 acres. There are some small wet areas and patches of Sitka alder (*Alnus sinuata*) which do not appear on Map 2-7. There are 103 acres of rock and talus habitat in South Fork, proportionately less than in most of the watersheds in the subbasin. There are three lakes in the watershed.

Williams Lake is a 35 acre lake and bog on a bench (Map 2-7). This area has dual ownership between federal and private. This are is surrounded by a 125 - 175 year old conifer forest consisting of approximately equal amounts of Douglas-fir, Pacific silver fir, and noble fir and western hemlock. These trees provide a dense, shaded environment with a sparse understory.
Shrub communities border the lake on the east and west, and water flows from the lake through beaver dam on the east side. The Williams lake area is an example of a Cascadian massive seep-formed lake undergoing peat bog/quaking bog succession.

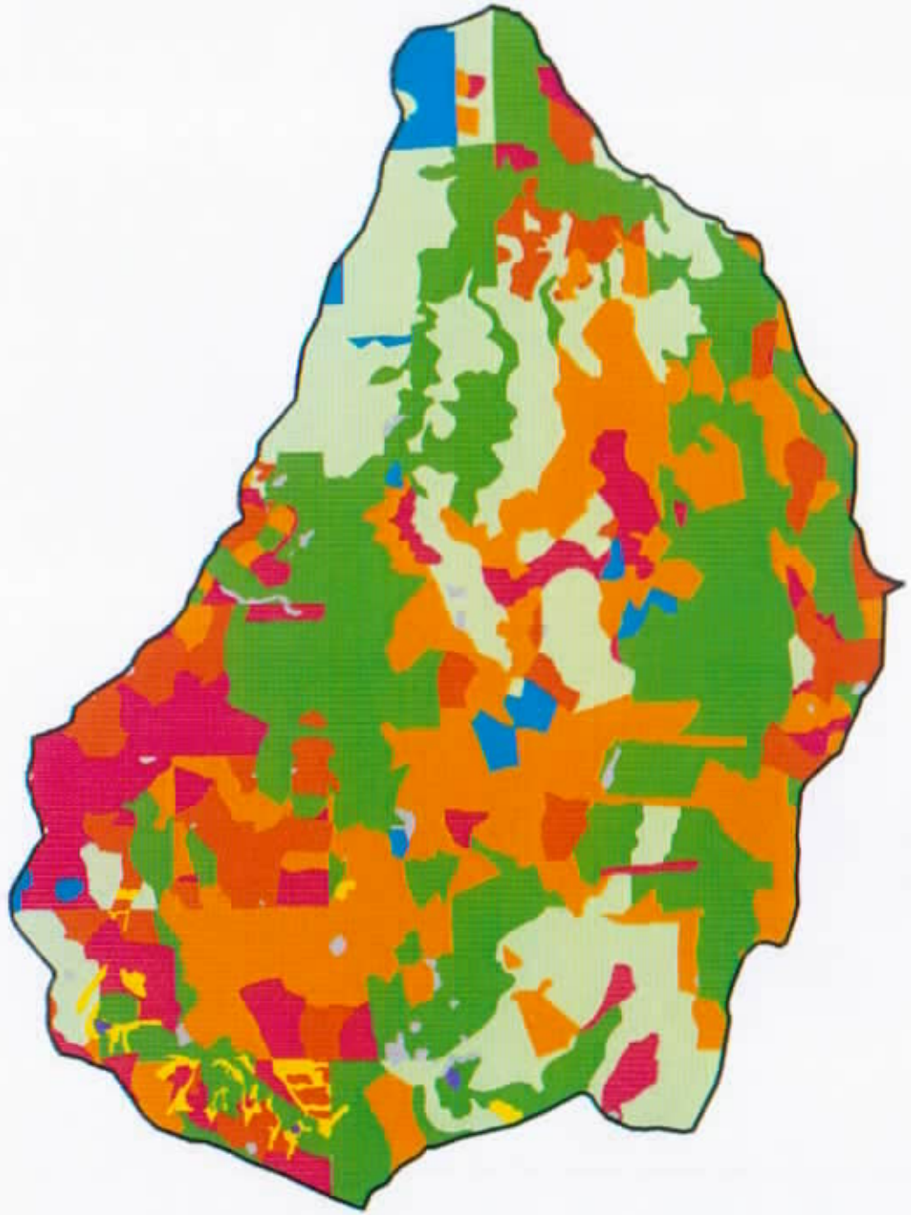
Seral Stages

Seral stages within the South Fork watershed can be grouped into three broad developmental stages: early, mid, and late seral (Table 2-10). Currently, 35% of the vegetated acres in South Fork are in an early seral condition, 34% in mid seral, and 31% in late seral (Map 2-8). The three seral stages vary by both species composition and structure of the vegetation. Seral stage is an important ecological driver within the watershed affecting a variety of ecosystem functions, including wildlife species use and migration, nutrient cycling, hydrologic function, production of snags and coarse woody debris, and disturbance processes (fire, insects, disease, and windthrow), among many others. Seral stage also greatly influences aesthetic and potential economic aspects of the watershed.

"Currently, 35% of the entire South Fork watershed is in an early seral condition, 34% in mid seral, and 31% in late seral."

South Fork Clackamas River Watershed

Vegetative Structure



Legend

- Closed Sap/Pole
- Closed Small Saw
- Grass/Forb/Shrub
- Large Conifer
- Open Sap/Pole
- Open Small Saw
- Rock
- Shrub Wetlands
- Water

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MAP 2-6

South Fork Clackamas River Watershed

Special Habitats

Legend

- Landform Failure
- Rocky Land
- Rock with Scattered Conifer
- Rock with Scattered Shrubs
- Shrub Wetlands
- Red Alder Wetlands
- Wet shrubland with Scattered Conifers
- Water

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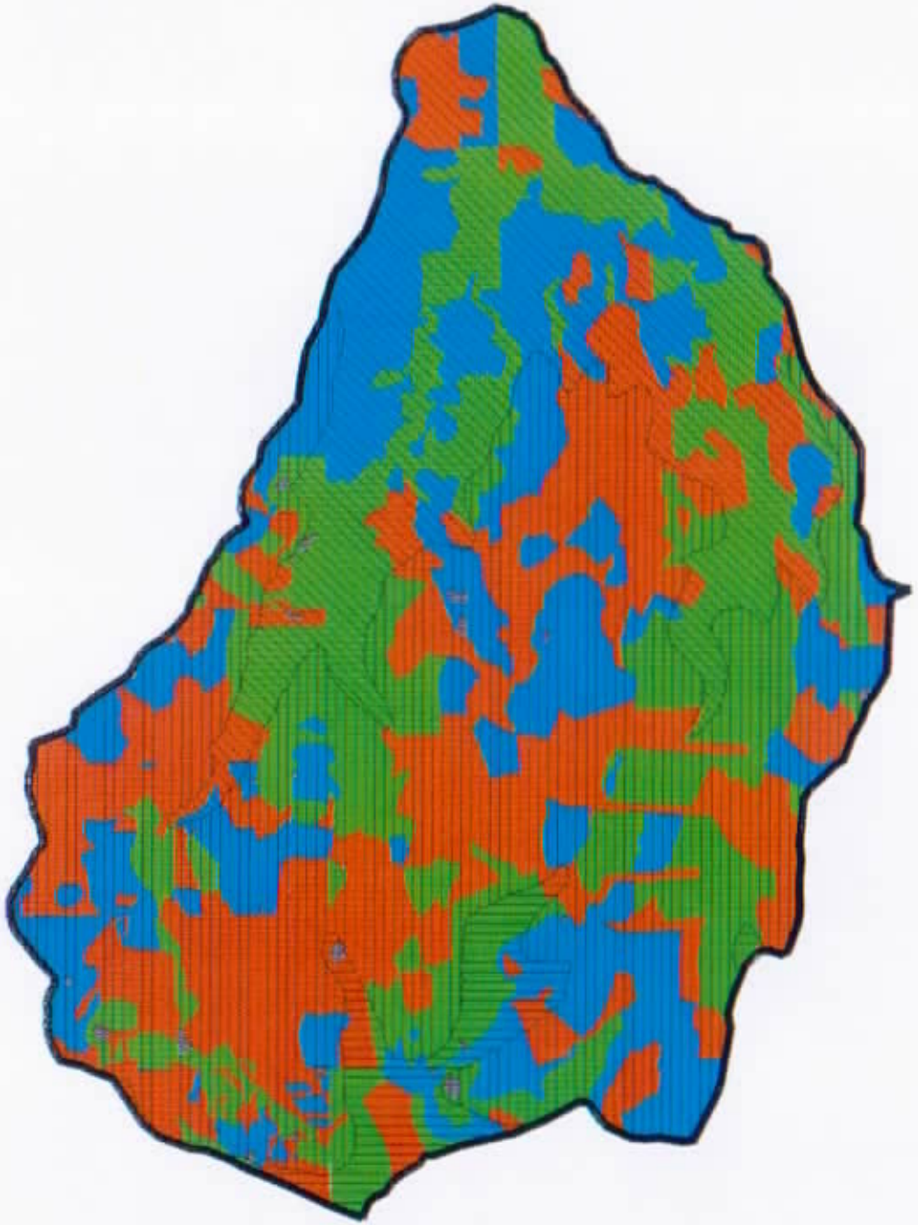
MAP 2-7

South Fork Clackamas River Watershed

Seral Stages - Current



Legend

- Early
- Late
- Mid
- Non Veg
- Mtn. Hemlock Zone
- Silver Fir Zone
- Western Hemlock Zone

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MAP 2-8

For this analysis, seral stages were defined according to stand structure rather than stand age. This means that some older stands on poorer sites are included in the mid seral rather than the late seral category and some younger stands on good sites are included in the late seral category rather than mid seral. Late seral stands were defined as stands dominated by conifers at least 21 inches in diameter. The late seral category would generally include both old growth and mature stands that have not yet fully developed old growth characteristics. The mid seral category includes closed sapling/pole stands (average stand diameter less than 8 inches, dense canopy) and small sawtimber (stands dominated by conifer trees ranging from 8-21 inches in diameter). The early seral category consists of grass/forb/shrub stands (clearcuts that have not yet advanced to the sapling/pole stage), shelterwoods, meadows, and open sapling/pole stands (conifers greater than 10 feet tall, less than 60% canopy cover).

"Thirty Four percent of federal lands in the watershed are currently classified as late seral habitat. Of the Late seral stands, 49 percent reside in the LSR and another 19 percent are in Riparian Reserve outside the LSR."

Table 2-10. Percentage of area in early, mid and late seral stands.

	FEDERAL LANDS (Forest Service & BLM)	TOTAL WATERSHED
EARLY	34%	35%
MID	29%	34%
LATE	34%	31%

Late-Successional Habitat

Thirty four percent of federal lands in the watershed are currently classified as late seral habitat (Map 2-9). Of the Late seral stands, 49 percent reside in the Late-Successional Reserve (LSR) and another 19 percent are in the Riparian Reserve outside the LSR. These are stands dominated by conifers at least 21 inches in diameter. Most of the stands classified as late seral are larger second growth that have not yet developed all of the characteristics of an old growth forest. The South Fork watershed contains 25 percent (4475 acres) that are classified as older then 250 years old (Map 2-10). Most of the late seral stands in South Fork originated in the late 1700's to late 1800's.

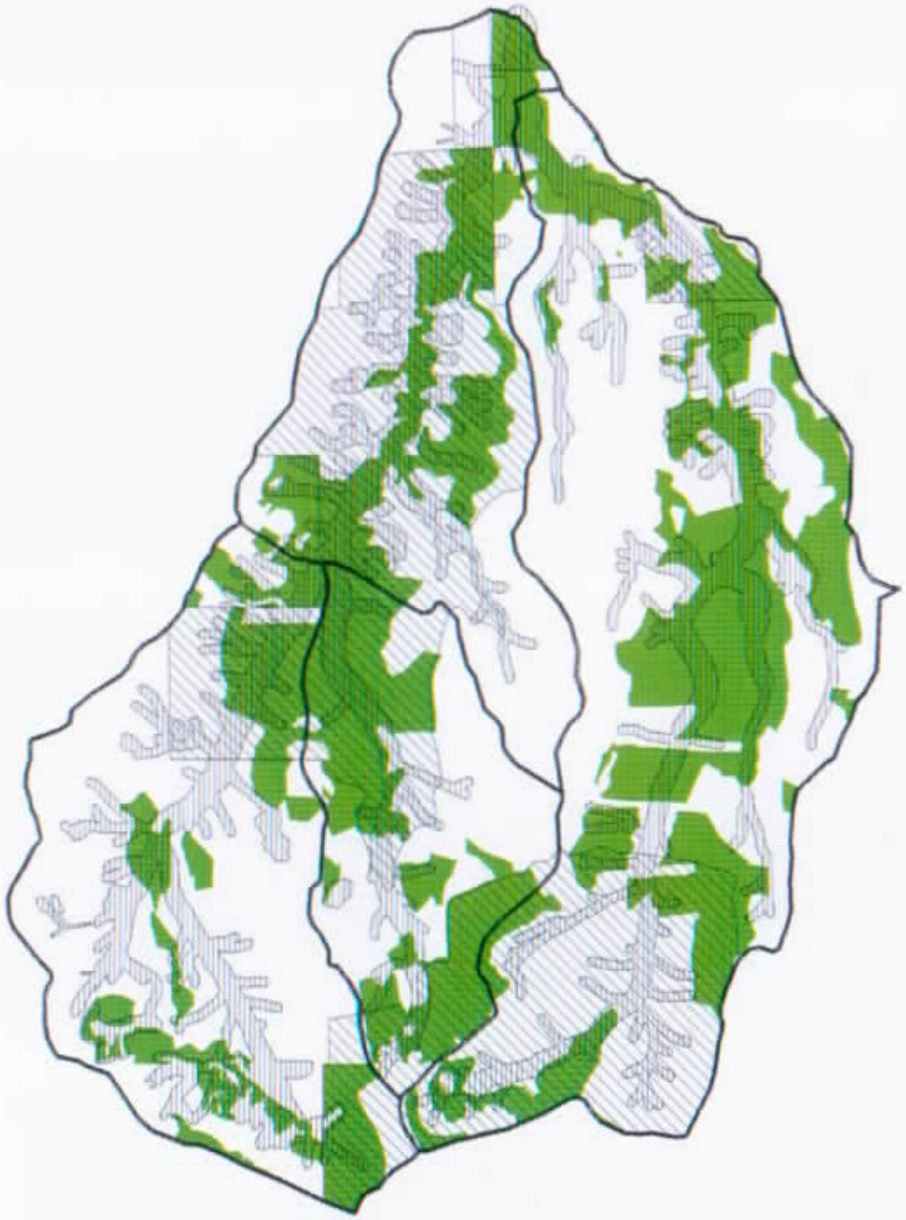
The Northwest Forest Plan requires that all remaining late-successional stands should be retained in fifth field watersheds in which 15% or less of the federal land is late-successional forest. Late-successional forest was defined by the Northwest Forest Plan as mature (80+ years) and old growth stands. This was approximated for analysis purposes as being stands with conifers greater than 21 inches in diameter. For the South Fork watershed late-successional forest was assumed to be equivalent to late seral. The intent of the 15 percent retention is for these isolated late-successional patches to function as refugia where old growth associated species, particularly those with limited dispersal capabilities, are able to persist until conditions become suitable for their dispersal into adjacent stands.

Current Age Distribution

Map 2-10 shows the current age distribution of stands on public land in the South Fork watershed. There are 4475 acres (shown in green) that are over 250 years old. There are 2590 acres of these old stands located in the Late-successional Reserve and another 647 acres in riparian reserve outside the LSR. In the northern portion of the watershed the area shown in blue is the result of stand replacement fires in the early 1900's. The remainder of the age classes, from 1950 to the present, are the result of timber harvest.

South Fork Clackamas River Watershed

Late Successional Habitat



Legend

- Late Seral
- Late Successional Reserve
- Riparian Reserve

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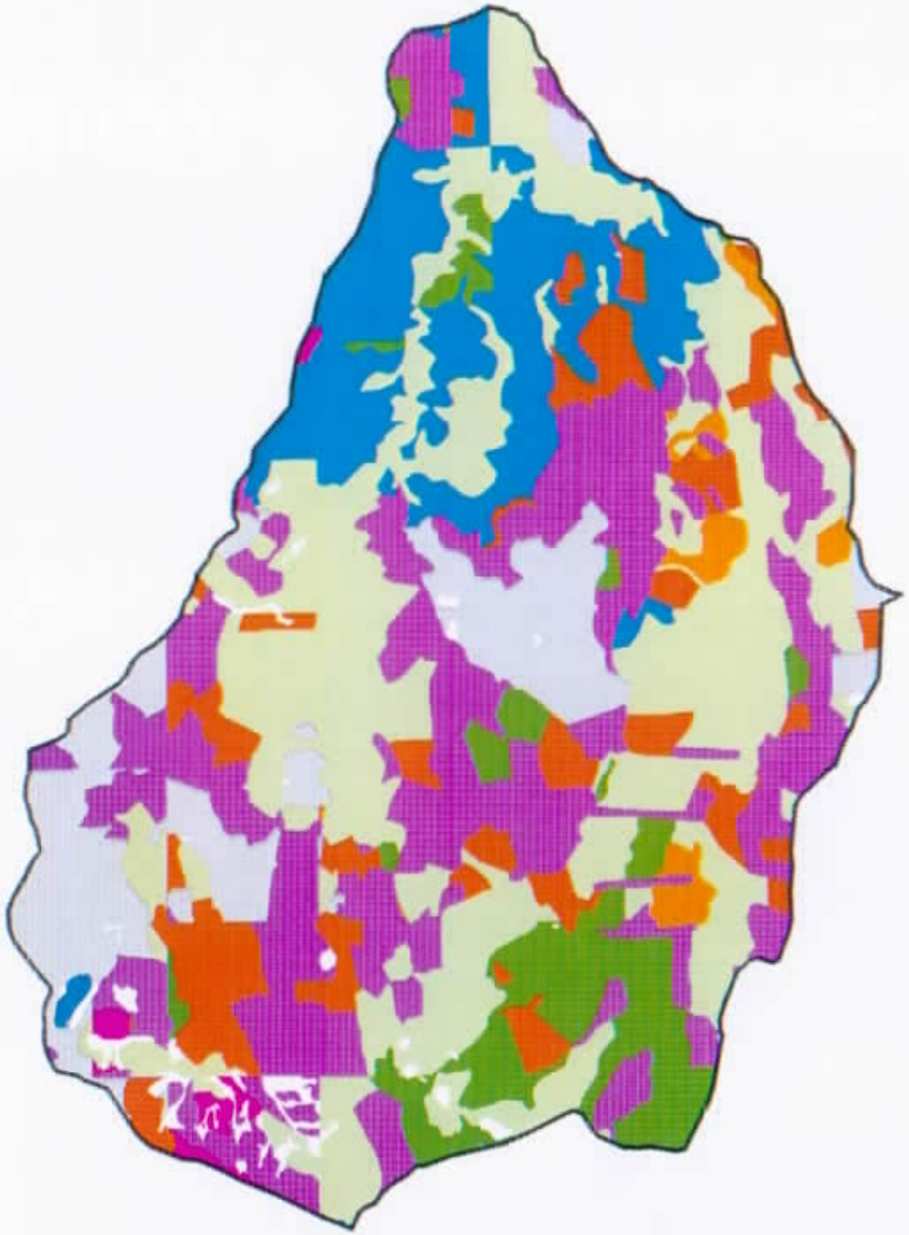
MAP 2-9



South Fork Clackamas River Watershed

Current Age Distribution

Legend

- Less Than 20 yrs
- 20-39 yrs
- 40-49 yrs
- 50-99 yrs
- 100-149 yrs
- 150-199 yrs
- 200-249 yrs
- grater Than 250

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MAP 2-10

Forest Series

Map 2-8 also shows the forest series that occur within the South Fork watershed: western hemlock, Pacific silver fir, and mountain hemlock. Forest series represent major differences in ecological factors such as plant community composition, growing season length, snow accumulation, productivity (particularly, the maximum size attained by mature trees) and wildlife use patterns.

Thirty percent of the watershed is in the western hemlock series, 65% is in the Pacific silver fir series. Five percent is in the mountain hemlock zone on the south to southeast border of the watershed.

Range of Natural Variability

The idea of the range of natural variability (RNV) is based on the fact that ecosystems are not static and that they vary over time and space. The dynamic nature of ecosystems exemplifies the need for us to consider ranges of conditions under natural disturbance regimes, rather than single points in time. A key assumption of this concept is that when systems are "pushed" outside the RNV there is a substantial risk that biological diversity and ecological function may not be maintained.

In 1993, the Pacific Northwest Region undertook an assessment of the RNV for several ecosystem elements that are believed to be key to ecosystem health and sustainability. The Regional Ecological Assessment (REAP) analysis was done at the subbasin scale (USDA 1993). Historic conditions were defined for the period between 1600 and 1850.

Figures 2-3 and 2-4 show the relationship between the current condition of the South Fork watershed and the estimated RNV in the Clackamas subbasin (from REAP) for two of the identified key ecosystem elements, amount of early and late seral vegetation. Only Forest Service lands within the subbasin were included in the REAP analysis. These numbers are expressed as percent of the total area (either watershed or subbasin) within each forest series.

The amount of early seral vegetation is more then the estimated range of natural variability in the Pacific silver fir, mountain hemlock and western hemlock series (Figure 2-3).

The amount of late seral vegetation within the South Fork watershed is within the estimated RNV in western hemlock and mountain hemlock forest series (Figure 2-4). There is currently 3% less early seral in the Pacific silver fir series than in the estimated RNV. The early seral is due to recent harvest activities creating the early seral and the mid seral is a result of stand replacement fires in the early 1900's.

Figure 2-3. Current condition compared to historic range of amount of early seral vegetation. Values shown are percentage of the total area within each forest series.

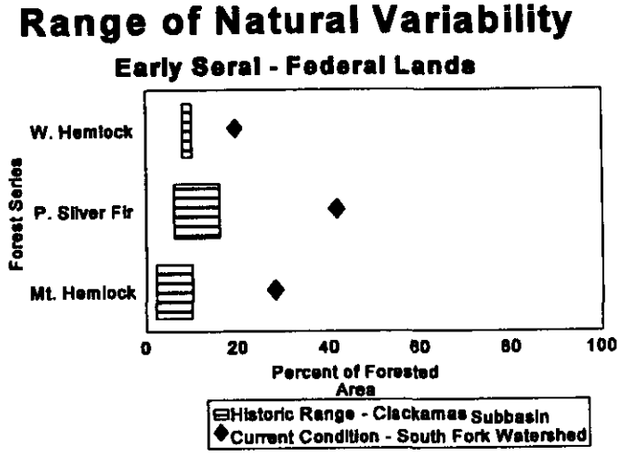
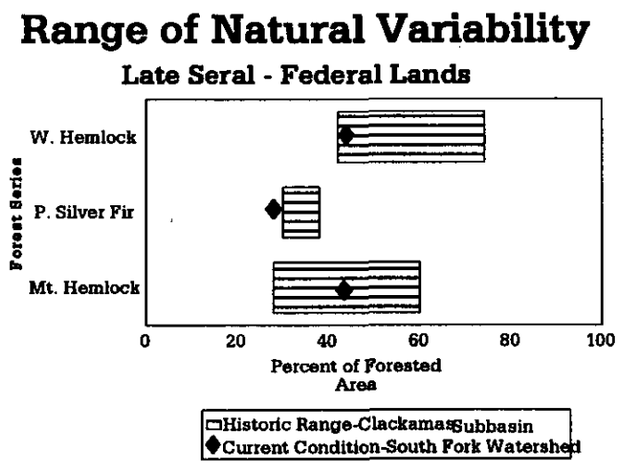


Figure 2-4. Current condition compared to historic range of amount of late seral vegetation. Values shown are percentage of the total area within each forest series.



Landscape Pattern

Current

Overall percentage of the area within various seral stages is not the only aspect of the distribution of vegetation that should be considered. The spatial arrangement is also important. Landscape pattern is a critical determinant of landscape scale ecological processes.

Some ecologically important features of landscape pattern are the amount of edge habitat, degree of fragmentation of late-successional forest (and conversely, connectivity of late-successional forest), and the amount of interior habitat. Fragmentation is one aspect of landscape pattern that has received a great deal of attention. As fragmentation of a landscape increases, the amount of interior forest habitat decreases, and the amount of edge habitat increases. Increasing edge benefits some species and is detrimental to others (Marcot and Meretsky, 1983; Rosenberg and Raphael, 1986; Temple and Cary, 1988; Yahner, 1988). As fragmentation increases, the amount of interior forest habitat decreases, impacting organisms which require large patches of interior habitat (Franklin and Forman, 1987). South Fork watershed contains some fragmented late seral habitat, with several areas of unfragmented late seral habitat.

Connectivity

The Northwest Forest Plan developed a strategy of a network of reserve areas to meet the needs of late-successional forest species. Connectivity of late-successional habitat, as addressed in the strategy, can be broken into three major categories.

"South Fork's role in the Northwest Forest Plan's connectivity strategy is in the LSR and Riparian Reserves (68% of the late seral habitat is in LSR and Riparian Reserves)."

* LSR's (Late-Successional Reserves): intended to be large, contiguous blocks of habitat that can sustain populations or subpopulations of most late-successional associated species. The intervening matrix does not need to be late-successional habitat but must provide needs for dispersing individuals.

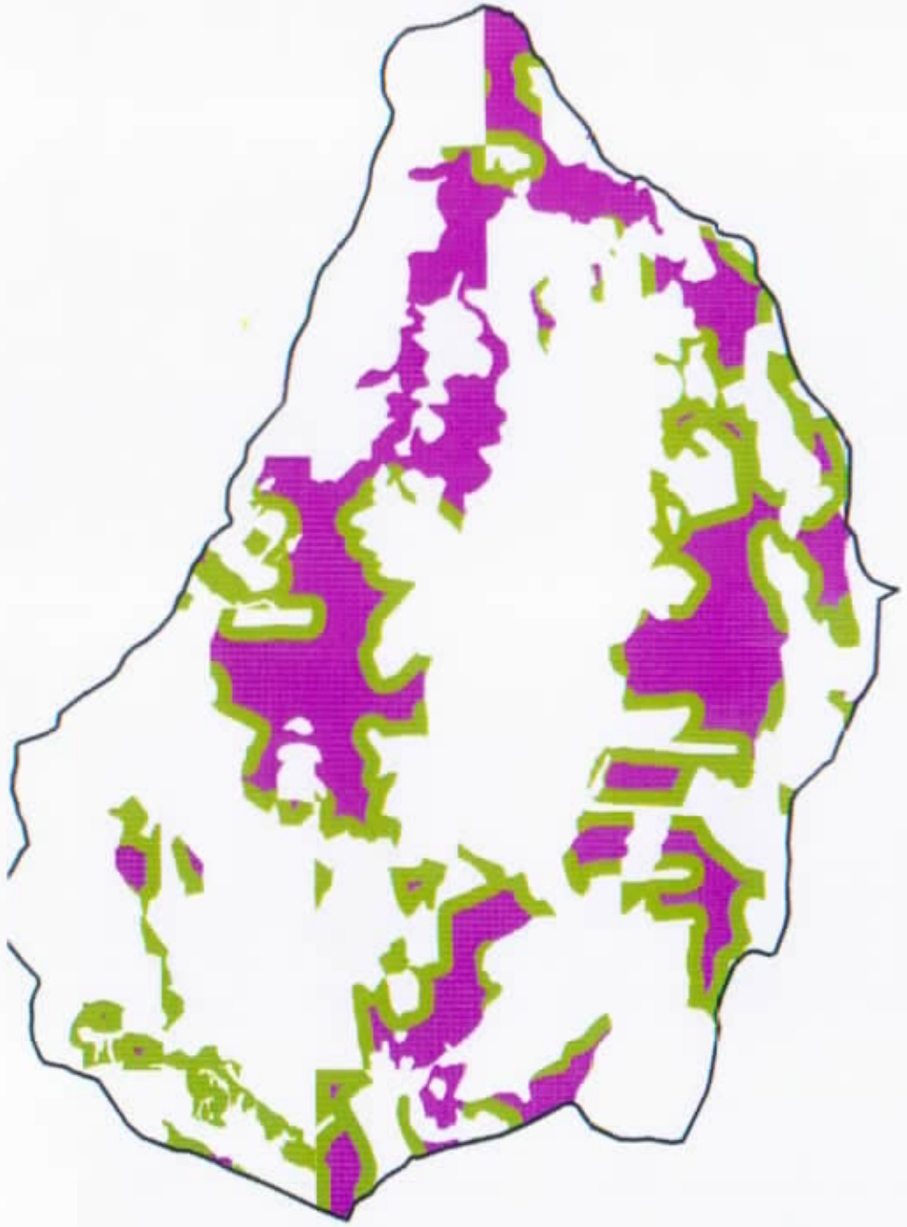
* Riparian Reserves: provide connectivity for less mobile species unlikely to survive outside late-successional forests even during dispersal.

* Isolated small blocks of late-successional habitat in the matrix for species to move between LSR and for refugia for sessile species.

South Fork watershed is matrix and LSR. There two LSRs in the South Fork watershed. The LSR network in Lower Clackamas watershed is connected into the LSR in the north west portion of South Fork watershed. South Fork's role in the Northwest Forest Plan's connectivity strategy is in the LSR and Riparian Reserves (68% of the late seral habitat is in the LSR and Riparian Reserves).

Interior Habitat

Map 2-11 shows the current interior habitat that is present within the watershed. Interior habitat 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 of a functional edge varies due to many site specific



South Fork Clackamas River Watershed

Current Interior Forest

Legend

- Late Seral Edge
- Interior Late Seral Hab.

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MAP 2-11

factors. Mid seral stands, roads, and the watershed boundary were not counted as edge for this analysis.

South Fork has 3174 total acres of interior habitat (18% of the vegetated acres in the watershed). The largest and most contiguous blocks of interior habitat are located in the LSR and Riparian Reserves of the watershed (77% of the interior habitat).

Historic Landscape Pattern

"Two percent of the watershed was early seral in 1944, 13% was mid, and 84% was late seral."

Fire, historically, was the dominant landscape pattern forming disturbance in this portion of the Cascades. Map 2-12 shows the distribution of seral stages in the South Fork watershed in 1944. This map is from a vegetation map that was completed for Oregon and Washington in 1944. The mapping was done at a large scale, and is not entirely spatially accurate at the smaller watershed scale.

Two percent of the watershed was early seral in 1944, 13% was mid, and 84% was late seral. The mid seral stands were the result of stand replacement fires in the late 1800's to early 1900's.

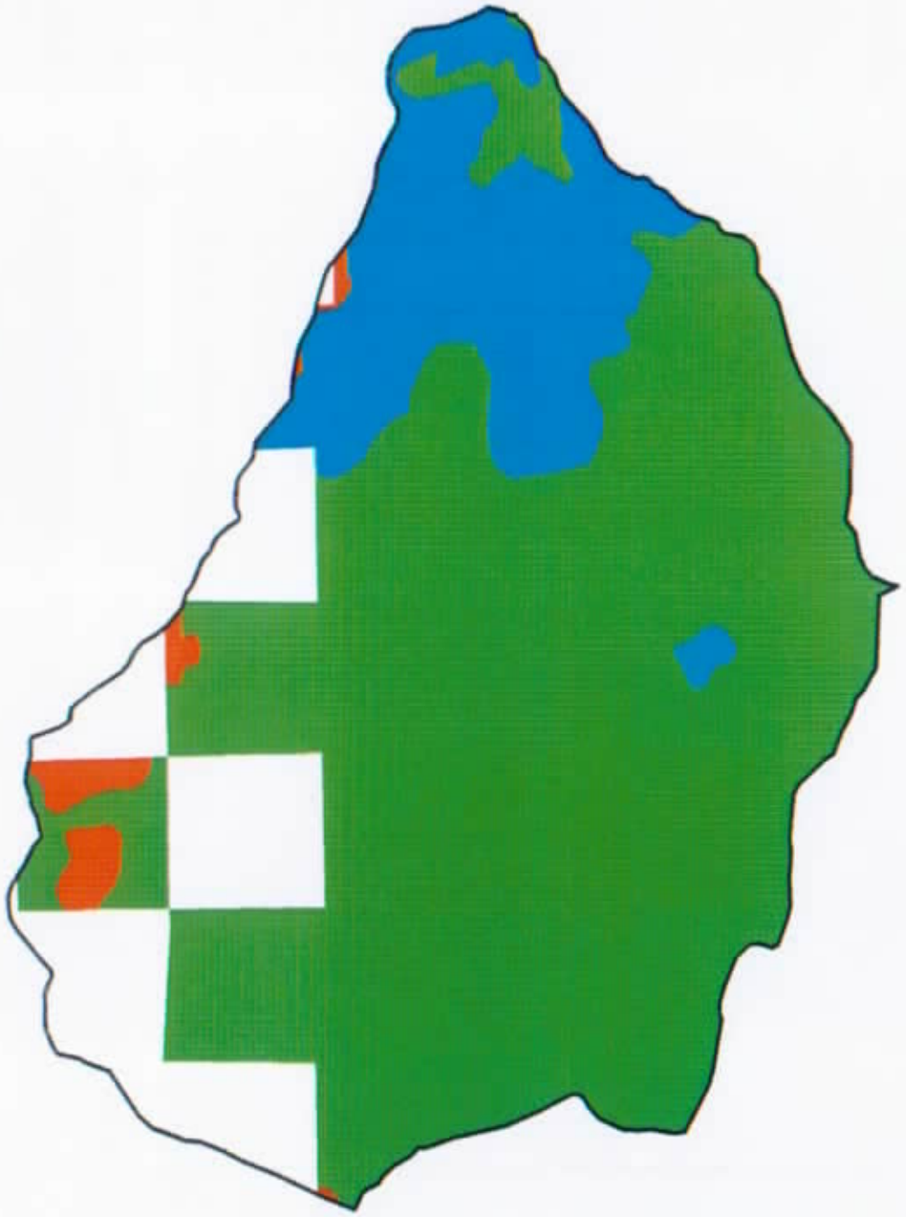
The majority of South Fork watershed was dominated by late seral landscape pattern in 1944. Logging began as a major land use in South Fork watershed in the 1950's and has continued to present, creating the dominant landscape pattern.

Fire Regimes

The Mt. Hood National Forest has been divided into eleven fire ecology groups based on vegetation, fire frequency, and behavior (Evers et al., 1994). The South Fork watershed contains only one of these groups, Fire Group 8. It is the "warm, moist western hemlock and Pacific silver fir" fire ecology group. This group is a stand replacement fire type, with a fire frequency of 50-300+ years.

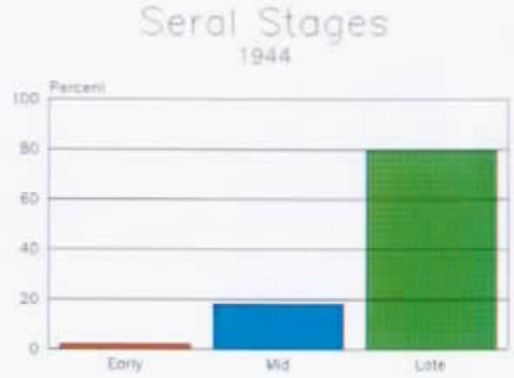
South Fork Clackamas River Watershed

Historic Seral Stages - 1944



Legend

- Early
- Late
- Mid



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MAP 2-12

Insects, Disease and Windthrow

Douglas-fir bark beetle (*Dendroctonus pseudotsugae*) are present at endemic levels throughout the Clackamas drainage. When abundant favorable breeding habitat becomes available, usually from windthrow, bark beetle population can rise to epidemic levels creating mortality in live trees. Creation of wildlife structures especially in shaded or moist environments can provide favorable habitat for bark beetle. In the South Fork Clackamas drainage, disturbance by insects have been considered minor since windthrow has been salvaged promptly. Future management in the watershed in which wildlife structures, such as down logs or snags, are created over a large area or where windthrow is not promptly salvaged will increase the potential for bark beetle outbreaks.

Laminated root rot (*Phellinus weirii*) and Shoestring root rot (*Amillaria mellea*) are found throughout the drainage in scattered small pockets. Their occurrence and impact in the South Fork Clackamas drainage is considered minor.

Wind, harvest and road building have been the major disturbance agents in the South Fork Clackamas watershed. Windthrow was first noted in the 1950's as harvest began on South Fork Ridge. It has affected primarily old growth stands along South Fork Ridge and upper South Fork Clackamas drainage. The prevalent damaging wind storms are from the southwest under saturated soil conditions during the fall. East and southeast winds during winter months have also contributed to the amount of windthrow in the watershed. Past history show windthrow damage to occur primarily on ridges and upper drainages of the South Fork Clackamas watershed.

"Wind, harvest and road building have been the major disturbance agents in the South Fork Clackamas watershed. Windthrow was first noted in the 1950's as harvest began on South Fork Ridge."

Species and habitat

Amphibians

Streams and riparian areas offer the most likely habitat for amphibian species inhabiting this area. Species known to occur in the drainage include Cope's giant salamander *(Dicamptodon copei)*, tailed frog (*Ascaphus truei*), Cascade torrent salamander (*Rhyacotriton cascadae)*, and Pacific giant salamander (*Dicomptodon tenebrosus*). Although no documented sightings have been recorded, it is thought that habitat exists for the following species: Red-legged frog *(Rana aurora)*, Clouded salamander *(Aneides ferreus)*, and Oregon slender salamander (*Batrachoseps wrighti)*. All of the species listed above were found in or along streams and all but the pacific giant salamander and cascade torrent salamander carry some type of protection designation (see Threatened, Endangered, and Sensitive section below). Presence of other amphibians is likely as terrestrial habitat, water quality, and water temperatures are favorable.

Special habitats

Special habitats are those which provide a unique niche for species associated with them. These species may not be dependent on these habitats but use them as primary breeding and/or non-breeding habitat. A list of potential users of South Fork's special habitats may be found in the Analysis File. Special habitats found within the watershed include, but are not limited to, wet meadows, lakes, rock/talus slope, cliffs, bogs, and tunnels (Map 2-7). Of particular interest in the South Fork drainage are the Williams Lake area and the abandoned South Fork Waterworks tunnels.

The Williams Lake and bog ecosystem is an excellent example of a Cascadian massive seep-formed lake undergoing peat bog/quaking bog succession. A quaking bog involves the filling in of the basin from the surface. Natural elements of ecological importance include a subalpine emergent wetland, a subalpine shrub wetland, a subalpine forest wetland, and a subalpine permanent pond. Plant communities at the bog have become specialized, adapting to the geographic and hydrographic systems which have

formed the lake. The seep system has fostered the formation of a peat bog around the rim of the shallow lake, and this peat bog is now beginning to form a quaking bog. Although not recognized under protective status, specialized micro-habitats found on the wet seeps contribute to a rare habitat complex with significant botanical values (USDA, BLM, 1991). A complete report, published by the BLM Salem District, may be found in the Analysis File.

The abandoned tunnels of the South Fork Waterworks seem an unlikely special habitat but they are providing roosting sites for several bat species within the drainage, including species listed on the Sensitive species list by the state of Oregon and the USFS. Many bat species inhabit caves and/or mines as breeding and roosting sites. The South Fork watershed lacks caves and mines but the tunnels may serve as adequate substitutes.

Mapped rock and/or talus slopes occupy approximately 70 acres within the watershed. This habitat type provides nesting, roosting, hiding, and foraging opportunities for a variety of small mammals, birds, and amphibians. Predators, such as cougar (*Felis concolor),* bobcat (*Lynx rufus*), and hawks (*Acipiters)*, utilize these areas for foraging while others may den in the cave-like openings between the rocks.

Three lakes, Helen, Williams, and Memaloose are located within the watershed and contribute to wetland complexes found within the Upper and Memaloose subwatersheds. These lakes, along with the varied wetlands (shrub wetland, shrub conifer wetland, etc. Map 2-7) provide "focal points" of diversity in the watershed - habitat provided for both a greater array and more unusual species than are found in the surrounding landscape. Amphibians, mammals, birds, reptiles, insects, and various flora can be found in and around the lakes.

"The Williams Lake and bog ecosystem is an excellent example of a Cascadian massive seep-formed lake undergoing peat bog/quaking bog succession."

Threatened, Endangered, Sensitive, and C-3 Plant Species

There are no known Threatened or Endangered plant species within this watershed. Streams, wetlands and springs associated with the South Fork drainage include habitat for nineteen species of Sensitive plants (table 2-11). Of these, two plant species that have documented occurrences in and adjacent to cool, canopied streams, include *Corydalis aquae-gelidae* (cold water corydalis) and *Huperzia occidentalis* (fir club moss). *Huperzia occidentalis* and *Corydalis aquae-gelidae* are found growing in or adjacent to springs, and streams. The former, is found on duff, moss covered rocks, and downed logs and the latter; in cool headwater habitats and in the gravels of moderately scoured streambeds. Potential habitat for three species of Sensitive upland plants also occurs within the watershed. One of these three species; *Aster gormanii* (Gorman's aster), is found in association with the rock outcrops along the southern edge of the watershed boundary.

The Northwest Forest Plan calls for the survey and management of several species of fungi, lichens, bryophytes, and vascular plants referred to as "C-3 species". Information on the occurrences of these species within the South Fork Clackamas Watershed is lacking; especially for non-vascular plants. Of these species, one vascular plant; *Corydalis aquae-gelidae* has documented sightings. *Corydalis aquae-gelidae* is listed in the Northwest Forest Plan C-3 Species List and has specific habitat requirements and minimum buffer width prescriptions with regard to adjacent land management proposals. *Allotropa virgata* (sugarstick) has been known to occur in the area but there are no formal documented sightings. Finalized Survey Protocols and Management Recommendations are due out for all species in 1997.

Historic disturbances within the plant communities in the South Fork Clackamas watershed have included logging activities and subsequent blowdown, fertilization activities, road construction, roadside vegetation management, fire, and litter. Some activities utilized mechanized equipment in and

adjacent to headwater streams, removed adjacent canopy cover, and created disjunct populations where roads bisected streamflows. Sensitive plant species such as *Corydalis aquae-gelidae* and *Aster gormanii* have been adversely affected by these activities. Reduction of species populations and habitat integrity has occurred historically throughout the watershed. Opportunities exist for the rehabilitation of habitat areas for these plant species throughout the South Fork.

Table 2-11 Threatened, Endangered, and Sensitive Plant Species

SPECIES	Status By Agency			Habitat in South Fork	Documented Occurrence in South Fork
	USFWS	ODA/ONHP	USFS		
Agoseris elata (tall agoseris)		2	Sensitive	Yes	
Aster gormanii (Gorman's aster)	Former C2	1	Sensitive	Yes	Yes
Botrychium lanceolatum (lance-leaved grape fern)		2	Sensitive	Yes	
Botrychium minganense (gray moonwort)		2	Sensitive	Yes	
Botrychium montanum (mountain grape fern)		2	Sensitive	Yes	
Botrychium pinnatum (pinnate grape fern)		2	Sensitive	Yes	
Carex livida (pale sedge)		2	Sensitive	Yes	
Cimicifuga elata (tall bugbane)	Former C2	C,1	Sensitive	Yes	
Corydalis aquae-gelidae (cold-water corydalis)*	Former C2	C,1	Sensitive	Yes	Yes
Coptis trifolia (three leaflet goldthread)		2	Sensitive	Yes	
Diphasiastrum complanatum (ground cedar)		2	Sensitive	Yes	
Huperzia occidentalis (fir club-moss)		2	Sensitive	Yes	Yes
Lycopodiella inundata (bog club-moss)		2	Sensitive	Yes	
Ophioglossum pusillum (adder's tongue)		2	Sensitive	Yes	
Scheuchzeria palustris var. americana (scheuchzeria)		2	Sensitive	Yes	
Sisyrinchium sarmentosum (pale blue-eyed grass)	Former C2	C,1	Sensitive	Yes	

Table 2-11 Threatened, Endangered, and Sensitive Plant Species

SPECIES	Status By Agency			Habitat in South Fork	Documented Occurrence in South Fork
	USFWS	ODA/ONHP	USFS		
Streptopus streptopoides (kruhsea)		2	Sensitive	Yes	
Utricularia minor (lesser bladderwort)		2	Sensitive	Yes	
Wolffia columbiana (water-meal)		2	Sensitive	Yes	

USFWS = United States Fish and Wildlife Service
Former C-2 = Candidate Species for Endangered or Threatened Status Category discontinued in 1996
ODA = Oregon Department of Agriculture, Natural Resources Division
C = Candidate species for listing as Endangered or Threatened
ONHP = Oregon Natural Heritage Program
1 = Taxa which are Endangered or Threatened throughout their range
2 = Taxa which are Endangered or Threatened but more common elsewhere
* = Table C-3 Survey and Manage Vascular Plant Species (Refer to Northwest Forest plan for Table C-3 Lichen, Bryophyte, and Fungi Species)
USFS = United States Forest Service

Noxious Weeds

The introduction of non-native plant species, especially noxious weeds, is a potential threat to native biological diversity. Noxious weed invasions can reduce biodiversity through the displacement of plant species necessary for wildlife habitat and can also adversely affect reforestation, visual quality, and recreational activities. Noxious weed species occurring within the South Fork Clackamas drainage include *Hypericum perforatum* (St. Johnswort), *Senecio jacobaea* (tansy ragwort), *Cirsium arvense* (Canada thistle), *Cytisus scoparius* (scotch broom), *Centaurea diffusa* (diffuse knapweed), and *Centaurea maculosa* (spotted knapweed). These species are found throughout the watershed in areas associated with roads, timber harvest activities, and recreational use. Non-native seed can be carried to areas of ground disturbance through vehicle use, logging equipment, contaminated erosion control and forage seed mixes, wind, and biological vectors.

The Mt. Hood National Forest has an established Management Plan with the Oregon State Department of Agriculture regarding the prevention and control of Noxious Weeds. The Management Plan recommends the use of an integrated weed control plan that includes manual, biological, and chemical controls. All vegetation management is in strict accordance with the guidelines established in the Final E.I.S. ; Managing Competing and Unwanted Vegetation (U.S.D.A.,1988).

Two sites within the South Fork watershed were included in the Mt.Hood National Forest Noxious Weed Removal E.I.S. of 1993. The selected alternative included the use of herbicides at two sites along Forest road 4500 in non-riparian areas. The herbicide was applied with a backpack sprayer to individual *C.maculosa* and *C. diffusa* plants within the road prism in 1994 and 1995. In addition, *Longitarsus jacobaea* (tansy flea beetle) has been released at two sites within the watershed (1995) as a biological control for *Senecio jacobaea* (tansy). At this time, monitoring data is incomplete but ocular surveys show no further spread of the knapweed sites.

Threatened, Endangered, and Wildlife Sensitive Species (T, E, & S)

Table 2-12 displays information on T, E, & S (animal) species of concern on the Clackamas River Ranger Districts. Of those species, six are known to occur within the watershed. These species include: Northern bald eagle (*Haliaeetus leucocephalus*), Townsend's big-eared bat (*Corynorhinus plecotus)*, Cope's giant salamander (*Dicamptodon copei),* tailed frog (*Ascaphus truei),* Cascade frog *(Rana cascadae),* and Northern spotted owl (*Strix occidentalis caurina*). See the district biologist for locations. Habitat exists for other TE&S species but confirmation of their presence is unknown. The South Fork Analysis File contains a list of species potentially occurring in the drainage and their protective status, if any.

"Northern bald eagle, Townsend's big-eared bat, Cope's giant salamander, tailed frog, Cascade frog and Northern Spotted owl are T, E, & S species known to occur in South Fork watershed."

Table 2-12. Threatened, Endangered, and Sensitive Wildlife Species

Species	Status By Agency			Habitat in South Fork?	Known occurrence in South Fork?
	USFWS	State (Oregon)	USFS		
Spotted owl	Threatened	Threatened	Threatened	Yes	Yes
Bald eagle	Threatened	Threatened	Threatened	Yes	Yes
Peregrine falcon	Endangered	Endangered	Endangered	Yes	No
Harlequin duck	---	Sensitive	Sensitive	Yes	No
Sandhill crane	---	Sensitive	Sensitive	No	No
Townsend's big-eared bat	Former C2	Sensitive	Sensitive	Yes	Yes
Wolverine	Former C2	Sensitive	Sensitive	No	No
White-footed vole	Former C2	Sensitive	Sensitive	No	No
Red-legged frog	Former C2	Sensitive	Sensitive	Yes	No
Western pond turtle	---	---	Sensitive	No	No
Painted turtle	---	---	Sensitive	No	No
Cope's giant salamander	---	Sensitive	Sensitive	Yes	Yes
Larch mountain salamander*	---	Sensitive	Sensitive	No	No
Tailed frog	---	Vulnerable		Yes	Yes
Cascade frog	---	Vulnerable		Yes	Yes

USFWS = United States Fish & Wildlife Service
USFS = United States Forest Service
* C3 Survey and Manage Species

Northern bald eagle

Nesting habitat is found in all forest types bordering coastal, lake, or river areas. Nests are normally in the upper canopy of trees and located within a half mile of water. Although the watershed contains suitable nesting and roosting habitat, foraging habitat is questionable and prey availability may be the limiting factor for nesting bald eagles (Fenzel, 1993). Bald eagles are commonly seen along the South Fork of the Clackamas River late summer through early fall.

Townsend's big-eared bat

This species is closely associated with cavity roosts for resting and breeding. Cavities may take the form of human-made structures such as buildings, bridges, mines, and tunnels, or as found in nature with caves (Perkins and Levesque, 1987). The body temperature of cave dwellers varies with the air temperature making them extremely sensitive to temperature change and disturbance. Potential habitat exists within the watershed as documented sightings have occurred.

Cope's giant salamander

This salamander is generally found within streams and seeps in moist temperate coniferous forests, from sea level to approximately 4,400 feet elevation and where streams temperatures do not exceed 18 degrees C. Several streams within the watershed provide habitat and documented sightings have occurred. Cope's are difficult to distinguish from Pacific giant salamanders so observer reliability should be considered.

Tailed Frog

In our region, this species may be found in clean, cold, fast moving streams which have a cobble or boulder substrate and range between sea level and 7000 feet elevation. Adults are most active at night, feeding on insects found in or along streams and in the moist forests nearby. Mating occurs in late September and eggs are laid the following June (Corkran and Thoms, 1996). The South Fork watershed contains several areas which provide adequate habitat for the tailed frog and documented sightings have occurred.

Cascade Frog

This species may be found in small lakes, ponds, and marshes adjacent to streams and mountain meadows which range between 2000 feet and 6000 feet elevation. Mid-spring breeding occurs in bogs or ponds with cold springs (Corkran and Thoms, 1996). The South Fork watershed contains several sites which meet the requirements for this species and documented sightings have occurred.

Northern spotted owl

The northern spotted owl is a federally listed threatened species that is closely associated with late seral forest ecosystems. Nesting occurs in cavities of mature and/or over mature trees, roosting normally takes place in dense multi-layered forests, and foraging ranges across many habitat types.

The South Fork watershed contains 5,885 acres of suitable habitat (i.e., habitat available for roosting, nesting, and foraging) and 9,787 acres of dispersal habitat (i.e., habitat which satisfies needs for foraging, roosting, dispersal, and protection from predators). Table 2-13 summarizes information about spotted owls within the watershed. Three spotted owl pairs currently exist in the drainage, two of which are in an incidental take situation. Incidental take occurs when less than 1,182 acres of suitable habitat is found within a 1.2 mile radius, or less than 500 acres of suitable is found within a 0.7 mile radius, of an owl activity center. No resident singles are present in the watershed.

Table 2-13 . Suitable Habitat Acres and Take Occurrences for the Northern Spotted Owl within the South Fork Watershed.

Owl #	Suitable Habitat Acres w/I 0.7 mi.	Suitable habitat Acres w/I 1.2 mi.	Take situation?
Pair 598791A	406	899	Yes
Pair 5980Z92	374	1336	Yes
Pair 5324Z85	609	1716	No

Survey and Manage Animal Species

Survey and Manage species, also referred to as C-3 species, are species which require protection through survey and management standards and guidelines as outlined in the Northwest Forest Plan's Record of Decision (ROD). Two animal species, one mammal and one amphibian, are of concern in this portion of the analysis. Direction from the ROD requires that each of these species be managed under survey strategy #2, "survey prior to activities and manage sites."

Red Tree Vole

The red tree vole *(P. longicaudus)*, a highly specialized tree-dweller, depends on Douglas fir trees for nesting and foraging. Its nests are built 6 to 150 feet off the ground and it feeds on Douglas-fir needles.

Currently 1,972 acres of primary habitat exists within the watershed, mainly along the South Fork Clackamas River and the Memaloose Creek. Primary habitat consists of stands classified as large conifer (stands with at least 30% canopy closure attributed to trees greater than 21 inches diameter breast height) greater than 300 acres, which occur at less than 3,000 feet elevation, and are in the western hemlock or Pacific silver fir vegetation zones (Mellen, 1995). Secondary habitat, concentrated along the northeastern boundary of the watershed, comprises 884 acres of the watershed and is described as stands classified as large conifer between 75 and 300 acres, which occur at less than 3,000 feet elevation, and are in the western hemlock or Pacific silver fir vegetation zones. Marginal habitat, found scattered throughout 1,371 acres of the northern half of the drainage, is classified as closed small conifer (stands with at least 60% canopy closure and trees between 8 and 21 inches diameter breast height) greater than 75 acres, which occurs at less than 3,000 feet elevation, and are in the western hemlock or Pacific silver fir vegetation zones.

Larch Mountain Salamander

This species (*Plethodon larselli*), also listed as Sensitive by the Forest Service, is associated with steep, wooded, talus slopes where the rocks are of small size and there are relatively large amounts of decaying plant material and small quantities of soil. They have been found in various types of talus areas, including some with little or no moss or other vegetative cover on the rocks. They have also been observed in woody, overgrown areas where talus is not readily visible unless ground surface is disturbed (personal communication, A. Young, 1996).

Within the South Fork watershed, little habitat is available for this species. Although 70 acres of rock/talus exists within the drainage, it is not located in the steep, wooded areas preferred by the Larch mountain salamander. In addition, this is the extreme edge of the known range.

Pine Marten/Pileated Woodpecker Management Areas (B5)

Currently, one B5 Management Area exists within the watershed and is located within Matrix land (Map 2-13 or Map 3-3). The desired future condition for B5 areas as outlined in the Mt. Hood Forest Plan, states that B5 areas are to contain characteristics such as high densities of quality den and nest snags and defective green trees, limited recreational and motorized vehicle access, and a healthy, older forest with mid-level canopy reaching maturity. Key habitat features for pine marten (*Martes americana*) are large patches of late-successional forest, intact forests along riparian zones, and coarse woody debris of varying decay stages to support prey species. Key habitat features for pileated woodpeckers (*Dryocopus pileatus*) are mature/overmature stands, large amounts of down woody material, large defective trees (for nesting roosting, and foraging), and large snags.

At present, the watershed is fairly well connected by Late Successional Reserves and Riparian Reserves, much of which is in mid and late seral conditions. As with much of the Clackamas drainage, the South Fork watershed appears to lack snags and down woody debris.

Surveys for pine marten have not been conducted in the watershed and no documented sightings have occurred. Pileated woodpecker use is evident in much of the watershed, especially where remnant snags exist.

Snags and Coarse Woody Debris

Approximately 50 snag associated (animal) species potentially occur within the watershed (see Analysis File). Most primary cavity nesters are generalists and can make use of snags in any seral condition. However, three species of woodpecker (black-backed, three-toes, and pileated) require snags to be in late seral conditions. Two other avian species, the mountain bluebird and western bluebird, require snags in an early seral condition, and four species, (barred owl, pine marten, flying squirrel, and northern spotted owl) require late seral forests.

Surveys completed over the last several years indicate that certain structural elements that are often found after catastrophic fire disturbance (patches of unburned trees, scattered large snags, large downed logs) are absent or are present in low densities in harvest created openings. Figures 2-5 and 2-6 display the densities of medium and large snags and down wood in different structural stages. The figures show that managed stands contain, on average, far fewer large snags and logs than unmanaged stands. Large snags and down log density are also influenced by stand structure and forest series. In general , the large conifer stands have greater densities of large and medium sized logs than small sawtimber stands.

Mt. Hood Forest Plan Standards and Guidelines call for leaving enough snags in new harvest units to support, over time, at least 60% of the biological potential (carrying capacity) of cavity excavators. Estimates of biological potential currently tier to a model devised by Neitro, et. al. (1985). The model shows approximately 2.6 snags per acre are necessary to achieve 60% biological potential for woodpeckers at the stand level. A concern of this approach is that no assurance exists that this level of snags retention provides for an equivalent level of biological potential for other snag associated species (e.g., nearly all bats, arboreal rodents, bluebirds, swallows, and denning carnivores). Currently, snags levels appear to above Mt. Hood Forest Plan standards in all large conifer stands, below standards in most small saw stands, and below levels in all managed stands. This information, combined with the fire history, vegetative structure, and past harvest activity, would indicate that the watershed is lacking sufficient amounts of all snag classes.

Coarse woody debris is important for denning areas; as a source of invertebrate prey species for insectivorous birds and salamanders; and habitat for voles, shrews, and various fungi which are used by the northern flying squirrel and other small mammals. Coarse woody debris density and condition is available from surveys conducted in 1987 and 1992. Figures 2-7 and 2-8 illustrate the distribution of coarse woody debris in the managed and unmanaged stands, respectively. Coarse woody debris availability corresponds well with the snag availability discussed

earlier. Logs are most abundant (15-20 logs/acre) in large unmanaged conifer stands and least abundant

(5-6 logs/acre) in managed stands. ROD standards for regeneration units in Matrix (240 lineal feet/acre, 20" minimum diameter) is equivalent to 15 pieces per acre while Mt. Hood Forest Plan Standards for other harvest types (salvage, thinning, etc.) is 100 lineal feet/acre, equivalent to 6 pieces per acre.

Deer and Elk

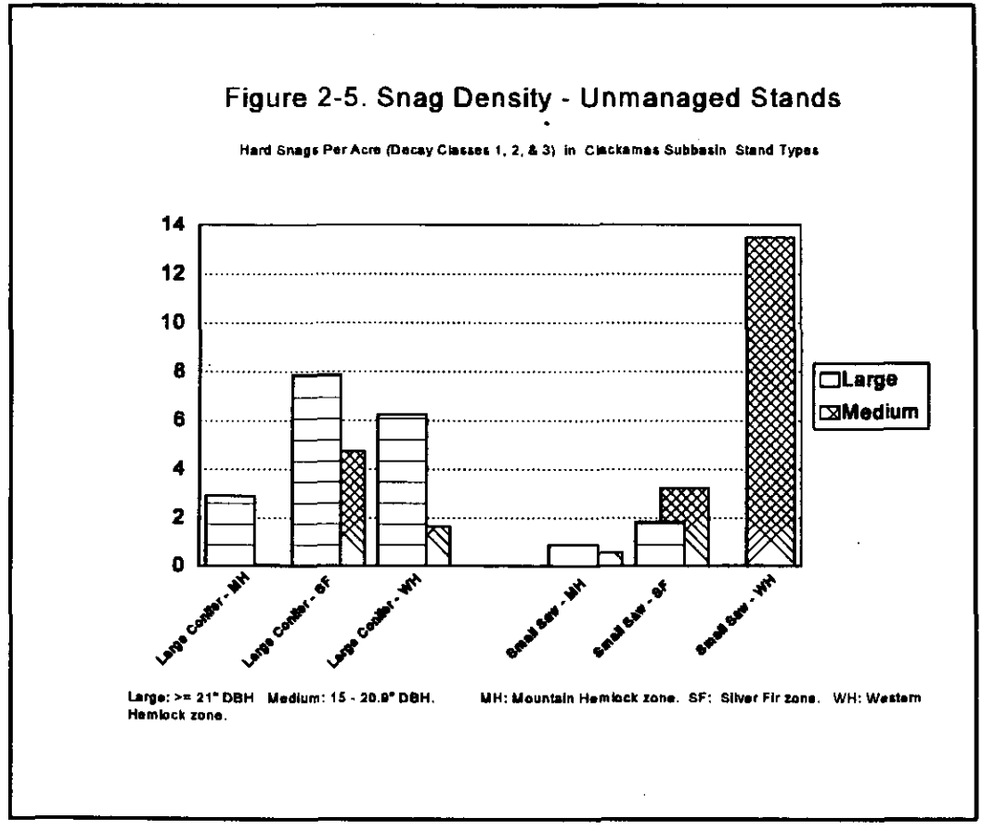
The South Fork watershed contains approximately 17,647 acres, of which roughly 19% (3409 ac) is Inventoried Deer and Elk Winter Range as designated by the Mt. Hood Forest Plan (see Map 2-13). Within that designation, winter range is separated into two categories, "normal" and "severe". Normal winter range generally falls below 2,800 feet elevation while severe winter range falls below 2,300 feet elevation. Forestwide Standards and Guidelines pertaining to Inventoried Deer and Elk Winter Range indicate that by the year 2000, open road densities should not exceed 2.0 mi/sq mi (FW-208).

Table 2-14 displays the existing winter range road densities (on Federal lands) within the drainage and indicates that in all cases, road densities meet those recommended by the Mt. Hood Forest Plan.

In addition to normal and severe winter range designations, values of range have been placed on the habitat. These values, "crucial", "high", and "moderate", are for determining type and duration of seasonal restrictions placed on harvest operations occurring in winter range. A description of these values and their guidelines can be found in the Analysis File.

Road densities, as well as availability, sizing/spacing, and quality/quantity of forage and cover, all form the overall habitat effectiveness of a given area. Table 2-15 displays the current condition of habitat and availability for the watershed, while Figure 2-9 illustrates a visual definition of the habitat types. The South Fork watershed contain 75% of deer and elk habitat cover types and 25% is in forage habitat. Thirty Three percent is in optimal cover which contributes to hiding cover, thermal cover and forage habitat (Map 2-14). It appears that South Fork watershed currently is meeting the habitat needs for deer and elk. However, field verification should occur at project level planning to ensure accuracy.

Fiqure 2-5. Snag Density - Unmanaged Stands



Fiqure 2-6. Snag Density - Managed Stands

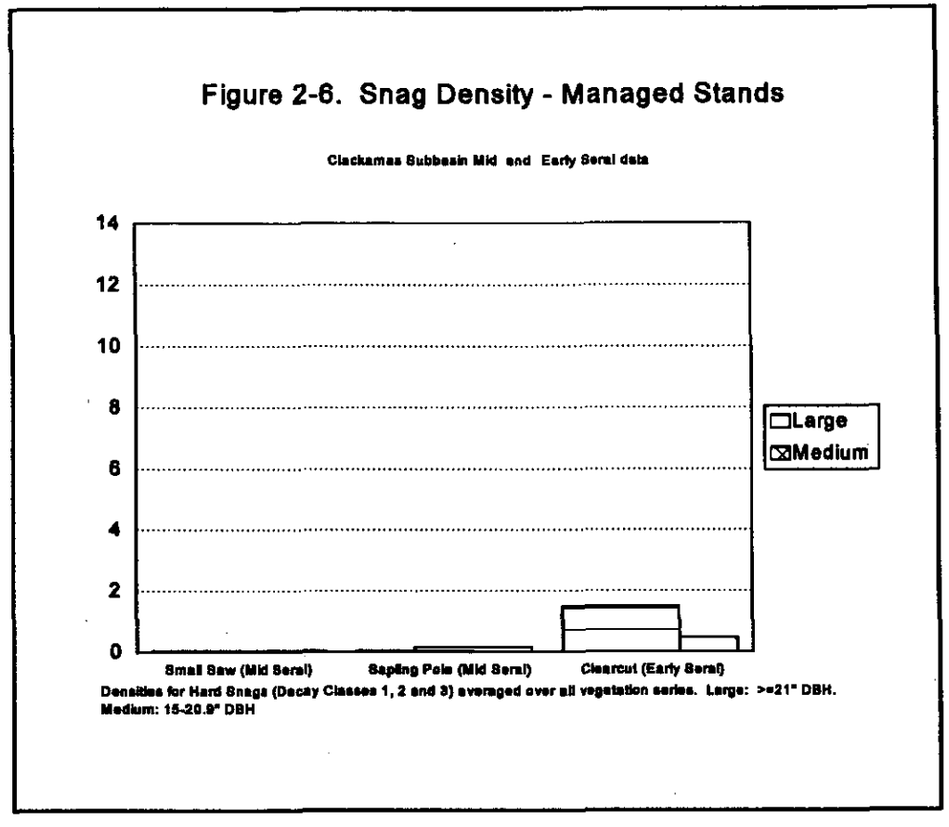


Figure 2-7. Log Density in Managed Stands Plantations

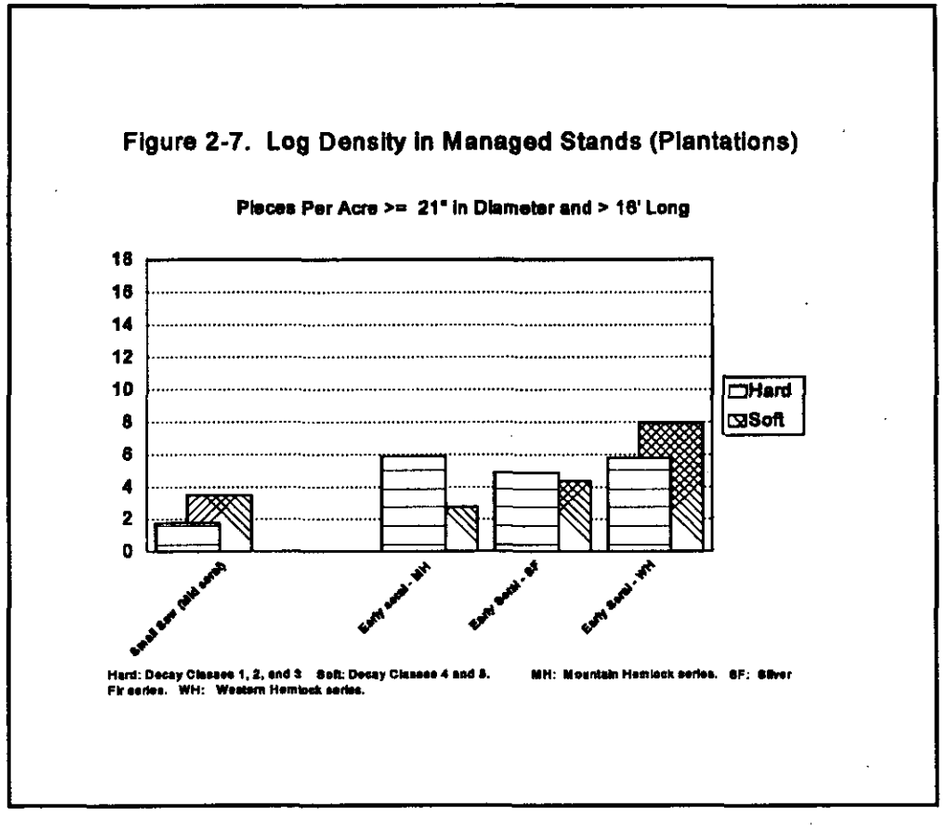


Figure 2-8. Log Density in Unmanaged Stands

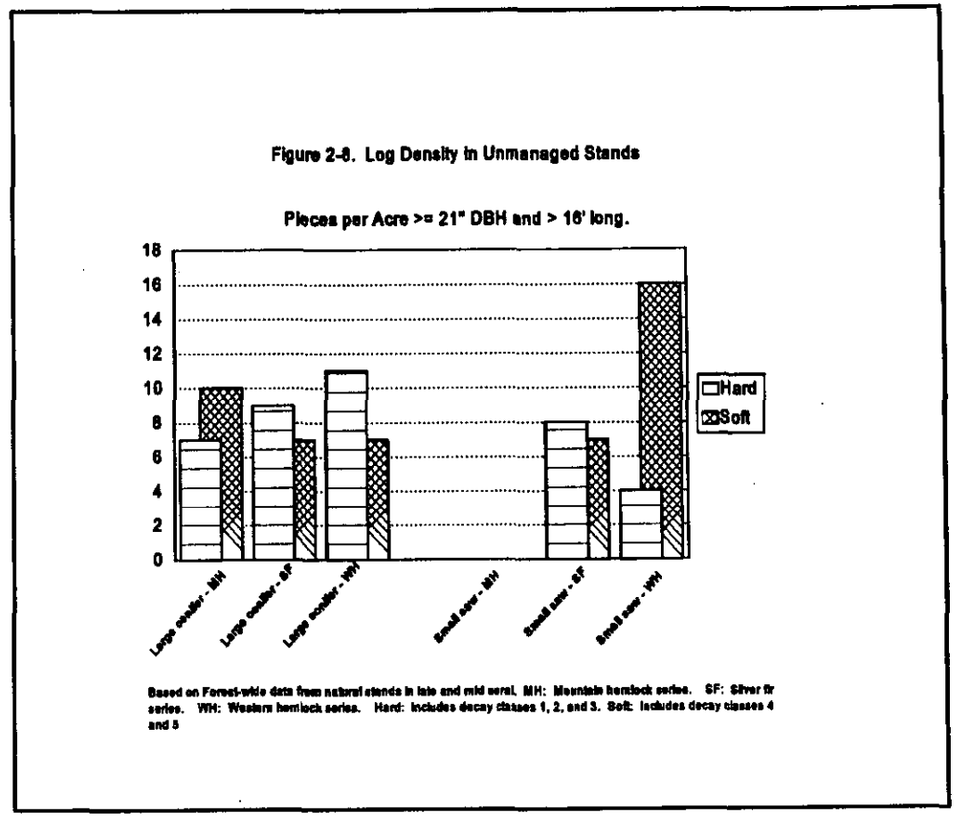
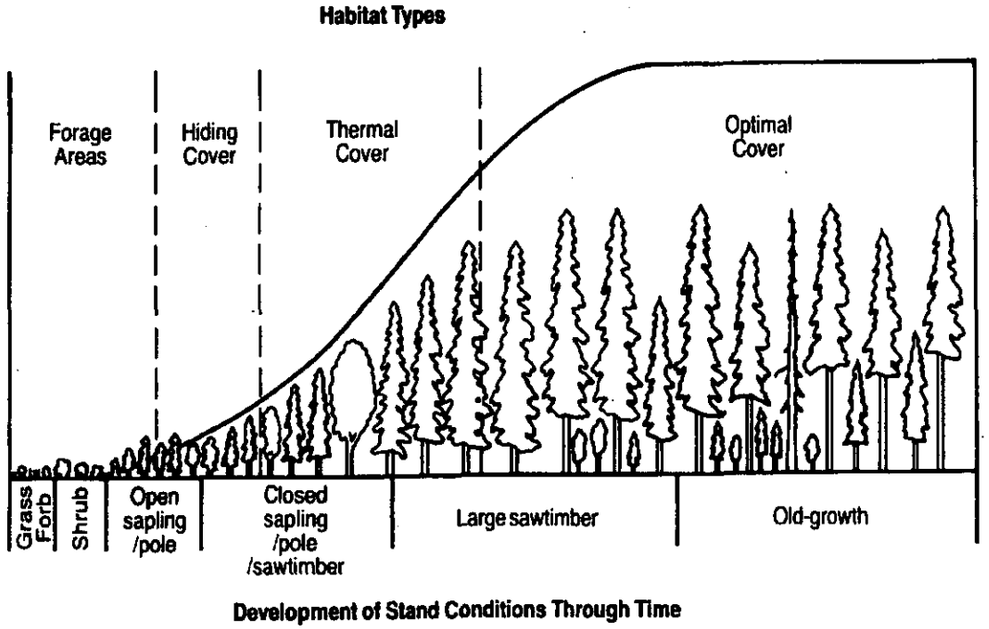


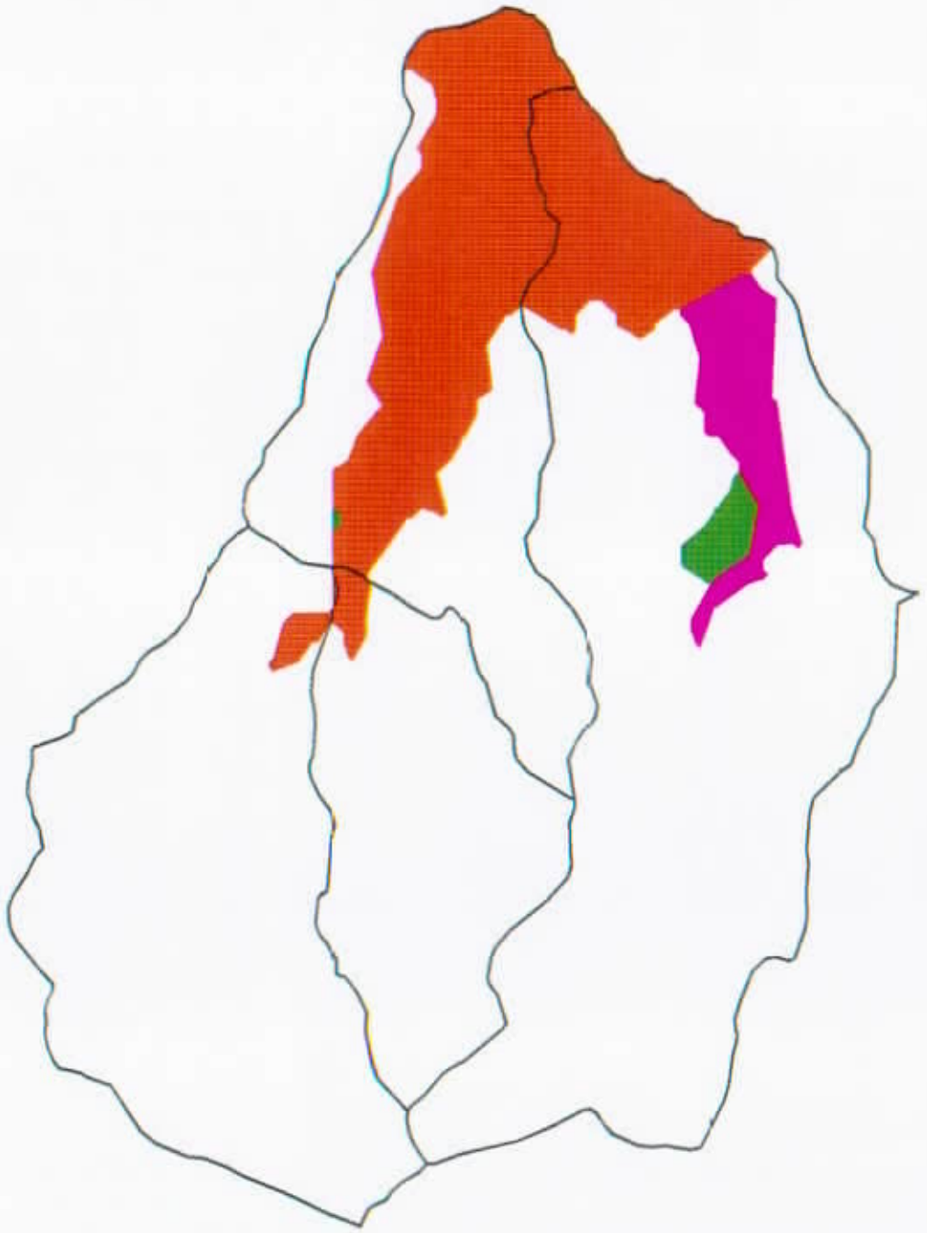
Figure 2-9. Habitat Types



"The South Fork watershed contains approximately 17,647 acres, of which roughly 19% (3409 ac) is Inventoried Deer and Elk Winter Range."

South Fork Clackamas River Watershed

Wildlife Habitat Areas



Legend

- Crucial Inventoried Winter Range
- High Inventoried Winter Range
- Moderate Inventoried Winter Range

SCALE 1:72480

1 0 1 2

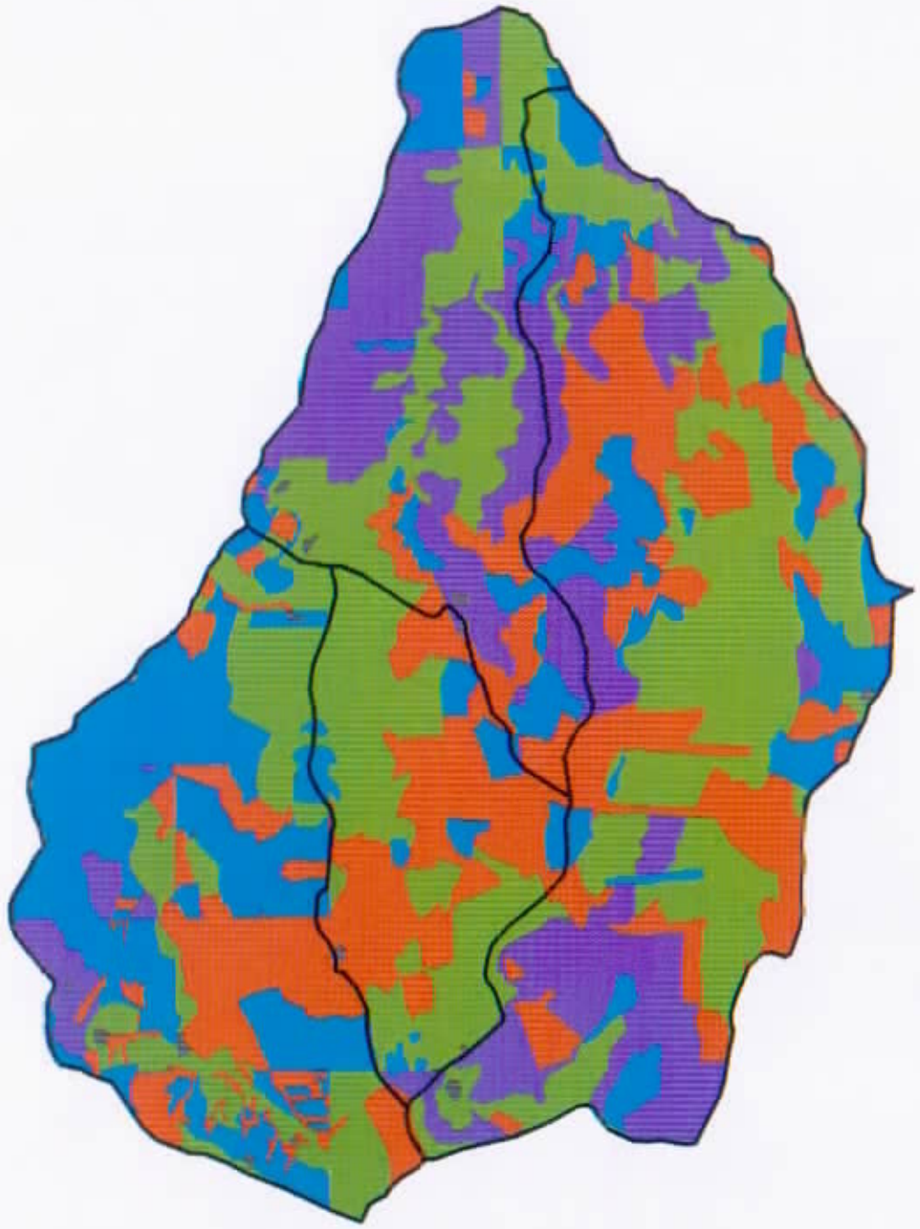
MILES

N W E S

MAP 2-13

South Fork Clackamas River Watershed

Big Game Habitats Types



Legend

- Forge Areas
- Hiding Cover
- Optimal Cover
- Thermal Cover
- Non Habitat

SCALE 1:72480

1 0 1 2

MILES

N W E S

MAP 2-14

Table 2-14. Deer and Elk Winter Range (WR) on Federal Lands

WR Type	WR Ac.	WR Rd Mi (open)	WR Sq.Mi.	Total Rds/ Sq.Mi.	Meets FP S&G?
Crucial (Severe)	2747	3.64	4.29	0.85	Yes
High (Severe)	534	0	.83	0	Yes
Moderate (Normal)	128	0	.20	0	Yes
Total	3409	3.64	5.32	0.68	---

FP - Mt. Hood National Forest and Resource Management Plan
S&G - Standards and Guidelines (FW-208 in this case)

Table 2-15. Deer and Elk Habitat Availability Cover types and habitat characteristics based on Habitat Effectiveness Model, Wisdom, et. al.

Cover Type	Habitat Characteristic(s)	Acres	%
Forage	Grass, Forb, Shrub, Meadow	4347	25%
Hiding	Hardwood, Closed Sap Pole, Open Sap Pole, Open Small Saw	3875	22%
Thermal	Closed Small Saw	3470	20%
Optimal	Large Sawtimber, Old Growth	5885	33%

Forage - Palatable vegetation of nutritional value
Hiding - Any vegetation capable of hiding 90% of a standing adult deer at 200 feet or less
Thermal - Stands at least 40 feet tall with at least a 70% canopy closure. Used for thermoregulation.
Optimal - Used for hiding, thermoregulation, avoiding disturbance, and if necessary, foraging. (USDA, 1986)

No known migration routes traverse through the South Fork watershed. However, one route does run from west to east just outside of the watershed boundary, north of Dead Horse Canyon. Movement has also been observed between South Fork Mountain and Fish Creek (personal communication, K. Marshall, 1996).

Potential calving and fawning grounds, characterized by the presence of water, downed logs, hiding cover, and available forage, may be located throughout the watershed but no known sites have been identified.

Trends

Vegetation Pattern Trends

Chapter 3, Landscape Analysis and Design, displays the desired vegetation patterns for the South Fork watershed, as described in the Northwest Forest Plan, the Mt. Hood Forest Plan, and the BLM Resource Management Plan. Map 3-3 is the Concept Design, which shows the long-term vegetation pattern for the watershed. Chapter 3 describes in detail how this map was developed. The future trends in vegetation patterns in South Fork will be based on the implementation of this design, from management direction described in the Northwest Forest Plan, the Mt. Hood Forest Plan, and the BLM Resource Management Plan. Over the next 20 years most early seral habitat of the South Fork watershed will move into mid seral condition. Stand management will focus on thinning of mid seral stands. Early and mid seral stands in areas to be aggregated in the future will be thinned to enhance windfirmness and stand growth and vigor. Early and mid seral stands in LSR and Riparian Reserves will be thinned to promote late seral characteristics.

The Concept Design, Map 3-3, shows that over the long-term most of the South Fork watershed will be in an late seral condition. Two percent of the watershed (Table 2-16) is in private ownership that is zoned as forestland.

Table 2-16. Long-term Future Vegetation Pattern.

PATTERN TYPE	ACRES	WHERE	% OF TOTAL WATERSHED
Aggregated	2422	Matrix / C1, Timber Emphasis / General Forest (BLM)	13 %
Interim Retention of Late Seral	49	Remaining late seral refugia (Connectivity of LSR)	.5 %
Managed Mosaic	889	Matrix C1, Timber Emphasis / General Forest (BLM) Where landform and adjacent allocations make the area too dissected to be in an aggregated pattern	5 %
Projected Aggregated	441	Private timberland	2 %
Retain and promote late seral forest	9409	Late successional reserves, Riparian Reserve, unmapped LSR	53 %
Windbreak	1426	Select areas around the LSR	8 %
Perforated	3110		18 %
Williams Lake special Habitat	47	Williams Lake Area	.5 %

It is projected that this area will be in an aggregated pattern in the future, with some larger early seral openings and younger mid seral blocks. Thirteen percent of the watershed will be in an aggregated pattern on Federal lands. This will consist of larger patches of early and mid seral habitat ranging from 0-120 years old, arranged in a mosaic pattern across the landscape. Snags, down logs, and some live trees will be retained in these areas, as prescribed by management direction. The Concept Design shows that most of the late seral habitat in the South Fork watershed in the future will be in the LSR and Riparian Reserves.

Species Trends

Plants

The Riparian Reserve network will help to provide future habitat for the re-establishment of *Corydalis aquae-gelidae*. The restoration of previously harvested and roaded tributaries would allow recruitment of new *Corydalis aquae-gelidae* seedlings, and the potential occupation of the channel by historic plant communities.. The increased riparian canopy will reduce fluctuations in shade, moisture, and water temperatures and decrease the potential for high intensity scouring of the channel.

The retention of coarse woody debris in future harvest units may provide potential habitat for *Huperzia occidentalis* in addition to several bryophyte, fungi, vascular plants, and lichen species listed as Survey and Manage species in the Northwest Forest Plan. The logs may provide transitional islands for the recovery of these species.

Aster gormanii populations should expand along ridgetops where vehicle use and litter is decreased.

"The Riparian Reserve network will help to provide future habitat for the re-establishment of Corydalis aquae-gelidae."

Animals

Timber harvest and its associated activities, specifically road building and overstory tree removal, may decrease habitat for amphibians. Species associated with Riparian Reserve habitat are expected to remain stable or increase due to improved riparian conditions. In the future, suitable spotted owl habitat will be located primarily in the Riparian Reserves. The Matrix lands are expected to provide for dispersal needs.

As implementation of policies occurs (i.e., ROD), special habitats are expected to remain stable or slightly improve.

Generalists and mid seral associates are expected to remain stable or increase.

A gradual recovery of snags and down logs within previously harvested areas is likely to occur.

Forage will continue to be available for deer and elk as early seral conditions are created.

Although hiding and thermal cover for deer and elk may decrease in Matrix lands, it is expected to remain stable or increase within LSR's and Riparain Reserves. South Fork Clackamas Watershed Analysis

Recommendations

Implement Conceptual Design as described in this document.

Thin second growth stands and young plantations to develop windfirmness, to accelerate development of large diameter trees for wildlife structures, and to maintain health and growth of stands in Matrix, as well as in Late Successional and Riparian Reserves.

Develop silvicultural prescriptions for providing a variety of wildlife structures of various decomposition classes over time, and which considers the developmental stage of the existing stand, the diameter size of the existing stand, the function that wildlife structures would provide to various species, high stress environmental conditions, the retention of wind damaged trees and the risk to the existing stand based on factors conducive to Douglas-fir bark beetle.

Implement mitigation measures and harvest designs which would minimize wind damage, especially to reserve stands and stands adjacent to reserves.

Remove the B5 land allocation (Pileated Woodpecker/Pine Marten Habitat Area) in the watershed through a Forest Plan amendment. This area, located in Matrix, is not considered necessary for late seral connectivity.

Surveys indicate that down wood components are lost when left less than 100 feet from roads. To discourage collection by firewood gatherer's, place DWD further than 100 feet from roads.

Provide a variety of wildlife structures (snags, DWD) of various decomposition classes over time. Evaluate the risk of bark beetle infestation.

Current and Reference Condition

The focus of recreation use in the South Fork watershed is motorized dispersed recreation and special forest products harvest. The rough terrain and the lack of significant landscape features like large bodies of water limit the types and levels of recreation use in the watershed. Recreation uses include scenic and recreational driving, hunting, fishing, camping, hiking, off-highway-vehicle (OHV) use, and nature study like astronomy. Use levels are considered low compared to other watersheds in the Clackamas River drainage except recreational driving and hunting. Recreation features in watershed include three small lakes, Williams, Memaloose, and Helen, three miles of trail, three mountain peaks with limited access and vista opportunities and Road 45 which is a well maintained loop road with a high use level of recreational driving. The lower 4.2 miles of the South Fork River has also been found to be eligible for Scenic classification under Wild and Scenic River designation because of its free flowing character and the presence of late winter run coho salmon. The lower South Fork River has also been designated an Oregon State Scenic Waterway.

Recreation opportunities in the watershed range from Roaded Modified to Semi-primitive Non-motorized on the Recreation Opportunity Spectrum(ROS). The Roaded Modified ROS classification applies to most of the watershed and indicates a roaded environment where vegetation has been substantially modified, some self reliance may be required, and developed campsites are not usually available. Roads, timber sale landings, and logging slash are usually evident in the landscape and interaction with other users is moderate. Memaloose Lake and the lower mainstem of the South Fork River offer a semi-primitive recreation setting which is a predominately natural-appearing environment of moderate size where permanent structures are rare. Motorized access is restricted in a semi-primitive setting and interactions with other users are rare.

"Recreation use levels are considered low compared to other watersheds in the Clackamas River drainage except recreational driving and hunting."

The three primary features of the watershed which attract use are its close proximity to local communities, low level of management presence, and easy, improved access on Road 45. In addition to recreation uses, the watershed is also valued for special forest products like firewood and bough sales and receives some of the highest use for Christmas tree harvest in the drainage. Proximity, access, and lack of management presence has also contributed to illegal and anti-social behavior such as garbage dumping, underage drinking, stolen vehicle dumping, poaching, and firewood theft. Although these activities occur at a high level in this watershed, especially firewood theft, poaching, and stolen vehicle dumping, the watershed does not have the same reputation for lawlessness as North Fork watershed.

Because no use figures are available for dispersed recreation, analysis of use is based on anecdotal information from Forest Service employees and the public. For the purpose of this analysis, stratification of the watershed includes the river corridor of the South Fork Clackamas River, the lakes and mountain peaks in the watershed headwaters and Road 45.

Road 45

Road 45 is an improved road which circles the perimeter of the watershed crossing east to west through the headwaters of Memaloose Creek, East Fork, and South Fork. Road 45 is a popular day use drive because it is a 56 mile loop road close to local communities and provides the primary access for recreation sites and activities in the watershed. This includes both high use areas in the extreme northeast and southwest areas of South Fork watershed which receive a proportionally higher concentration of dispersed camping, hunting, and target shooting as well as garbage dumping, poaching, and partying. Many of the rock pits, borrow pits, and timber sale landings along the road also serve as sites for unmanaged target shooting and dispersed camping as

well as party sites and garbage dumps. Road 45 is also the main route to roads 4510 and 4520 which provide access to Clear Lake and OHV sites on the west side of Goat Mountain in the Upper Clear Lake watershed to the west of South Fork watershed. Contingent upon snow levels, the road is heavily traveled in the winter and receives some of the highest use in the Clackamas River drainage for Christmas tree harvest. A minor amount of overflow camping occurs at the northern entrance of the watershed along Road 45 from Clackamas River corridor users during the summer recreation season and during river related events. Both trailheads in the watershed are also located on Road 45 which provides access to the South Fork River corridor and Memaloose Lake.

South Fork Clackamas River

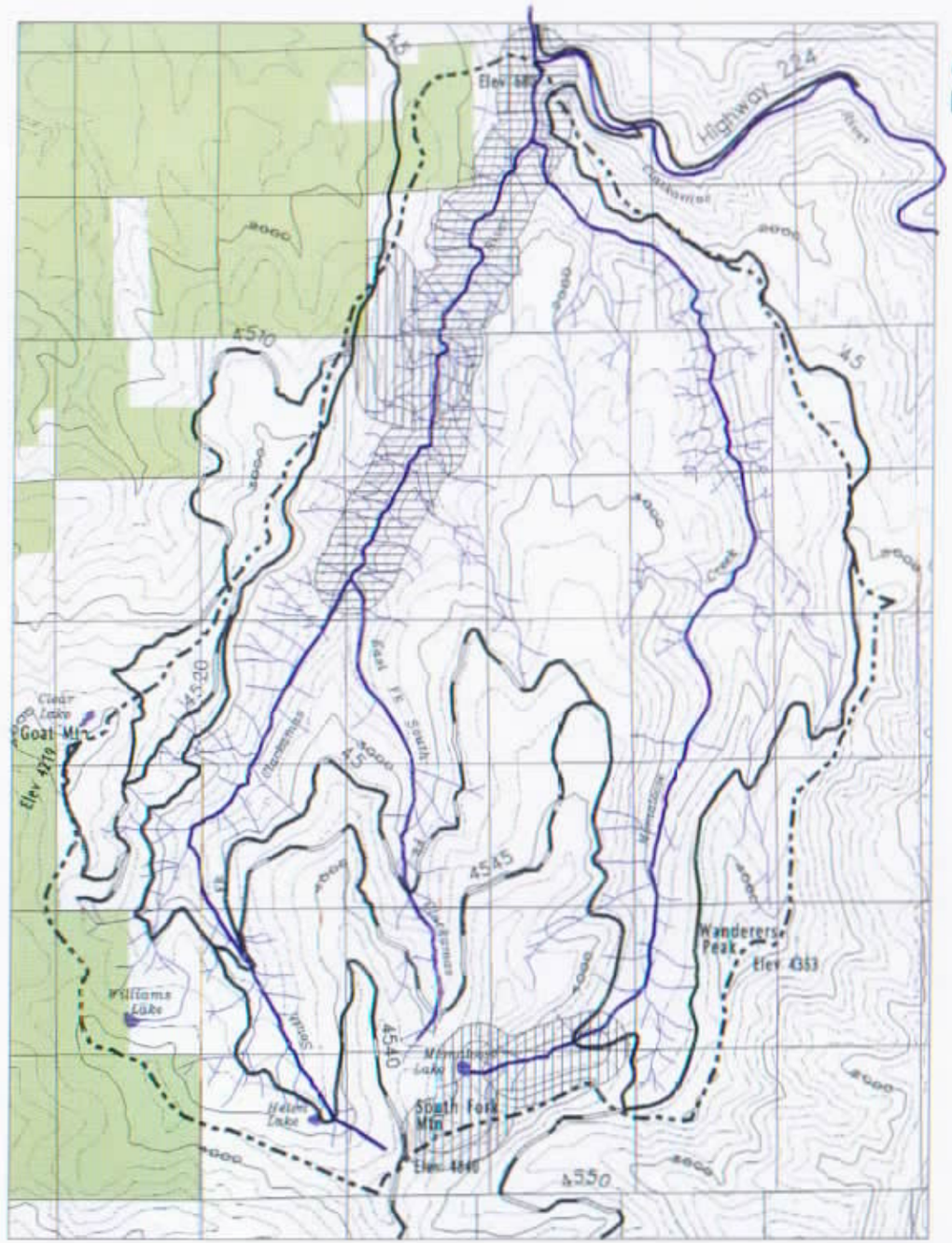
The steep slopes and unroaded character of the lower South Fork River limits recreation use. Only one trail, #515 the Hillockburn Trail, provides access to the lower river corridor. Open to hikers, equestrians, and mountain bikers, the trail serves primarily as fishing access for anglers and use is light. The trail is 1.5 miles long with grades of 10-30% and drops from an elevation of 2,200' at the trailhead at Road 45 to 1,500' at the river. Although there are native winter steelhead, spring chinook, and coho salmon which occupy the lower 0.4 miles of the river below the barrier falls, current regulations do not allow fishing for these species. The sport fisher includes native rainbow and cutthroat trout, hatchery run summer

"The steep slopes and unroaded character of the lower South Fork River limits recreation use."

steelhead and stocked brook and rainbow trout. The lower South Fork River also provides the angler with a primitive fishing experience because access involves hiking and in most cases in steep canyons. This helps to isolate and protect the fish from human harassment and increased angling pressure as well as providing a primitive setting for fishing. As noted, the river has been found eligible for Wild and Scenic River designation (Map 2-15) with fisheries as the Outstandingly Remarkable Value from it's confluence with the East Fork Clackamas River and the mainstem of the Clackamas River. Until a final eligibility study has been completed, management direction includes retention of the 1/4 mile interim boundary on both sides of the river above the average annual high water mark. Within this boundary, the Visual Quality Objectives (VQO) specified in the Mt. Hood forest Plan is retention in the foreground for a Scenic segment of an eligible river. In addition, in 1988 the river was designated a State Scenic Waterway through the Oregon Rivers Initiative. The State Scenic Waterways Act requires that the State Land Board approve any alteration of the bed and/or banks of a scenic river or wetlands within the scenic waterway. Although steep valley side slopes restrict dispersed camping opportunities, limited camping occurs consistently during summer recreation season at the confluence of South Fork and the mainstem of the Clackamas River by boaters. The proposed Urban Link Trail is planned to cross South Fork River near its confluence with the Clackamas River and could increase visitor use in the area. In particular, the Oregon City Waterworks and multiple waterfalls could become a recreation attraction if the Urban Link Trail is constructed.

Lakes

Two of the three small lakes in the headwaters of upper South Fork subwatershed and Memaloose subwatershed are used by recreationists for camping, fishing, and hiking opportunities. Helen Lake at just over 2 acres is not stocked with fish and receives little recreation use. Memaloose Lake in the Memaloose subwatershed is a 5 acre lake which offers a primitive backcountry fishing and camping opportunity. Stocked by the state with brook, rainbow, and cutthroat trout and is considered a "put and take" fishery. Due to the shallow shore of Memaloose Lake, bank fishing is limited and many anglers use flotation devices. There are five user built campsites with fire rings at the lake and one pit toilet located approximately 200' from the creek. Recreation use is primarily day use fishing and overnight weekend use averages an estimated five campers during the summer recreation area. The Memaloose Lake Trail #515 is the only access to the lake and is open to hikers, equestrians, and mountain bikers. The



South Fork Clackamas River Watershed

Viewshed

Legend

- Private Land Ownership
- Gravel, Suitable for Passenger
- Single Lane Paved
- Watershed Boundary
- Trail Viewshed
- Eligible Wild and Scenic River

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MAP 2-15

trailhead is located on Road 45 and the trail serves as ccess to the vista opportunity at the top of South Fork Mountain as well as Memaloose Lake. Under the Mt. Hood Forest Plan, Memaloose Lake is a B-12 Backcountry Lake allocation with the objective of protecting or enhancing, the recreation, fish, wildlife, and scenic values of designated lakes Under the Northwest Forest Plan, Memaloose Lake and trail are located within a Late Successional Reserve. Because motorized access is restricted to both Memaloose and Williams Lake, the fish are protected from human harassment and increased angling pressure as well as providing a primitive setting for fishing.

Williams Lake is a 35 acre lake and bog located on both BLM administered land and private land in the Upper South Fork subwatershed. The lake and bog ecosystem under
BLM management has been designated for special management as An Area of Critical Environmental Concern (ACEC). The lake is still popular for fishing, hunting, and dispersed camping and three camp firerings as well as garbage and debris have been noted at the site both on BLM and private land. The primary management objective for the ACEC is to protect and preserve the lake and bog ecosystem for educational and scientific purposes and if recreation use leads to the deterioration of significant ecological value, actions will be taken to protect those values. Currently, access to the lake is by a user trail and motorized vehicle use, including OHV use, is restricted. Like Memaloose Lake, Williams Lake is stocked by the state with brook, rainbow, and cutthroat trout and is also a "put and take" fishery.

"South Fork Mountain, Elevation 4,840', has both road and trail access to the summit and is valued for the scenic vista which includes views of five volcanos."

Mountain Peaks

Other recreation destinations in the watershed which receive dispersed recreation use in the watershed are the peaks of Wanderers Peak, South Fork Mountain, and Goat Mountain. Wanderers Peak, elevation 4,353', has a non-system user trail to the top and receives only minimal use. South Fork Mountain, Elevation 4,840', has both road and trail access to the summit and is valued for the scenic vista which includes views of five volcanos. Trail #515 which connects Memaloose and South Fork Mountain is steep with average grades of 10-20%. The segment of Trail #515 from Road 45 to the lake is estimated to receive more use than the segment from the lake to the mountain top because of the alternative roaded access to the summit of South Fork. The Goat Mountain area is also a popular destination both in South Fork watershed as well as the Upper Clear Lake watershed. The summit of Goat Mountain, elevation 4,219', currently serves as an administrative use site for radio transmitters and has restricted vehicle access. The roaded area around Goat Mountain is an OHV recreation site which spans the watershed and administrative boundaries. A higher proportion of the use reportedly occurs in the less steep terrain on BLM land outside South Fork watershed but Road 4510, 4520, and adjacent spurs and skid trails are also used. The OHV use is primarily day use with only minor camping except during hunting season. A rock pit on Road 4520, in the Goat Mountain area, is also valued by a Portland astronomy club for astronomy study.

"The watershed is noted for exceptionally high levels of Christmas tree harvest."

Special Forest Products

The watershed is noted for exceptionally high levels of Christmas tree harvest during years which is limited only by snowlevels and use is concentrated in the upper elevations of the watershed where pacific silver fir is available. Because Christmas tree harvest is primarily a road based activity, a higher proportion of trees come from second growth stands on Road 45. Bough harvest and firewood cutting, both legal and illegal, have a high occurrence in the watershed. Cedar has been harvested in years past but is less available now. South Fork watershed also receives mushroom harvest but is not known for major mushroom collection sites or high value mushroom species. Greenery is collected for both the nursery and florist trade such as rhododendron, salal, and vine maple.

Hunting

Deer hunting is a popular activity in South Fork watershed with a minor amount of hunting for elk, bear, and grouse also occurring. Although there are no known resident herds of deer in the watershed to ensure hunter success, proximity to Estacada and local communities make it a popular destination for road based, day use hunting and dispersed camping activity increases during hunting season, particularly along roads 4545-120 and 4545-130. The meadows, wetlands, and small lakes in the upper South Fork subwatershed also attract a higher level of hunting activities and dispersed hunting camps. (Map 2-16) The watershed also has a reputation for an extremely high levels of poaching because of its close proximity to local communities, county road access, and low management presence.

Other Uses

Like North Fork watershed, South Fork watershed is also the setting for many uses which are illegal and/or anti-social. Garbage dumping, including toxic materials, is estimated to be as prevalent as in North Fork watershed but is not as visible due to the refuse dumped down the steep slopes. Rock pits, borrow pits, and landings are used as underage party spots, unmanaged target shooting areas, and dump sites. The watershed is reported to have a high level of night time use not related to overnight camping and there are more abandoned vehicles in this watershed than any other watershed in the Clackamas River drainage.

Illegal firewood cutting and bough harvest and poaching are concerns within the watershed. South Fork watershed, however, does not have a high incidence of homeless camps possibly because of limited low visibility camping sites near water accessible by roads. South Fork watershed does not have the same level of reported violence as North Fork watershed and has not yet been tagged by local gangs. Unmanaged OHV use is limited in South Fork watershed because of the steep slopes although access to OHV destination sites in the Goat Mountain area outside the watershed boundary is by way of Road 45.

Trends

Recreation use in the watershed and traffic through the watershed to other recreation destinations is expected to increase as the population of Portland and local communities increases. Demand for all recreation activities currently occurring in the watershed: driving for pleasure, fishing, hunting, target shooting, camping, and hiking are all projected to rise according to the State Comprehensive Outdoor Recreation Plan (SCORP). Also according to SCORP, there is a regional shortage in the supply of primitive and semi-primitive recreation settings and the South Fork watershed could play an important role in the provision of those settings particularly areas like the mainstem of the lower South Fork River and Memaloose lake.

Increased hunting and fishing pressure could lead to lower hunter and angler success. User conflicts could also rise with increase number of users. Road closures could also limit recreation opportunities for motorized recreation like dispersed camping, hunting, and OHV. New Oregon State OHV regulations could increase trail and quad bike use on open roads which could lead to user conflicts with administrative, commercial, and recreational traffic.

Along with increased recreation use, it is expected that the anti-social and/or illegal activities occurring there now will continue to increase. Special forest products harvest, both legal and illegal, could increase with population increases and with market fluctuations. And because Road 45 goes through both LSRs, special forest product harvest like Christmas trees, boughs, and firewood cutting could be limited as late seral forest structure is attained in the reserves. And as late seral forest structure is retained in the reserves, the scenery in the viewsheds of the river and trails should be adequately protected.

Recommendations

- Pursue land exchange or acquisition of private lands adjoining Williams Lake Area of Critical Environmental Concern.

- Continue aggressive garbage cleanup measures.

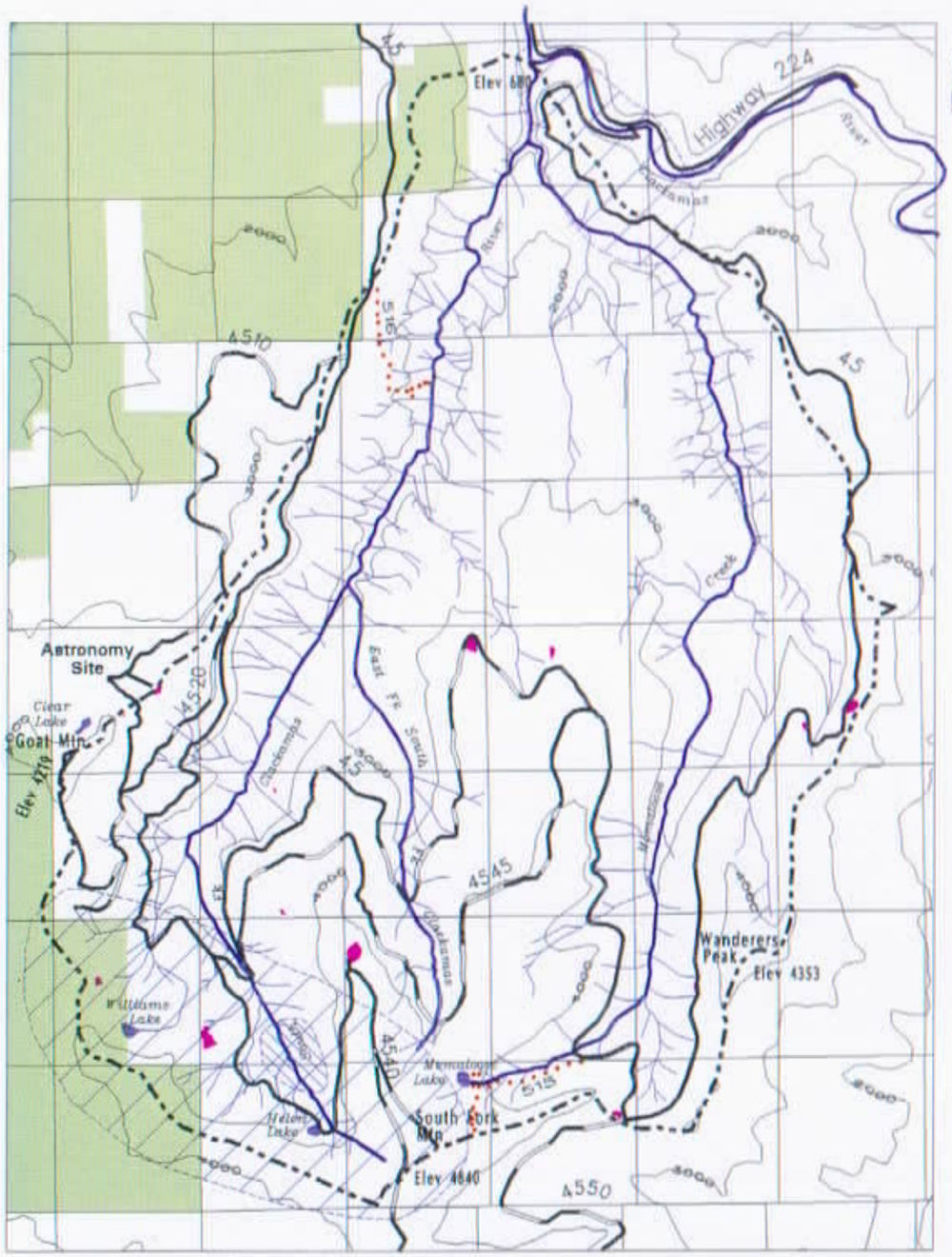
- Rehabilitate selected landings, rock pits, and borrow pits along Road 45 to discourage parties and garbage dumping as well as reducing erosion and improving scenery.

- Coordinate FS and BLM management of OHV use on Goat Mountain.

- Discourage recreation use of bat habitat in the South Fork Water Board tunnel.

South Fork Clackamas River Watershed

Recreation



Legend

- Private Land Ownership
- Gravel, Suitable for Passenger
- Single Lane Paved
- Trail
- Watershed Boundary
- Rock Quarry
- Hunting Camps
- High Use Areas

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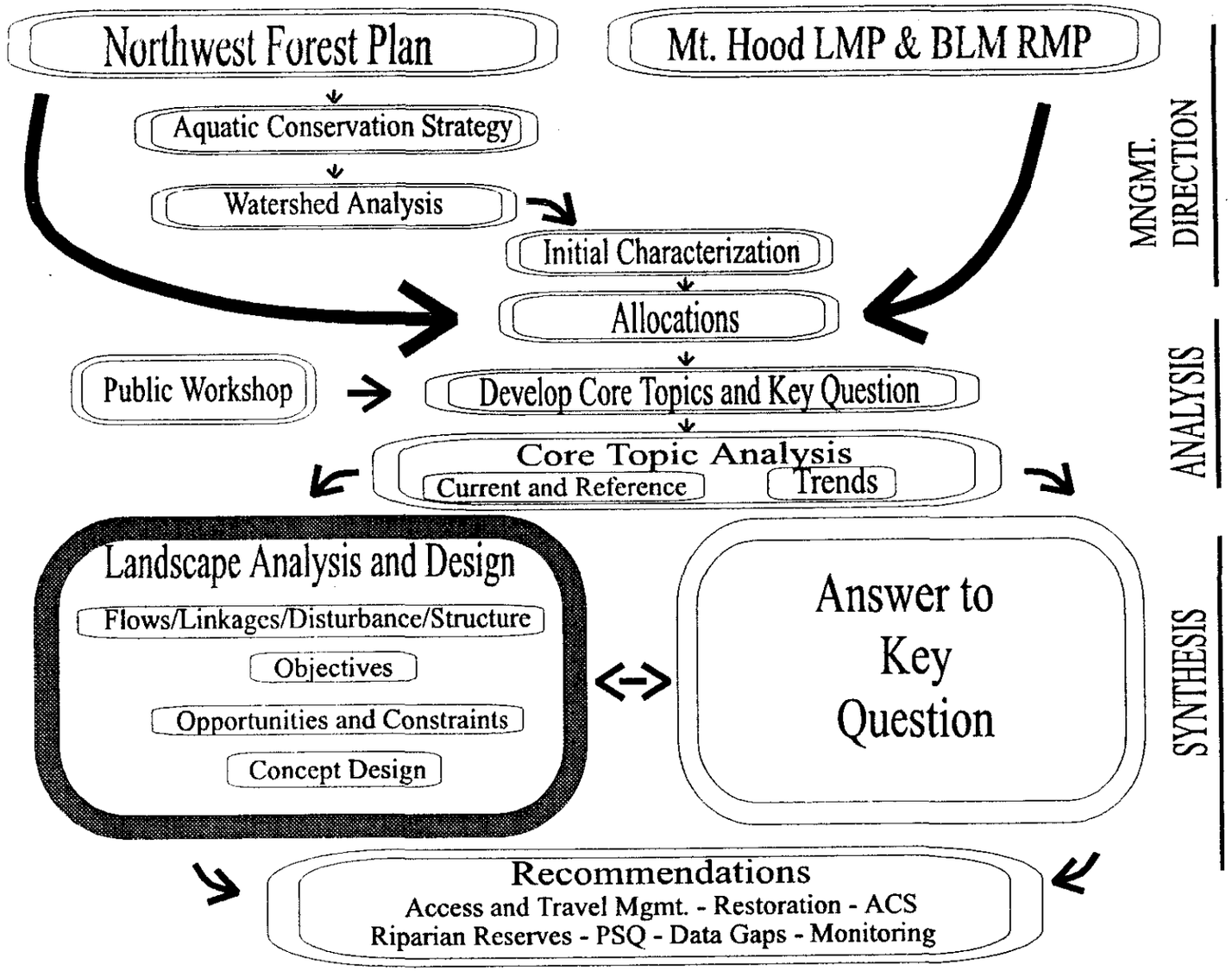
MAP 2-16

Chapter 3
Landscape Analysis and Design



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 management objectives. The premise of the LAD process is that different landscape structures in the watershed can be arranged spatially according to the management direction within the parameters of the watershed's physical and biological potential. Information about the LAD process is described in detail in the publication *Forest Landscape Analysis and Design* by Diaz and Apostol, 1992. The goal of using the LAD process in the South Fork watershed Analysis is to synthesis current management direction from the Northwest Forest Plan, Bureau of Land Management Resource Management Plan, and the Mt. Hood Forest Plan, with the site specific analysis and recommendations from the watershed analysis to 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 landscape scale understanding of the watershed.

The LAD process for the South Fork watershed began with a comprehensive review of management direction and land allocations and was followed by an analysis of landscape structure, flow phenomena, linkages to the larger landscape, and disturbance regime. This analysis combined with landscape objectives from the existing management direction were used to create an opportunities and constraints map and a conceptual landscape design for the watershed. The designs and plans produced during the LAD process graphically display where future management activities will occur in the watershed and serve as a bridge between analysis and site specific project development.

Landscape Allocations and Design Objectives

Because design is an objective driven process, the establishment of clear landscape objectives for the watershed design is a critical first step of the process. Design objectives for South Fork watershed were derived from the Northwest Forest Plan, Mt. Hood Forest Plan, and the BLM Resource Management Plan.

The next step in the LAD process involved translating the management objectives into vegetation pattern types. Some management directions and land allocations have clear vegetation pattern objectives such as the retention of late seral forest structure in the Riparian Reserves and Owl Activity Centers. Other vegetation pattern objectives had to be developed from the management direction based on watershed specific ecological structures and processes. The following list includes both management direction from the land allocations and the watershed specific vegetation pattern types.

Northwest Forest Plan

Late Successional Reserves

Goal: The objective of the Late Successional Reserves is to maintain a functional, interactive, late successional and old-growth ecosystem. They are designed to serve as habitat for late successional and old growth related species including the norther spotted owl. In addition, one hundred acres of the best northern spotted owl habitat will be retained as close to the nest site or owl activity center as possible for all known spotted owl activity centers located on federal lands in the matrix. Only one 100 acre LSR is located in the South Fork watershed and is not illustrated on the allocations map.

Riparian Reserves

Goal: Achieve and maintain riparian and aquatic habitat conditions for the sustained, long-term production of fish, selected wildlife and plant species, and high quality water for the full spectrum of the forest's riparian and aquatic areas. A secondary goal is to provide habitat connection for late-successional species and dispersal habitat for other terrestrial species.

Matrix (also C 1 Timber Emphasis from Mt. Hood Forest Plan and General Forest from BLM RMP)

Goal: Provide lumber, wood fiber and other products on a regulated basis, based on the capability and suitability of the land. The intent is to retain structural components like 15% green trees, snags, and down woody debris to facilitate species flow. A secondary goal is to function as connectivity between LSR's and provide habitat for a variety of organisms associated with both late successional and younger forests. This is the predominate land allocation within the watershed and is similar to the C1 Timber Emphasis land allocation from the Mt. Hood Forest Plan.

Bureau of Land Management

General Forest Management Area (GFMA)

Goal: The primary objectives of the GFMA are to manage for timber production while providing for long term site productivity, forest health, cavity nester habitat and biological legacies. Emphasis would be placed on the use of intensive forest management practices and investments to maintain a high level of sustainable timber production.

Goal: The primary objective is to provide for protection of fragile sites due to steepness, high watertable, rocky soils, or non-forest areas while contributing to meeting other ecosystem goals such as late-successional habitat, aquatic resources, and special habitats. This is an administrative withdrawal which overlays the General Forest Management Area allocation.

Williams Lake Area of Critical Environmental Concern (ACEC)

Goal: To protect and preserve the lake and bog ecosystem for educational and scientific purposes. Consistent with this objective, the ACEC has been divided into two management zones: a primary zone (60 acres) and a caution zone (30 acres). Management of the primary zone, containing the key ecological values, will be directed toward maintaining relatively undisturbed conditions. The caution zone, established to provide a buffer against windthrown trees, will be managed for multiple resource use.

Mt. Hood Forest Plan

C1: Timber Emphasis
See Matrix

A9: Key Site Riparian

Goal: Maintain or enhance habitat and hydrologic conditions of selected riparian areas, notable for their exceptional diversity, high natural quality and key role in providing for the continued production of riparian dependent resource values. Note that this allocation overlaps with the B12 Backcountry Lake allocation, one of the B5 Pine Martin/Pileated Woodpecker Habitat Areas, and a Late Successional Reserve.

B1: Wild and Scenic River

Goal: Protect and enhance the resource values for which a river (Clackamas River) was designated into the Wild and Scenic Rivers System.

B2: Scenic Viewshed

Goal: Provide attractive, visually appealing forest scenery with a wide variety of natural appearing landscape features. Utilize vegetation management activities to create and maintain a long term desired landscape character

Eligible Wild, and Scenic Rivers

Goal: The South Fork Clackamas River is eligible for designation by congress as a Wild and Scenic River. Management activities should be designed to protect the free-flowing nature and outstandingly remarkable values of the river until it is designated as a Wild and Scenic River or released from consideration. Until final eligibility determination, management direction includes a 1/4 mile interim boundary on both sides of the river above the average annual high water mark. The Visual Quality Objective (VQO) for the foreground of the river in the Scenic segment is Retention which means the scenery should appear as a predominantly natural landscape where human activities are not evident to casual visitors.

B5: Pileated Woodpecker/Pine Marten Habitat Area

Goal: Provide Forestwide mature or old growth forest habitat blocks of sufficient quality, quantity, and distribution to sustain viable populations of pine marten and pileated woodpecker. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices.

B7: General Riparian Area

Goal: Achieve and maintain riparian and aquatic habitat conditions for the sustained, long term production of fish, selected wildlife and plant species, and high quality water for the full spectrum of the forest's riparian and aquatic areas. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices. This is a watershed-wide allocation and is not mapped.

Trail Viewshed

Goal: Maintain the scenic quality from the trails with "natural appearing" or "partially altered" scenery in the 1,320' viewshed on either side of the trail.

B8: Earthflow

Goal: Maintain hydrologic and physical balances to prevent reactivation or acceleration of large, slow moving earthflow areas. Allow for the management and utilization of forest resources through the use of special management practices.

B12: Backcountry Lakes

Goal: Protect or enhance the recreation, fish and wildlife, or scenic values of designated lakes. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices.

Private Land:

Goal: Projected Aggregated harvest pattern of large openings on zoned industrial forest private lands retaining few structural components and narrow riparian buffers..

Landscape Structure

Landscape Structure is an analysis of the existing vegetation pattern based upon the landscape ecology definitions of matrix and patch. (Forman and Godron 1986). The matrix within the watershed, based upon the criteria of relative area, connectedness, and control over landscape dynamics, is defined as mature forest composed of three structural classes: large conifer, closed small sawtimber, and open small sawtimber. Patch types within the watershed are "special habitats" and include hardwood patches, wetland patches, rock patches like rock outcrops and talus slopes, and three small backcountry lakes. South Fork watershed has comparatively fewer special habitats compared to other watersheds in the Clackamas subbasin.

Currently, 35% of the entire South Fork watershed is in an early seral condition, 34% is in mid seral, and 31% in late seral. The forest series that occur within the watershed include western hemlock, Pacific silver fir, and mountain hemlock. Thirty percent of the watershed is in the western hemlock series, 65% is in the Pacific silver fir series, and 5% is in the mountain hemlock zone on the south to southeast border of the watershed. Approximately 50% of the late seral habitat in the watershed is in the LSRs with the remaining 50% located in the Matrix allocation.

Flows and Linkages

Landscape flow phenomena are those identified elements which move across the landscape such as humans, animals, plants, water, fire, and air. (Diaz and Apostol) Linkages describe the those flow phenomena which move or connect across watershed boundaries. In South Fork watershed, the flow patterns of wind, anadromous fish, deer, and humans were analyzed (Map 3-1) The most critical flow phenomena in the watershed which affects landscape structure is wind. Southwest winds during the late fall months are the prevalent damaging winds but east and southeast winds have also contributed to the amount of windthrow in the watershed. The flow of anadromous fish, particularly the late run coho salmon, is blocked .4 miles up the lower South Fork River by a 70' waterfall. Because of the presence of the Late Succession Reserves connected by Riparian Reserves in the watershed, flows and connectivity for late seral dependant species are located primarily within the LSRs for the present and will extend into the Riparian Reserves in the future. No future need for additional late seral connectivity was identified except for an existing late seral stand adjacent to the headwaters of the East Fork South Fork Clackamas River. Because the Riparian Reserve in that segment of the headwaters is in an early seral condition, interim retention of the late seral stand would provide connectivity between the LSRs until the Riparian Reserve functions as late seral structure. Although there are no known resident deer or elk herds in the watershed, an east/west pattern of seasonal migration from Fish Creek watershed to the headwaters of Memaloose Creek and South Fork River has been identified. Road 45 was identified as the primary travel route for humans through the watershed. Additional roads were also identified as important routes for access to lakes, hunting areas, scenic vistas, recreation sites, and as linkages to surrounding watersheds for administrative management.

Disturbance Pattern

Fire, historically, was the dominant landscape pattern forming disturbance South Fork watershed. Stand replacement fires in the late 1800' and early 1900's created the existing mid seral forest structure in the northwest corner of the watershed. The South Fork Watershed is in the "warm, moist western hemlock and Pacific silver fir" fire ecology group. This group is a stand replacement fire type with a fire frequency of 50-300+ years. The importance of fire as a determinant of landscape structure changed with active fire suppression in this century.

Wind, in concert with timber harvest and road building, is currently the primary disturbance agent in the watershed. Windthrow was first noted in the 1950's as timber harvest began on South Fork Ridge and the watershed has a reputation for some of the highest windthrow risk in the Clackamas River subbasin. The highest risk areas in the watershed are the old growth stands along South Fork Ridge and in the upper South Fork subwatershed. The prevalent damaging wind storms are from the southwest under saturated soil conditions during the fall. East and southeast winds during winter months have also contributed to the amount of windthrow in the watershed.

Disturbance by Douglas-fir bark beetle has been considered minor in the South Fork watershed because of windthrow salvage which removes favorable breeding habitat. Laminated root rot and Shoestring root rot are found throughout the drainage in scattered small pockets but their occurrence and impact in the South Fork watershed is considered minimal.

Opportunities and Constraints

The Opportunities and Constraints map (Map 3-2) is a synthesis of key resource issues located spatially in the watershed along with inherent landscape characteristics such as potentially unstable landforms and areas of high windthrow risk. The overlapping and nested polygons identify areas of compatible and conflicting management objectives. Opportunities and Constraints mapped in the North Fork watershed include.:

- Landform stability concerns: High landslide potential was identified on three landform types, Resistant Rock/Steep Slopes, Weak Rock/Steep Slopes, and Landslide Deposits. These landform units have the potential to

constrain the size of timber harvest openings.

- Geologic Contacts: Near contacts between Resistant Rocks/Steep Slopes and Weak Rocks/Steep Slopes.

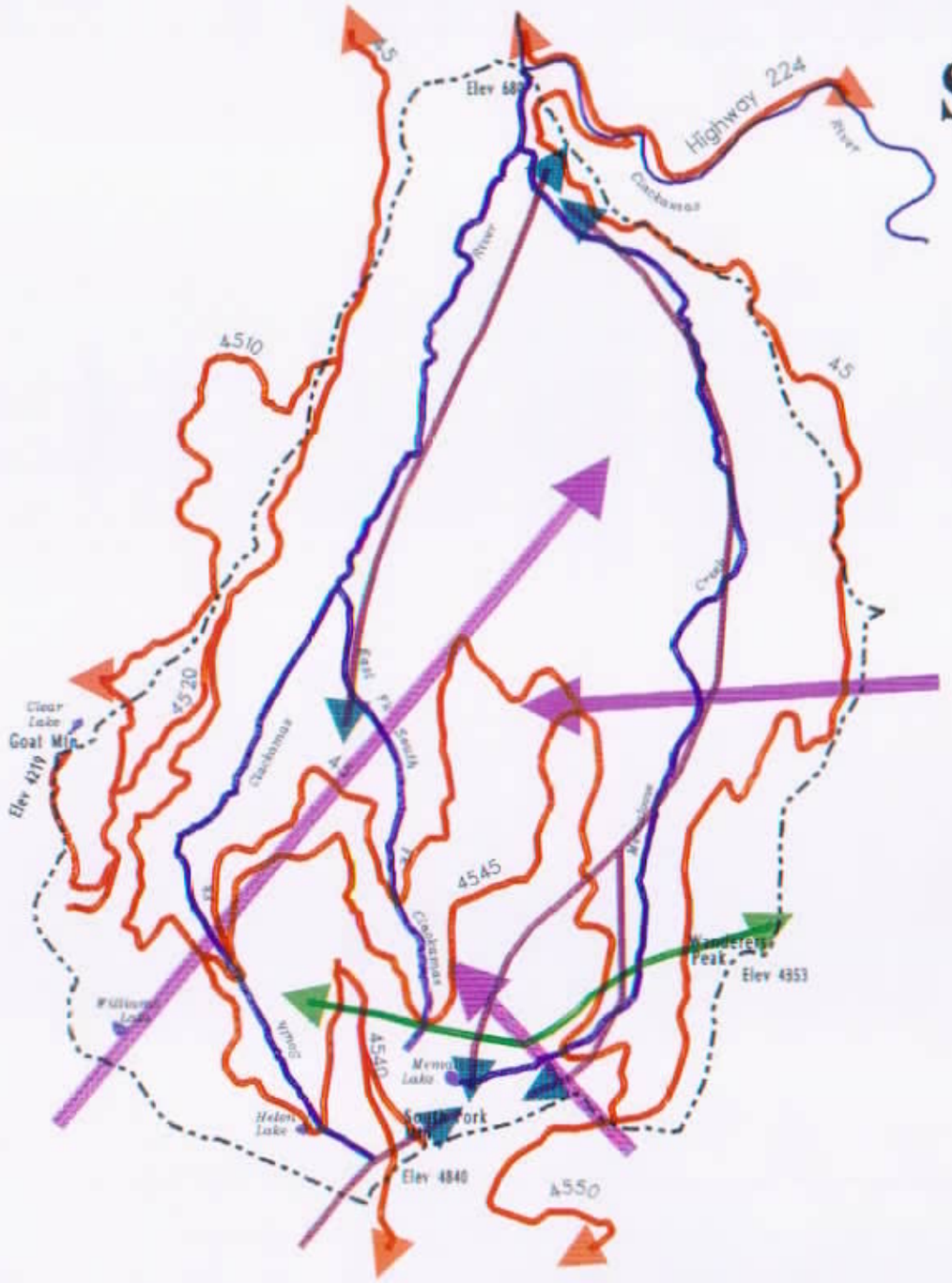
- Landforms with high windthrow risk: Because of the exposed character of these landforms, condition of the existing stands, past timber harvest pattern, and prevailing wind direction, these are areas expected to be at higher risk for windthrow events.

- Landforms prone to wind funnel effects risks: These are primarily saddles in the ridges surrounding the perimeter of the watershed which can channel wind velocity and increase local turbulence.

- South Fork River Viewshed: The 1/4 mile interim boundary on either side of the river marks the viewshed of the segment of the South Fork River eligible Wild and Scenic River designation. Management direction includes retention of the Outstandingly Remarkable Values

South Fork Clackamas River Watershed

Flows and Linkages



Legend

- Human Flow
- Water Flow
- Watershed Boundary
- Big Game Migration
- Late Seral Connectivity
- Wind Direction

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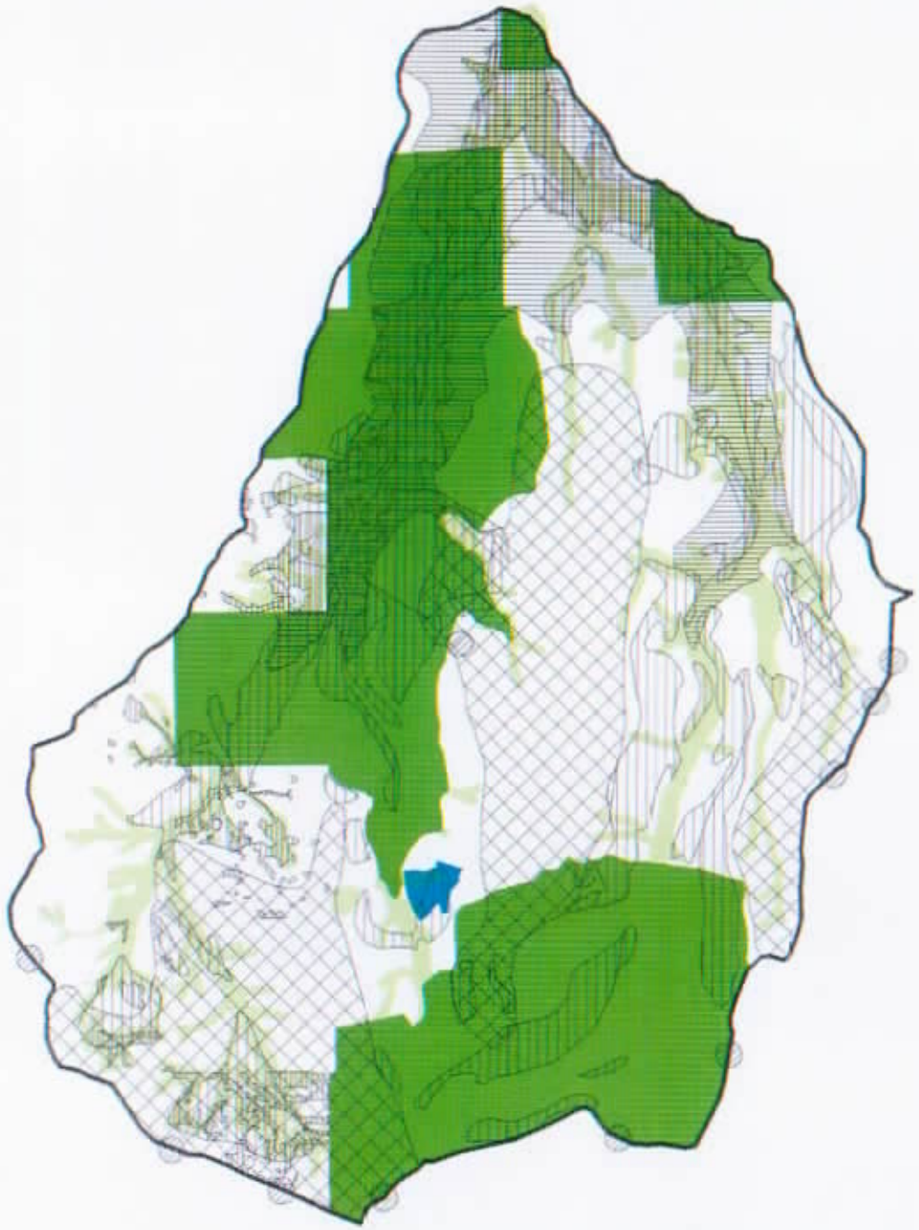
MAP 3-1



South Fork Clackamas River Watershed

Opportunties and Constraints

Legend

- Late Successional Reserve
- Riparian Reserves
- Interim Connectivity
- Landform Stability Concerns
- Inventoried Winter Range
- Landform with High Windthrow Risk
- Landform with Wind Funnel Effect Risk
- Fragile, Nonsuitable lands

NOTE: See Map 2-15 for Viewshed Locations

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MAP 3-2

of the river to be retained until a final determination of the river's status. The interim boundary does not respond to seen area, slope break, or site specific changes in landform.

- Trail Viewsheds: Under Mt. Hood Forest Plan, trail foreground viewsheds extend 1,320' on either side of Trail #515 and Trail #516

- 100 acre owl activity center: Requires the retention of late seral forest for habitat protection but is not displayed on maps.

- Inventoried critical and high deer and elk winter range: structural components like opening size, forage, and cover, must be compatible with the winter habitat needs of big game.

- Existing late seral stand which provides an opportunity for the provision of late seral habitat connectivity.

- Private land: windthrow risk and recreation patterns can be influenced by management activity across ownership boundaries.

- Administrative withdrawals on BLM land which are fragile/non-suitable for timber production can influence the vegetation

Conceptual Landscape Design

The Conceptual Landscape Design (Map 3-3 and Table 3-1) graphically displays the vegetation patterns desired under the existing management direction found in the Northwest Forest Plan, the Mt. Hood Forest plan, and the BLM Resource Management Plan. The Conceptual Landscape Design provides information specific to each pattern type, its management objectives, and recommended activities. 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 forest land managed under state law.

The primary determinants for the South Fork Design included the windthrow risk to Matrix allocations especially on South Fork Ridge, the windthrow risk to the LSRs and Riparian Reserves from timber harvest in adjacent matrix allocations, the presence of numerous special habitats in the headwaters of South Fork River, the steeply sloped river valleys, and the timber harvest objective for the matrix allocation. The design reflects the timber emphasis objective through the vegetation patterns of Aggregated and Managed Mosaic. The aggregated pattern type also has an objective of reducing windthrow damage by minimizing edge and fragmentation and cutting regeneration harvest units toward the prevalent damaging winds (see Ch. 4 Key Question). In the aggregated pattern type, early seral patch sizes are large, averaging greater than 100 acres and are comprised of smaller harvest units. The age classes within the early seral aggregated patch is 0-30 years. The windbreak pattern type is designed to minimize wind damage in select vulnerable positions around the LSR by providing windfirm stands 10-15 tree heights distance around the LSR. Within the Windbreak, silvicultural treatments emphasize thinning to promote windfirm stands and the size, shape, and placement of openings would be based on site specific windthrow risk. The boundary of the Windbreak is also flexible and can be moved in either direction based upon site specific information about wind patterns and damage. The Managed Mosaic pattern type focuses on the headwaters area of the South Fork River where seeps, springs, wetlands, and meadows as well as adjacent landforms and allocations make the area too dissected to be in an aggregated pattern. A variety of age classes defined by fingers of Riparian Reserves are represented in the Managed Mosaic pattern and the opening size, shape, and placement is a function of topography and Riparian Reserves. The Perforated pattern type is designed to protect slope stability and occurs on steep (>50%)slopes in Matrix land allocations. The variable sized openings of 5-20 acres fitted to landform in a relatively well connected forest canopy should protect slope stability based upon project level design.

The viewsheds of both trails and the Eligible Wild and Scenic River are within the LSRs and no further pattern type was developed. The B5 land allocation (Pileated Woodpecker/Pine Marten Habitat Area) is not considered to be necessary for late seral connectivity under the Northwest Forest Plan and is recommended for deletion through a Forest Plan amendment.

All the landscape design cells emphasize long term management of young second growth stands through thinning to promote windfirmness, maintain health and growth, and develop and retain future large structural components for wildlife habitat. Management activities also need to carefully assess wind patterns, vulnerable topographic positions, and risk in the field and apply appropriate mitigation measures to minimize windthrow. Additional mitigation measures may need to be implemented. Priorities for short term management of second growth stands to meet future windthrow objectives include:

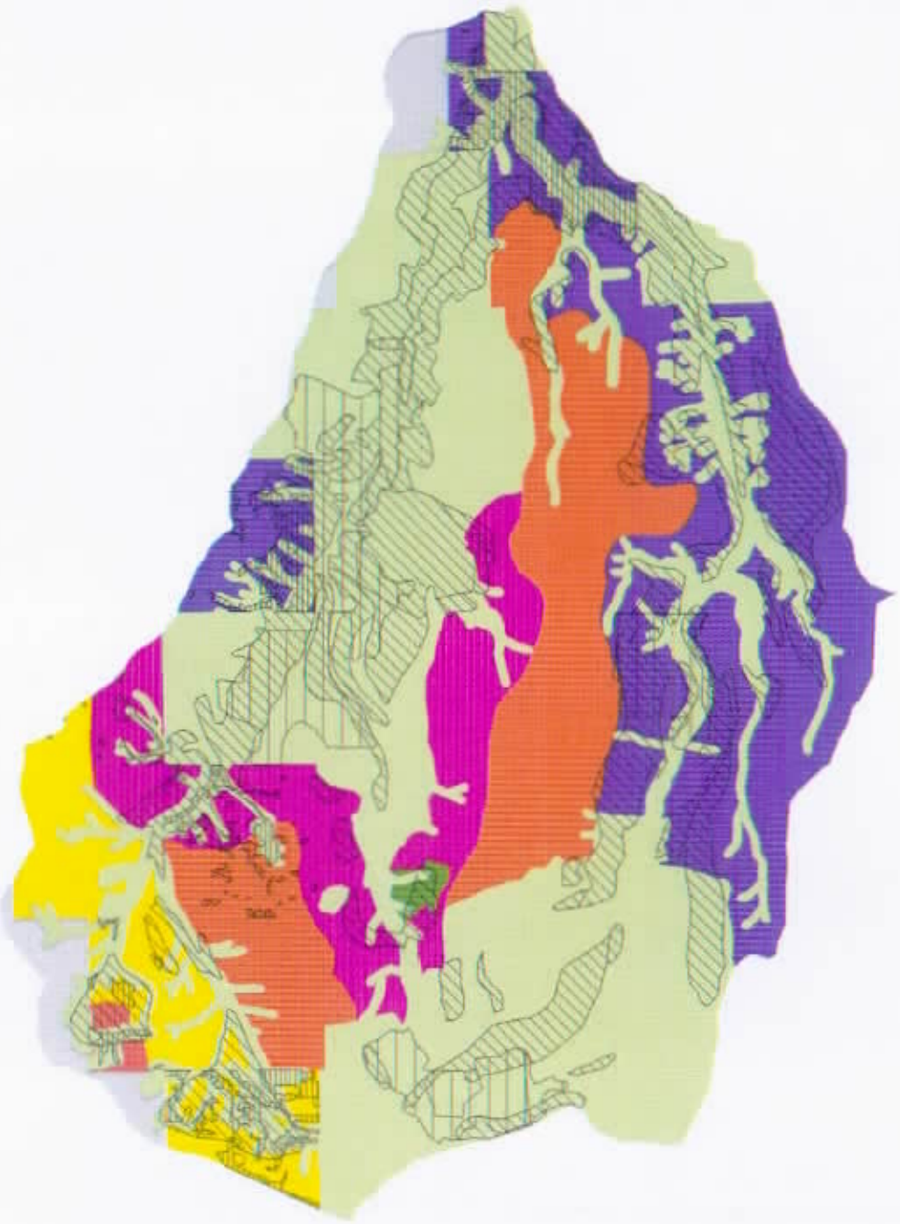
- fully stocked or overstocked young (<70 years old) mid seral plantations.
- fully stocked or overstocked older (>70 years old) mid seral natural stands and plantations
- young plantations (0-30 years old)

Recommendations

- Implement the Conceptual Landscape Design developed through the LAD process.
- Landforms with areas of potential instability need field verification by geomorphologist during project planning.
- Remove the B5 land allocation (Pileated Woodpecker/Pine Marten Habitat Area) in the watershed through a Forest Plan amendment. This area is not considered necessary for late seral connectivity.

South Fork Clackamas River Watershed

Concept Design



Legend

- Aggregated
- Windbreak
- Interim Connectivity
- Retain and Promote Late Seral Forest
- Managed Mosaic
- Perforated
- Projected Aggregated
- Williams Lake Management Area
- Marten/Woodpecker Areas
- Potentially Unstable Areas
- Fragile, Nonsuitable Lands

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MAP 3-3

Table 3-1 Conceptual Landscape Design Key

Pattern Type	Objectives	Includes	Management Direction
Retain and promote late seral forest 	* Late seral terrestrial connectivity * Protect and enhance aquatic and terrestrial habitat protection	* Late Successional Reserves (LSR) * Riparian Reserves * 100 acre Owl Activity Center	* Thin plantations and natural stands to accelerate production of large trees and promote windfirmness * Reduce risk from fire, insects, and disease * Release young conifers in Riparian Reserves
Pine Marten/Pileated Woodpecker Areas 	* Pine marten and pileated woodpecker habitat * Late successional habitat connectivity	* B 5 land allocation	* See recommendations
Windbreak 	* Develop treatments which emphasize minimizing adverse impacts to adjacent LSR and Riparian Reserves values * Timber production	* Selected perimeter of LSR * 10 - 15 tree heights in width * See Conceptual Design Map	* Promote wind firm forest stands adjacent to LSRs and Riparian Reserves * Variable openings of 5-40 acre openings embedded in well connected matrix of mid-seral forest stands * Boundary is flexible and can be moved in either direction based upon site specific information about wind patterns and landform
Fragile/nonsuitable Lands 	* Landform stability * Aquatic habitat protection * Special habitat protection	* BLM administered lands * See Conceptual Design Map	* Manage for terrestrial and aquatic habitat

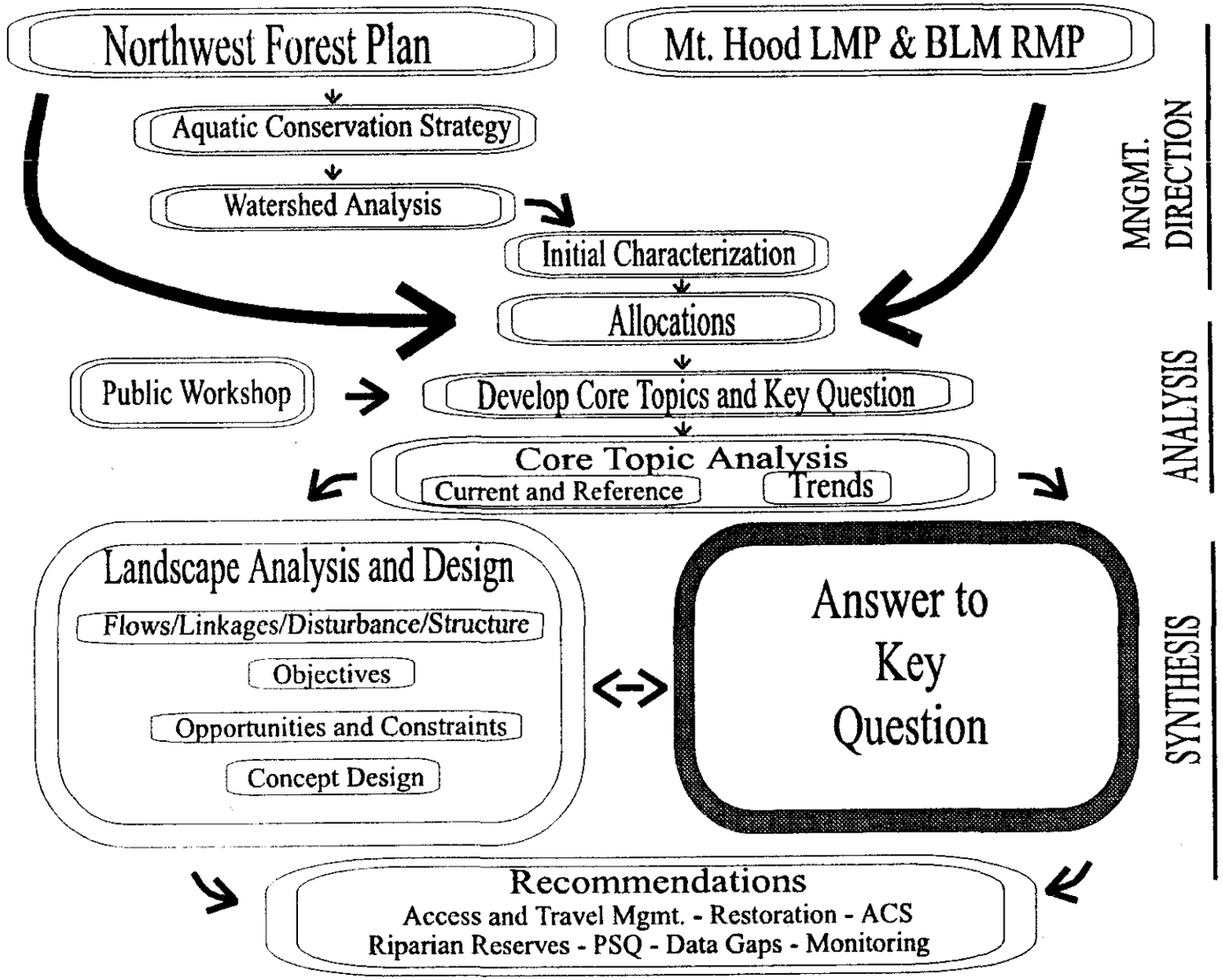
Table 3-1 Conceptual Landscape Design Key

Pattern Type	Objectives	Includes	Management Direction
Aggregated 	* Timber production * Minimize windthrow * Minimize fragmentation	* Matrix * C1, timber emphasis * General Forest (BLM)	* Patch sizes are large averaging >100 acres through aggregation of smaller patches (harvest units) * Age classes within early seral aggregated patch is 0-30 years * Create large patches of early and mid seral habitat ranging from 0 - 120 years old * Retain structural components like 15% green trees, snags, and down woody debris
Managed Mosaic 	* Timber production * Minimize windthrow * Protect and enhance aquatic and terrestrial habitat functions	* Matrix * C1, Timber Emphasis * Where landform and adjacent allocations make the area too dissected to be in an aggregated pattern	* Variety of age classes represented defined by fingers of Riparian Reserves * Opening size, shape, and placement is a function of topography and riparian fingers * Same as Aggregated Pattern Type but smaller patches because of adjacent allocations and landform
Projected Aggregated 	* Timber production	* Private forestland	* Large patches of early and mid seral habitat but without the structural components required under ROD * 100' riparian buffers on anadromous fish bearing streams * 50' buffers on all other streams

Table 3-1 Conceptual Landscape Design Key

Pattern Type	Objectives	Includes	Management Direction
Perforated 	* Timber production * Minimize impacts to slope stability	* steep slopes in Matrix and C1 land allocations	* Variable sized openings shaped to landform of 5-20 acres in a relatively well connected forest canopy
Potentially Unstable Areas 	* Aquatic habitat protection * Landform stability * Timber production	* Steep slopes on weak, intermediate, and resistant rock types * Quaternary landslides deposit	* Opening size determined after field verification * Include field verified unstable areas in Riparian Reserves
Interim Connectivity 	* Retain connected mature forest dispersal habitat until LSR and Riparian Reserves function as planned	* Large block of late seral habitat outside of LSR and Riparian Reserve * See Conceptual Design	* Retain late seral structure until LSR and Riparian Reserves function as planned
Williams Lake Management Area 	* To protect and preserve the lake and bog ecosystem	* Williams Lake Area of Critical Environmental Concern	* Primary zone: maintain undisturbed condition * Caution zone: buffer against windthrow and for multiple use

Chapter 4
Key Question



KEY QUESTION

Given the watershed's tendency for blowdown, what timber harvest pattern and silvicultural treatments would best retain structural components for future stand (15% in Matrix) and prevent blowdown of the Late Successional Reserves and Riparian Reserves?

Creating new openings in the forest through road building and timber harvesting may increase the chance of windthrow in adjacent forest stands. The South Fork of the Clackamas watershed shows a past history where conditions are favorable for windthrow. Of particular concern is the risk of increasing windthrow in Late Successional Reserves and Riparian Reserves through management of adjacent Matrix lands. Recognizing the many aspects of the forest environment which contribute significantly to windthrow will enable us to make management choices that minimize their effects. Given the watershed's history for blowdown, early and frequent management of young stands to promote windfirmness is critical to the development and retention of structural components as they become more susceptible to wind damage. Harvest patterns (such as cutting toward the wind) and unit design and location will also greatly influence risk for wind damage to adjacent high risk areas. Examining local blowdown history is the best clue to probable direction of damaging winds and estimate of windthrow risk. The Conceptual Landscape Design incorporates recommendations for management treatments that would promote windfirmness while meet objectives for timber production.

Existing conditions

Windthrow on the Estacada Ranger District generally has occurred as scattered small pockets around edges of harvest units, in wet soils, along root rot pockets and in along vulnerable topographic positions. In some areas, windthrow can be many acres, usually a result of fragmentation and vulnerable topographic positions. In the South Fork watershed, past windthrow has been quite extensive and heavy, primarily occurring on South Fork Ridge and the Upper watershed. Windthrow was first noted in the 1950's when harvesting began in the watershed on South Fork Ridge and has continued to present. The majority of blowdown salvage occurred during the 1970's and 80's following wind events. Of the two major drainages within the watershed, windthrow has primarily been in the South Fork subwatershed. Southwest winds with saturated soil conditions during late fall months are the prevalent damaging winds. East and southeast winds during winter months have also contributed to the amount of windthrow in the watershed. Stands primarily affected by wind events have been overmature stands weakened by age, mistletoe, root disease and along wet areas where canopies were suddenly opened and exposed to winds by harvest or adjacent windthrow.

Contributing factors to windthrow risk

There are several types of damage wind can cause to the environment, but this discussion will address only with that type that will uproot trees or snap them off higher up the bole. This type of damage is commonly called blowdown or windthrow. There will always be a certain level of wind damage within the environment, but several factors, including natural occurrences and management activities, can increase this potential. There are four different categories of factors contributing to wind damage in a given area. They include the prevalent damaging winds, stand conditions, physical environment, and management activities.

Stand conditions

The ability of a stand to withstand windstorms is dependent on a number of important stand attributes:

- Stand density - a stand grown in dense conditions create tall, skinny trees with little taper and small rooting systems, making these stands dependent on mutual (neighbor) support to remain standing (Harris 1989). A created edge facing prevailing winds removes this mutual support and the stand becomes unstable.

- Stand structure - stands with sheltered intermediate and suppressed trees have a higher potential for blowdown when the sheltered trees are exposed to winds suddenly. For example, when these trees are left as wildlife trees or to meet a visual objective. Dominant trees and trees that are exposed to winds because they are above the continuous canopy (emergents) tend to be more windfirm (Harris 1989). These trees have developed a low center of gravity, buttressed roots and strong stems in response to bending stresses from wind exposure (Harris 1989) over time.

- Species composition - some tree species are more susceptible than other to wind due to rooting habits. For example, Douglas-fir and western redcedar are considered to be more windfirm than the more shallow rooted western hemlock or silver firs.

- Stand age and condition - generally trees become less windfirm as they age, grow larger crowns, grow taller, lose vigor, and with introduction of disease and injury (Andersen 1954). However, larger crown does not necessarily mean higher risk. Open grown trees (wider spaced or crowns above other trees) are at less risk for windthrow despite the amount of crown. These trees generally have more taper and tension wood to withstand winds (Harris 1989). Young stands are generally windfirm because they have aerodynamic surfaces when compared to rough surfaces of old-growth crown canopies, they tend to be shorter and more tapered meaning they are more flexible, have a lower ratio of height to diameter which means more stem strength, have healthier larger root systems which means good anchorage and young stands tend to have management treatments such as thinning.

Physical Environment

Influences wind patterns across the landscape and rooting depth. Topographic factors can greatly affect the probability of blowdown.

- Soil depth/high water table - stands on shallow or wet soils are easily damaged because tree roots are unable to penetrate deeply.

- Topography - Areas with high wind velocities such as ridges and saddles and areas creating turbulence are susceptible to wind damage. Wind velocity increases at points of constriction such as saddles or narrow canyons. Topographic roughness increases turbulence and tends to concentrate surface winds (Map 4-1). Turbulence increases at the confluence of canyons or draws due to mixing of wind vectors which may be at different velocities and temperatures.

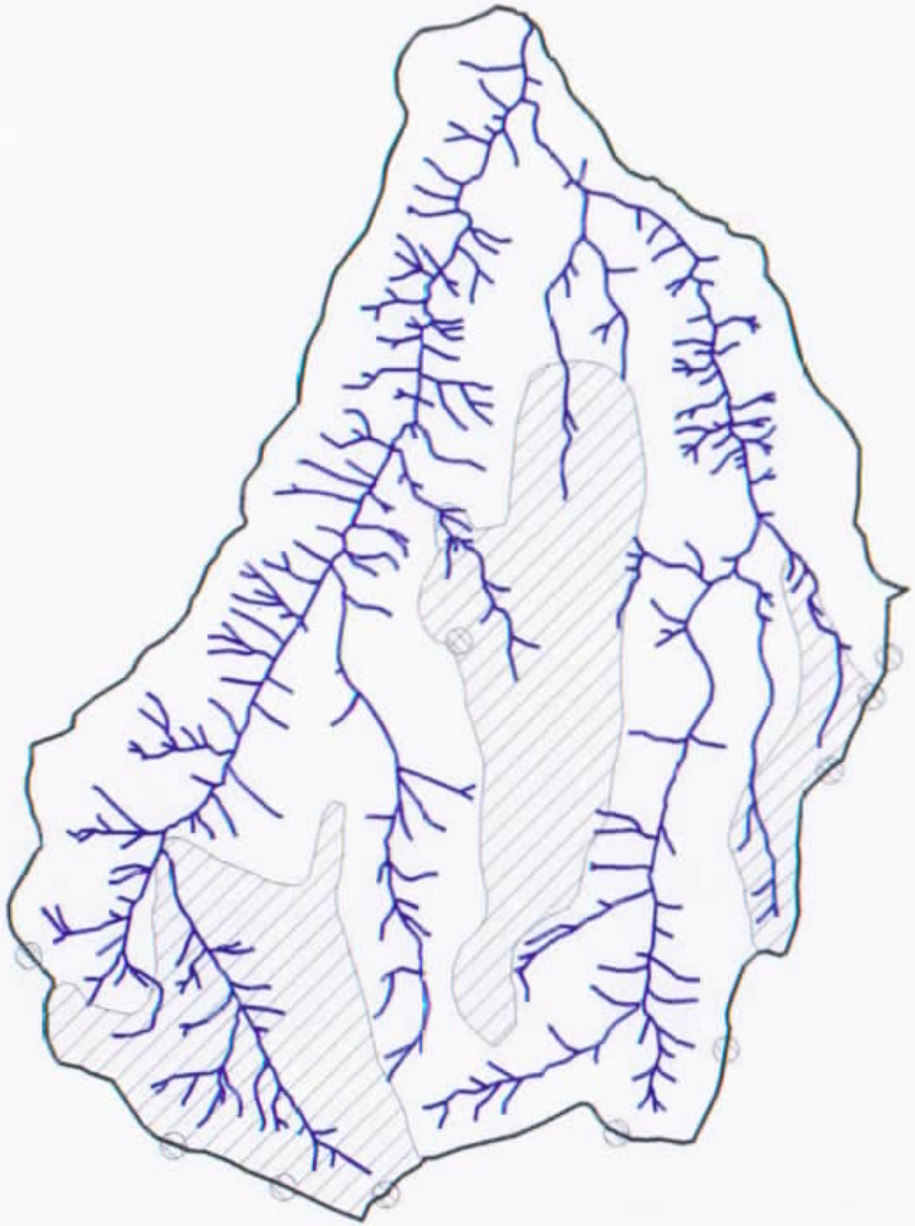
  Prevalent damaging winds - the wind direction causing the most damage. Generally, for the South Fork watershed these winds are the southwest winds. Damaging winds can also be affected locally by topography. The best clue to the probable direction is found on the ground by examining local blowdown history.

Management activities

Management activities can affect the incidence of windthrow:

- Size of opening created - to a point, larger openings increase turbulence and wind speed.

- Edge and fragmentation - large wind eddies created when smooth flowing wind encounters a forest edge are responsible for most of the damage caused by wind. These eddies extend ten to fifteen tree heights into the stand (Savill 1983) causing extensive damage. A wall of trees facing a prevailing wind are more at risk than edges created at an angle to wind directions. Fragmentation created by numerous dispersed, small units create a large amount of edge that are exposed to winds.



South Fork Clackamas River Watershed

Topographic Areas with High Windthrow Risk

Legend

- Landform with High Windthrow Risk
- Landform with Wind Funnel Effect Risk
- Streams

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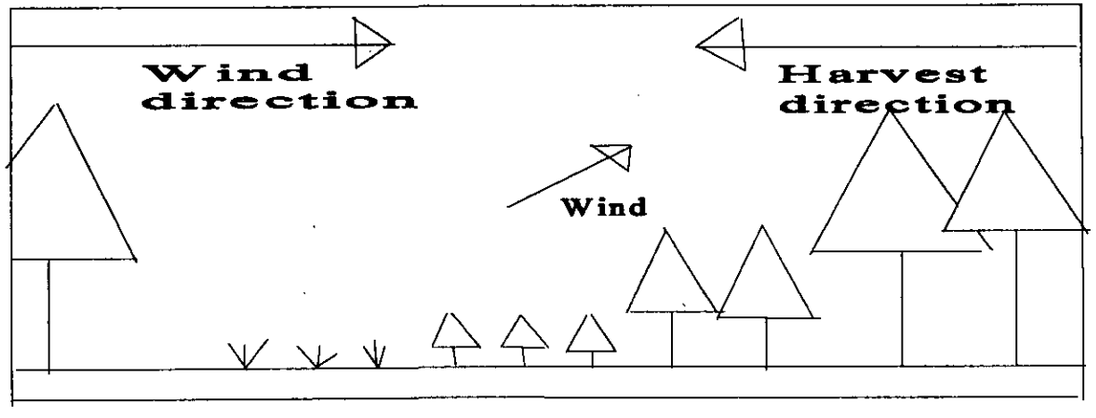
MAP 4-1

- Concentrated or aggregated harvesting reduces the amount of edge.
- Shape of openings - shapes which tend to funnel wind will increase risk of windthrow. Units with the long axis parallel to the direction of damaging winds tend to have damage at the far end.
- Retention after harvest - tighter spaced trees are less likely to be exposed to damaging winds (Somerville 1980).
- Windfirm borders - units placed against windfirm borders on the lee side are less likely to have blowdown.
- Harvest unit placement - units placed in vulnerable locations near saddles, narrow canyons, etc will have greater risk for blowdown.

Windthrow risk assessment

Using the four factors and past windthrow history, one can develop a broad assessment of risk for windthrow with management activities. Figure 4-1 shows the areas of high to moderate risk for repeated wind damage or catastrophic damage based on topography and current stand conditions and for the Conceptual Landscape Design (future desired stand conditions). Windthrow risk should be reassessed and verified in the field for each project to incorporate additional site specific clues to windthrow risk.

Figure 4-1



It should be noted that windthrow does not necessarily occur immediately following harvest, but can occur with any windstorm until an adjacent stand develops a tree architecture that is better able to withstand wind or until and adjacent opening has grown back enough to shelter the mature trees. While this would be about 50 years, normally most windthrow occurs in the first 5-10 years following a disturbance.

Silvicultural treatments and Management practices that decrease risk of windthrow

Many aspects of the forest environment contribute significantly to the amount of windthrow. Knowing what they are enables us to make management choices that minimize their effects. Management tools for decreasing windthrow risk can be divided into two categories: mature & old-growth and second-growth stands. In both categories, examining local blowdown history is the best clue to probable direction of damaging winds and estimate of windthrow risk.

Mature and old-growth stands

Stands have limited opportunities to minimize blowdown due to age and stand history (how the stand grew in what conditions). At this stage, growth has slowed, vigor declines, and disease, pests and injuries contribute to weakening the tree. Ability to influence tree architecture to that which is better able to withstand winds are limited. Options given assume regeneration harvest and therefore mostly centers around locating windfirm boundaries:

- Harvest unit shape - design regeneration unit boundaries so that leeward boundaries are not left perpendicular to prevailing winds and are as windfirm as possible. Design unit shape to avoid funneling winds.

- Cutting pattern - cut regeneration harvest units toward the prevalent damaging winds starting from a windfirm boundary (ie., young plantations, rock outcrops, etc). This will help to gradually lift the wind back up above the stand. Since various damaging winds are operating in the South Fork of the Clackamas watershed, site specific information should be used in determining the prevalent damaging wind direction. Aggregating regeneration harvest units will create less edge than numerous small and distributed units.

- Residual trees - avoid regeneration harvest prescriptions that leaves residual trees, such as shelterwoods in high risk areas unless prescriptions call for large woody debris from expected windthrow or trees are carefully selected for windfirmness. Wildlife trees should be topped or pruned soon after harvest. Select residual trees that are young, have little defect or injury which can weaken the tree, species which are more windfirm such as cedar and trees which are in the dominant crown class or open grown and have healthy root systems. Another option is to progressively reduce residual stand density over time using shelterwood prescriptions with high residual stand density or salvage logging. This would meet objectives in areas where there is a desire to leave a higher density of biological legacies in the form of green trees.

- Feathered edges - means using trees to help smooth the wind eddies and turbulence created when the wind enters an opening or encounters an edge. However, these practices have had little success in the past on the district. There are several reasons why these edges will continue to experience damage but chances for success will increase with careful selection of windfirm trees (healthy, well anchored, uninjured young trees with low height to diameter ratio) for 10 to 15 tree heights into a stand.

- Harvest unit location - expect blowdown in areas of high velocity winds and turbulence.

Second-growth stands and plantations

These stands have more opportunities for minimizing windthrow because they are generally still rapidly growing and healthier trees. An important long term objective for managing second growth stands and their health would be to manage for windfirmness of stands

as they grow older and more susceptible. Trees that have been exposed to wind when they are young and rapidly growing are less likely to suffer severe damage at an older age than those that have grown in tight stands. Thinning young stands helps to maintain stem strength and create healthier, larger root systems which anchor better as trees grow older, larger and more susceptible to wind damage (Oliver, 1990). Additional measures to design units and treatments prescriptions which consider prevailing winds and the physical environment would help to prevent catastrophic events over time.

- Density management - thin young plantations throughout their development frequently and/or heavily to create healthy large root systems, allow tension wood to develop from wind exposure and maintain taper. This accelerates growth of large structural components while reducing risk of loss of these structures to windthrow.

- Manage high risk stands and Reserves aggressively at an early age to maturity to develop windfirm stand boundaries for future management adjacent to these areas.

- Develop comprehensive logging system plan for the drainage.

- Cut pattern - cut regeneration harvest units towards the wind starting from a windfirm boundary.

- Aggregate regeneration harvest units to minimize edge.

- Top susceptible wildlife trees soon after harvest in high risk areas.

- Carefully select legacy trees. Choose for windfirmness.
- Reduce rotation length in areas of high wind hazard.

- Avoid excessive thinning of closed-canopied evenaged stands.

- Avoid damage to residual stand during harvest operations or restoration work (such as road ripping).

Management within South Fork of the Clackamas Drainage

In general, as early and mid seral stands become older, windthrow risk increases. Late seral stands are at highest risk due to vigor, disease and size of crowns. Harvest activities in and adjacent to these stands increases risk further. The Mt. Hood Forest Plan standard C1-025 directs timber activities to be implemented in such as way to minimized windthrow. The Northwest Forest Plan directs prevention of catastrophic damage in LSRs. The Conceptual Landscape Design addresses windthrow concerns and the need to retain late seral structures in the Reserves and on Matrix lands while meeting other resource objectives (table 4-1).

Table 4-1. Conceptual Landscape Design Cells on Matrix lands.

Design Cell	Management Direction addressing windthrow concerns
Aggregated	* Minimizes fragmentation and edge through aggregation of early seral stands.
Managed Mosaic	* Emphasizes aggregation of early seral stands where possible * Unit sizes are small which decrease windthrow risk depending on topography.
Windbreak	* Emphasis is strongly on providing windfirm stands in areas adjacent to selected Reserve boundaries through silvicultural treatments such as thinning and minimizing treatments where and which would detract from Reserve values.
Perforated	* Lands in this design cell were primarily not on high wind risk areas

All landscape design cells (Reserve and Matrix) emphasize long term management of young second growth stands through thinning to promote windfirmness, maintain health and growth, and develop and retain future large structural components for wildlife habitat. In addition, management activities need to carefully assess wind patterns, vulnerable topographic positions and risk in the field, and apply appropriate mitigation measures to minimize windthrow. Stands located on vulnerable topographic positions with high risk for wind may receive additional recommendation for alternate management strategies to prevent windthrow while meeting resource objectives. Additional mitigation measures may need to be implemented such as development of a comprehensive drainage logging system plan and harvest pattern for the Matrix lands adjacent to the Reserves.

Management priorities for a landscape which minimizes windthrow should be on second growth stands. Maintaining health and growth of these stands will lead to a more windfirm stand and trees with an architecture to withstand damaging winds.

Priorities for management of second growth stand for future windthrow objectives are as follows:

- fully stocked or overstocked young (< 70 years old) mid seral plantations
- fully stocked or overstocked older (>70 years old) mid seral natural stands and plantations
- young plantations (0-30 years old)

Stands within Reserves and adjacent Matrix lands should receive higher priority for management although a balance with Matrix lands should be maintained.

RECOMMENDATIONS

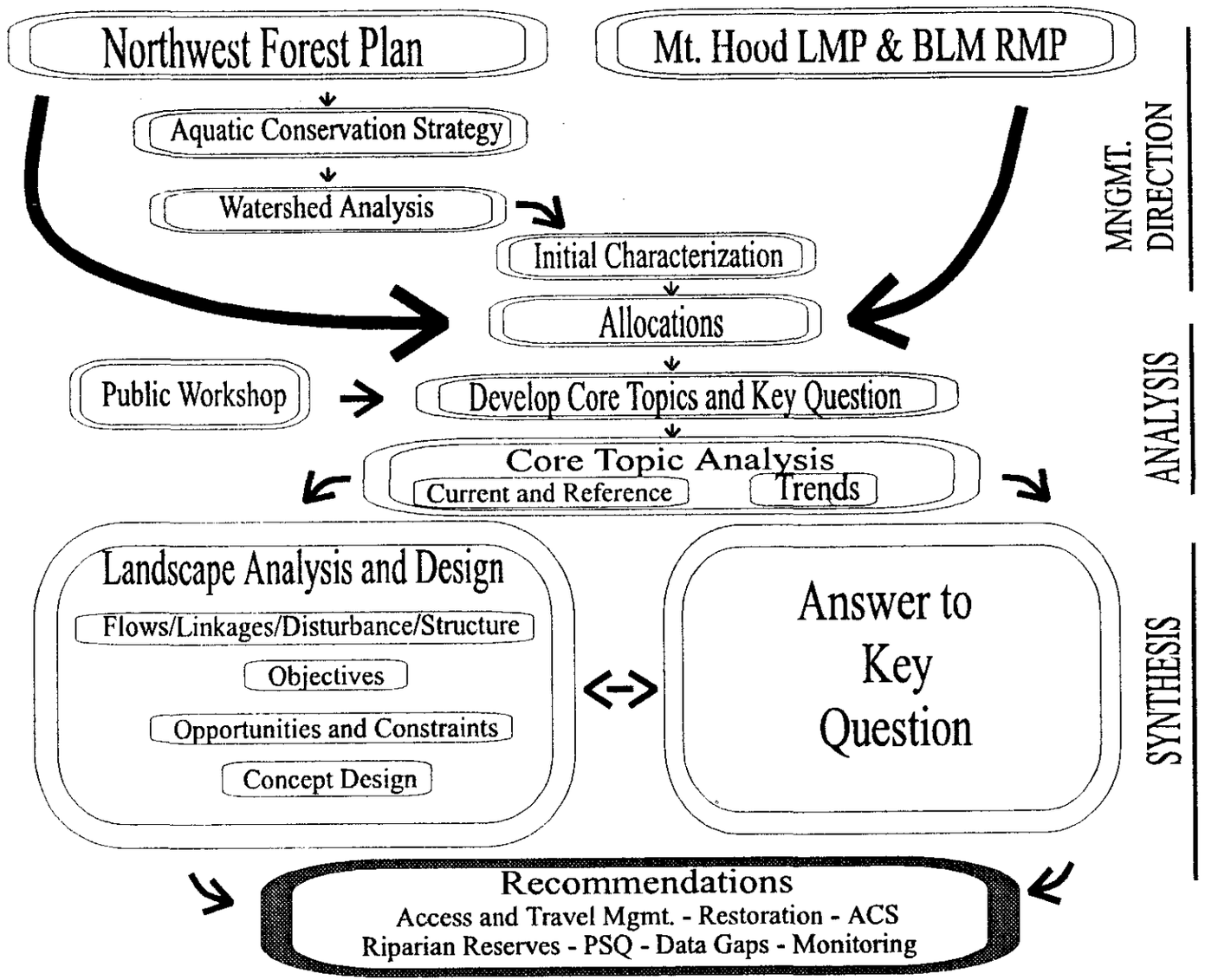
- Thin second growth stands and young plantations to develop windfirmness, to accelerate development of large diameter trees for wildlife structures, and to maintain health and growth of stands in Matrix as well as in Late Successional and Riparian Reserve.

- Develop silvicultural prescriptions for providing a variety of wildlife structures of various decomposition classes over time and which considers the developmental stage of the existing stand, the diameter size of the existing stand, the function that wildlife structures would provide to various species, high stress environmental conditions, the retention of wind damaged trees and the risk to the existing stand based on factors conducive to Douglas-fir bark beetle.

- Implement mitigation measures and harvest design which would minimize wind damage especially to Reserve stands and stands adjacent to the Reserves.

- Implement the Conceptual Landscape Design.

Chapter 5
Recommendations



RECOMMENDATIONS SUMMARY

AQUATIC

- Fish habitat restoration should concentrate on increasing in stream LWD through short and long term recruitment, particularly in the Upper and East subwatersheds, Memaloose and Oscar Creeks. This can be accomplished through placement of in stream structures, silvicultural thinnings (to promote late seral structure and windfirmness), and planting of western redcedar.

- Roads within the South Fork watershed should to be managed to reduce sediment effects and increased stream channel network or riparian and aquatic habitat functions, with emphasis on roads in East and Upper subwatersheds (See ATM).

- Landforms areas with potential instability, including Riparian Reserves, need field verification and refinement by geomorphologist during project planning.

- When performing riparian surveys/assessments, utilize the "Riparian Ecological Types" guide published Spring 1996 (Diaz & Mellen).

TERRESTRIAL

- Implement Conceptual Design as described in this document.

- Thin second growth stands and young plantations to develop windfirmness, to accelerate development of large diameter trees for wildlife structures, and to maintain health and growth of stands in Matrix, as well as in Late Successional and Riparian Reserves.

- Develop silvicultural prescriptions for providing a variety of wildlife structures of various decomposition classes over time, and which considers the developmental stage of the existing stand, the diameter size of the existing stand, the function that wildlife structures would provide to various species, high stress environmental conditions, the retention of wind damaged trees and the risk to the existing stand based on factors conducive to Douglas-fir bark beetle.

- Implement mitigation measures and harvest designs which would minimize wind damage, especially to reserve stands and stands adjacent to reserves.

- Remove the three B5 land allocations (Pileated Woodpecker/Pine Marten Habitat Area) in the watershed through a Forest Plan amendment. These areas, one located in Matrix, and two located within LSR's, are not considered necessary for late seral connectivity.

- Surveys indicate that down wood components are lost when left less than 100 feet from roads. To discourage collection by firewood gatherer's, place DWD further than 100 feet from roads.

- Provide a variety of wildlife structures (snags, DWD) of various decomposition classes over time. Evaluate the risk of bark beetle infestation.

SOCIAL

- Pursue land exchange or acquisition of private lands adjoining Williams Lake Area of Critical Environmental Concern.

- Continue aggressive garbage cleanup measures.

- Rehabilitate selected landings, rock pits, and borrow pits along Road 45 to discourage parties and garbage dumping as well as reducing erosion and improving scenery.

- Coordinate FS and BLM management of OHV use on Goat Mountain.

- Discourage recreation use of bat habitat in the Oregon City Waterworks tunnel.

RECOMMENDATIONS FOR INCLUSION IN LSR ASSESSMENT IN ADDITION TO STANDARD ANALYSIS

- Obtain current and recommended levels for snags and down woody debris

- Develop a fire management plan which addresses the rural/forest interface.

- Consider inpacts of the Special Forest Products program and it's users (mushroom, firewood, and bough collection, etc)

- Include anadromous portion of South Fork Clackamas River (0.4 miles) for restoration/enhancement opportunities for steelhead and coho spawning/rearing habitat

RESTORATION

Riparian connectivity in the Upper South Fork subwatershed has been identified as the highest priority restoration project in the South Fork watershed. This determination was based on the lack of shading along streams, elevated stream temperatures, high road densities, and the disconnection of plant communities. The resources affected by these issues include, but are not limited to: hydrology, botany, water quality, wildlife (high road densities), soils (sedimentation), and special habitats. The integration of restoration and silviculture activities is recommended in this subwatershed.

A restoration objective for the watershed, is the re-establishment of proper functioning condition in riparian areas adversely affected by management practices. Many of these streams include occurrences of *Corydalis aquae-gelidae* and potential habitat for other C-3 plant species. The enhancement of these previously harvested and roaded tributaries would allow recruitment of new *Corydalis aquae-gelidae* seedlings and the potential occupation of the channel by these historic plant communities.

Restoration projects could include riparian plantings of *Thuja plicata* (western redcedar) in site specific locations. Projects that propose to obliterate roads and culverts will help to reconnect channels, restore original streambeds, and allow for proper seed dispersal and establishment of the species. Along the steeper portions of the drainage, where past management activities are still an impact, riparian plantings should aid in streamside slope stabilization and would decrease the potential for high intensity scouring of the channel. This would favor the establishment of *Corydalis aquae-gelidae* by providing an increased canopy with less fluctuations in light, moisture, and water temperatures.

Recommendations for the retention of coarse woody debris may provide habitat for *Huperzia occidentalis* in addition to bryophyte, fungi, lichen, and other vascular plant species listed in the Northwest Forest Plan. These logs may provide transitional islands for the recovery of these species.

An additional restoration goal is the enhancement of sensitive plant species habitat adjacent to South Fork Mountain. Vandalism (litter, fire rings, broken glass) and vehicle use in the area has adversely affected an historic sensitive plant habitat site and subalpine plant species associated with the habitat. A restoration objective is the management of vehicular traffic and parking to restore the ridgetop habitat and the associated native flora.

Specific restoration objectives and project opportunities in South Fork watershed are listed in Table 5-1.

Table 5-1. Restoration Projects

OBJECTIVE	PROJECT	WHERE
Long Term: Promote late seral structure in Riparian Reserves for future LWD and terrestrial connectivity	Thin early and mid seral stands in Riparian Reserves to promote windfirmness and late seral structures. Plant western red cedar	Throughout watershed, particularly in East and Upper subwatersheds
Short Term: LWD and pool habitat is lacking in streams due to early and mid seral stands within Riparian Reserves	Introduce wood into streams using largest pieces available and/or consider recruiting large wood from outside sources	Throughout watershed, particularly in Memaloose and Oscar Creeks.
Reduce stream temperatures	To increase shade in the short term, plant hardwoods, such as alder, maple, and willow along stream banks	Throughout watershed, particularly in East and Upper subwatersheds, and Cultus, Elbow, and Oscar Creeks
There are known high priority roads needing restoration due to sediment concerns within the Riparian Reserves (See ATM)	Field verify and evaluate sediment producing roads	Portions of roads 45, 45-140, 45-200,45-220, 4530, 4540, 4540-120, and 4540-130
Improve scenic quality along Road 45 and decrease cut-bank sedimentation	Backfill and vegetate selected landings, rock pits, and borrow pits	Along Road 45 (Hillockburn Road)
Plant TES and/or Habitat Enhancement	Manage vehicular traffic and parking	South Fork Mountain
Plant TES and/or Habitat Enhancement	Manage access and plant ground cover and /or trees	Memaloose trailhead

ACCESS AND TRAVEL MANAGEMENT

Access and Travel Management (ATM) objectives were determined by identifying access needs for the public and various forest management activities like fire, timber, and recreation. Objectives of the ATM help focus priorities for maintenance and funding and identifying restoration opportunities. The goal of the ATM plan for South Fork of the Clackamas River is to reduce the resource effects of high road densities in certain subwatersheds while facilitating administrative, commodity and recreational uses on federal lands. Roads identified on Map 5-1 are roads which have a drainage wide influence in terms of providing administrative or recreational uses or roads which could be decommissioned to enhance or restore resource values. Roads that are not identified for access or closure will be reviewed at the project level for determination of need or opportunity for closure.

Roads identified to stay on the Forest Road system are not necessarily recommended for year-round access. Restricted access and use is currently imposed on certain roads, primarily by gates or berms to protect administrative sites and reduce wildlife harassment. Additional restrictions may be identified at the project level and are not recommended here.

ROAD TO KEEP OPEN

Roads listed in Table 5-2 are mainline roads which provide access for administrative and recreational uses, provide access to and for other ownerships (BLM & private), and provide access to mainline roads in adjacent watersheds. These roads would have priority for maintenance.

Table 5-2. Roads to keep open.

ROAD	COMMENTS
45	High priority maintenance to provide public access
45-180	Access to BLM & disposal site
4510	Provides access to Upper Clear Creek watershed
4520	
4530	From 45 to Williams Lake & 4531 to BLM, BLM timber haul route
4531	
4540	Provides access to Fish Creek watershed, FS timber haul route
4545	Loop road, not an accessible winter route
4550	Linkage to Fish Creek

The following Table 5-3 lists roads which are currently closed with a gate and to be maintained for administrative uses.

Table 5-3. Gated roads, maintain for administrative use.

ROAD	COMMENTS
45-220	CFR closure, Forest Seed Orchard, BLM access
45-240	CFR closure, access for BLM
4510-023	Accesses BLM
S04E05-33	Private & BLM
S04E05-6	Private & BLM

Table 5-4 lists roads in which future administrative access is anticipated primarily for forest management. These roads are available for closure with an earth berm, guardrail, gate, or allow to naturally close (soft closure). No road maintenance is expected , however, retain road beds and stormproof.

Table 5-4. Roads to keep but not maintain.

ROAD	COMMENTS
45 - 014	End of road available for decommissioning
45 - 015	
45 - 190	Retain for treatment of LSR stands
45 - 200	Retain for treatment of LSR stands
45 - 210	Gated
4520-012 & 020	
4530	From 4531 to pit to junction to Williams Lake
4545-011	
4545-120	
4545-122	
S05E04-303	Spur to Williams Lake
S04E05-5	BLM

ROAD TO CLOSE

The following roads are considered to be of high priority for road closure or decommissioning.

- Roads within Late Successional Reserves (LSR)
- Roads within subwatersheds with high road density, wetland complexes and in Riparian Reserves, i.e., Upper subwatershed
- Roads with high sediment delivery potential (generally roads which parallel and are within 300 feet of streams), i.e., Upper subwatershed

Table 5-5 lists the roads which are recommended for decommissioning to meet watershed objectives to reduce sediment delivery, reduce road densities in certain subwatersheds, to reduce impacts to special habitats and diverse plant communities, and to enhance LSR objectives.

Table 5-5. Road available for decommissioning

ROAD	COMMENTS
45 - 014	End of road only
45 - 011	
45 - 059	
4530-011	
4545-130	LSR
4545-122	
4545-120 spur	short spur on right past 122 junction
4545-122/013	
S05E04-TRX-25	

Table 5-6 lists road closures covered by recent signed NEPA documentation and may not have already been closed.

Table 5-6. Road closures covered by signed NEPA documentation

ROAD	COMMENTS
45-140	Gated
45-180	From ERFO project to end of road, disposal site
45-244	Soft closure, Fork Timber Sale

Table 5-7 lists roads already closed and still showing on transportation maps.

Table 5-7. Roads closed already.

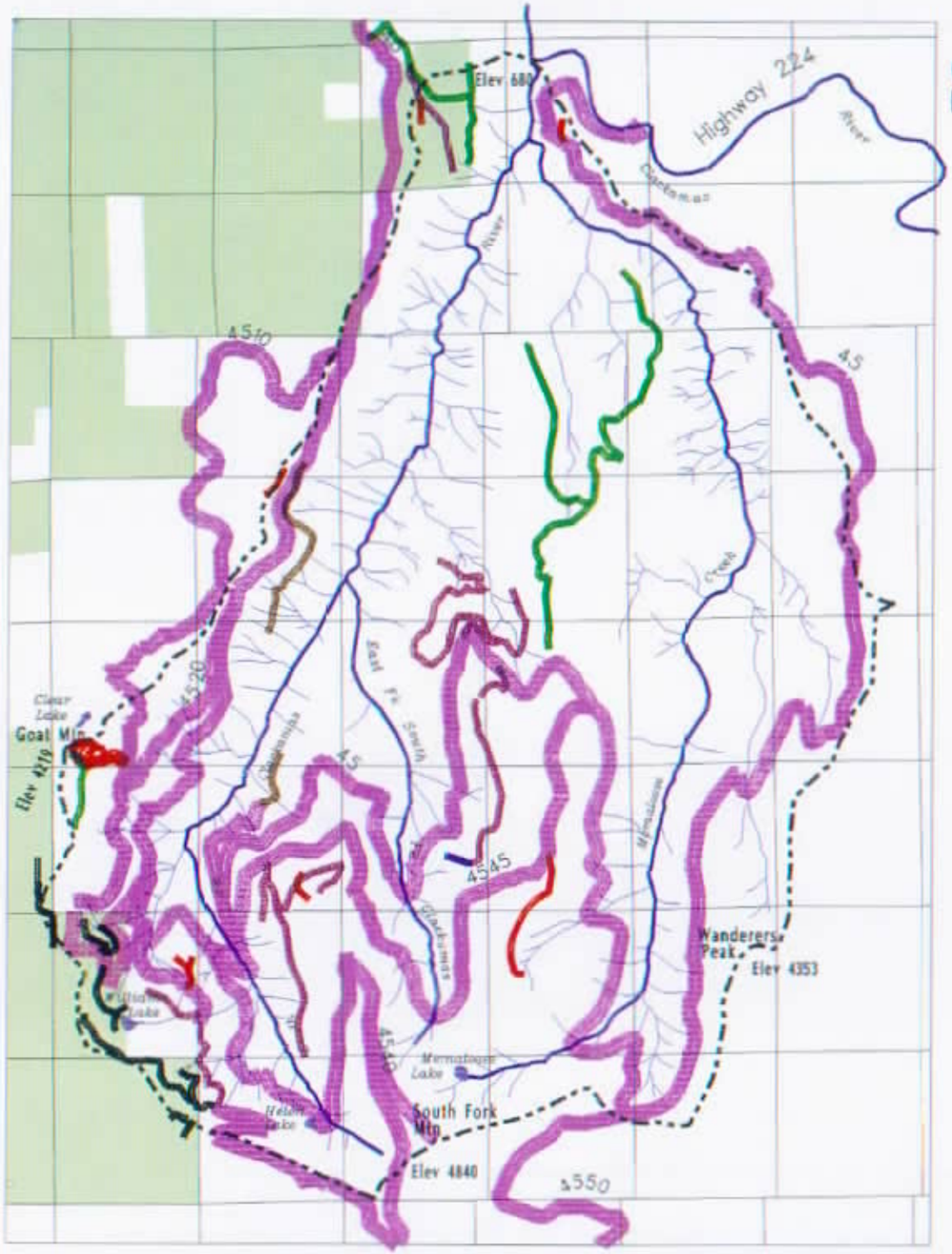
ROAD	COMMENTS
45-210	1/4 mile at end of road only

ROADS WITH CONCERNS

Table 5-8 lists roads which were identified with sediment delivery potential concerns based on GIS mapping. Sixty-nine percent of the potential sediment delivery from roads occurs in the Upper subwatershed. These road concerns should be field verified and recommendations developed to mitigate concerns through closure and/or road repair and maintenance. Also listed are roads with TES and/or Plant Habitat Enhancement concerns which should be addressed during project planning.

Table 5-8. Roads with sediment delivery potential concerns.

ROAD	COMMENTS
45	Upper subwatershed
45 - 140	
45 - 220	Elbow Creek TES and/or Plant Habitat Enhancement
45 - 220-035	TES and/or Plant Habitat Enhancement
4530	
4540	
4540-120	
4540-130	
4540-140	TES and/or Plant Habitat Enhancement
4500-210	TES and/or Plant Habitat Enhancement
4500-210-025	TES and/or Plant Habitat Enhancement



South Fork Clackamas River Watershed

Access Travel Management

Legend

- Private Land Ownership
- Roads Already Closed
- Gate, Maintain for Admin. use only
- Open Mainline Road
- Road Id by NEPA for Closure
- Obilterate
- Private Roads
- Retain Road Bed Storm Proof/No Maintenance
- Watershed Boundary

SCALE 1:72480

1 0 1 2

MILES

N W E S

MAP 5-1

AQUATIC CONSERVATION STRATEGY

The Aquatic Conservation Strategy as described in the ROD was developed to restore and maintain ecosystem health at both the watershed and landscape scales. This would protect the habitat for fish and other riparian dependent species and resources and restore currently degraded habitats. The four components of the strategy (Riparian Reserves, key watersheds, watershed analysis, and watershed restoration) provide the land management agencies the tools to maintain and restore productivity and resiliency of riparian and aquatic ecosystems.

The following recommendations would accelerate the rate of recovery of aquatic and riparian processes to meet the intent of the Aquatic Conservation Strategy.

Recommendations

- Fish habitat restoration should concentrate on increasing instream LWD through short and long term recruitment particularly in the Upper and East subwatersheds and Memaloose and Oscar Creeks. This is accomplished through placement of instream structures, silvicultural thinnings to promote late seral structure and windfirmness, and planting of western redcedar.

- Roads within the South Fork watershed need to be managed to reduce the sediment effects and increased stream channel network on riparian and aquatic habitat functions, with emphasis on roads in East and Upper subwatersheds

- Increase shade to reduce stream temperatures in Upper South Fork subwatershed by planting hardwoods, like alder, maple, and willow along stream banks.

RIPARIAN RESERVES

The Northwest Forest Plan designates Riparian Reserves at the margins of standing and flowing water, intermittent stream channels and ephemeral ponds, and wetlands. Riparian Reserves generally parallel the stream network but also include other areas necessary for maintaining hydrologic, geomorphic, and ecological processes, such as, unstable and potentially unstable areas affecting riparian and aquatic habitat function. The Northwest Forest Plan established criteria for delineating interim Riparian Reserve boundaries for five categories of streams or water bodies. These criteria for the South Fork Watershed are presented in table 5-9 and shown in Map 2-4. The Northwest Forest Plan further directs that critical hillslope, riparian, and channel processes be identified through watershed analysis in order to ensure maintenance and restoration of riparian and aquatic functions. Riparian Reserve widths displayed in table 5-9 are based on estimated site potential tree heights. Site potential tree heights were estimated using ecology plot information, and were stratified by forest series (western hemlock, Pacific silver fir, mountain hemlock). Estimated site potential tree height for the western hemlock series is 210 feet while the Pacific silver fir and the mountain hemlock series is 160 feet. Riparian Reserve widths, based on site specific potential tree height, will be refined during project level planning.

Table 5-9. Riparian Reserve Estimated Widths

CONDITION	WESTERN HEMLOCK SERIES	PACIFIC SILVER FIR & MOUNTAIN HEMLOCK SERIES
Fish Bearing Streams	420 feet slope distance from edge of channel	320 feet slope distance from edge of channel
Non-Fish Bearing Streams Perennial Streams	210 feet slope distance from edge of channel	160 feet slope distance from edge of channel
Constructed Ponds, Reservoirs, and Wetlands Greater than 1 Acre	210 feet slope distance from edge of wetland or maximum pool elevation	160 feet slope distance from the edge of wetland or maximum pool elevation
Lakes and natural Ponds	The body of water plus 420 feet slope distance	The body of water plus 420 feet slope distance
Intermittent Streams	210 feet slope distance from edge of channel	160 feet slope distance from edge of channel
Wetlands less than 1 Acre	The wetland and associated riparian vegetation	The wetland and associated riparian vegetation
Unstable and Potentially Unstable Areas	See text	See text

Unstable and Potentially Unstable Areas

Unstable lands can occur on the landscape in positions removed from riparian ecosystems and still have an effect on aquatic conditions. Mass movement events deliver large wood, sediment, and nutrients to aquatic systems. The intent of developing Riparian Reserves for unstable and potentially unstable areas is to ensure that the rate and distribution of sediment delivery does not alter stream channel forming processes or impair aquatic ecosystem functions.

No mapped unstable or potentially unstable areas were identified to include in the South Fork Riparian Reserve system. The following geologic conditions were identified as inherently unstable, meriting special attention during project level planning and field investigations (see Chapter 2, Aquatic section, Erosion Processes for further information). The presence of these conditions does not automatically mean that an area is unstable and, therefore, these areas were not included in the mapped Riparian Reserve system. These areas need to be investigated carefully during project level planning, and added to the Riparian Reserve system when appropriate.

- Landslide Deposits (QLS) - Four of the seven mapped landslides in the watershed occur in the Memaloose Creek drainage while two are found at the headwaters of the South Fork, and a lone slide resides along Oscar Creek.
- Weak Rock-Steep Slopes (WRSS) - Found adjacent to the South Fork and Memaloose streams, this landform is primarily concentrated in the lower third of the watershed where the most severe stream downcutting has occurred.
- Resistant Rock-Steep Slopes (RRSS) - Found sporadically in both of the major drainages, the highest concentration is in the headwall position of tributaries and around the glacial eroded headwaters of Memaloose and South Fork drainages.
- Contacts between weak rock (Tr) and resistant rock (Qtb). Changes in permeability at these contacts often result in springs or shallow groundwater tables. Altering the groundwater conditions in these areas can trigger slides and debris flows.

PROBABLE SALE QUANTITY

Timber commodity outputs in the South Fork Clackamas watershed are expected by intermediate (ie., thinning) and regeneration harvests. Harvest is planned to be accomplished within Matrix lands, Riparian Reserves, and could occur in Late Successional Reserves if findings in the LSR assessments concurs. Management activities will follow the policy direction provided in the Mt. Hood Forest Plan and the Northwest Forest Plan.

PSQ Based on Forplan Modeling for the Northwest Forest Plan

The long term probable sale quantity (PSQ) is estimated at a volume of 1.25 million board feet per year (MMBF) for this watershed. This translates to about 28 acres of regeneration harvest a year (or about 180 acres of thinning at 7 thousand board feet (MBF) per acre). This is based on Forplan model used to project the PSQ under the Northwest Forest Plan. A large proportion, if not all, of the PSQ outputs will be from C1-Timber Emphasis land allocation. The Northwest Forest Plan model included some assumptions which were based on either incomplete or missing data. These include the actual amount and location of riparian buffers, unstable areas, and buffers around known owl activity centers. The model also assumes the PSQ volume would be obtained from regeneration harvest during the first two decades and from thinnings during the next three decades (table 5-10).

Table 5-10. PSQ Estimates Based on Forplan Modeling for the Northwest Forest Plan

	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5
MBF/year	2,742	1,868	1,020	92	122
Clearcut Equivalent Acres	58	43	28	19	56

PSQ based on the Conceptual Landscape Design

The South Fork watershed has approximately 5,855 acres of Matrix/C1 Timber Emphasis lands. The Conceptual Landscape Design for Matrix lands depicts a landscape of 0-120 year old stands of intensely managed mid seral stands with a proportion of early seral either in aggregated patches, mosaic or in a distributed pattern of small perforations. Fingers or small groups of late seral trees/stands would be evenly distributed across the landscape. Based on the Conceptual Landscape Design for Matrix lands and for providing a regulated harvest, the following tables estimates the desired future conditions by seral stages and compares to the existing conditions. The Mt. Hood Forest Plan requires retention of 65% hydrologic recovery within the South Fork watershed. The following tables (table 5-11 and table 5-12) also estimates the ARPs under desired conditions compared to existing conditions.

Table 5-11. Existing watershed conditions by subwatersheds

Seral Stage	Upper Matrix (Acres)	East Matrix (Acres)	Lower Matrix (Acres)	Memaloose Matrix (Acres)	Total Acres Matrix	PSQ* (MBF)
Early	715	698	261	1393	3067	
Mid	152	135	260	878	1425	654
Late	72	122	1	1168	1363	1,238
Existing ARP	72%	69%	74%	91%	5855	1,892
Total Watershed Available acres @ 65% ARP	403	156	961	825		

* Thin volume based on 5 MBF/ac; Regeneration harvest volume of late seral based on 47 MBF/ac; Regeneration harvest volume of mid seral based on 30 MBF/ac.

The estimated PSQ for the next three decades, based on existing conditions assumes regeneration harvest of priority late (primarily in the Memaloose subwatershed) and mid seral stands over three decades at a rate that would produce the desired levels of early, mid and late seral stands in thirty years while maintaining ARP above 65% in each subwatershed. For example, in the Memaloose subwatershed, 1168 acres of late seral stands exists, 378 acres of late seral are desired and a maximum of 961 acres of total regeneration harvest is available to retain ARPs above 65%. Regeneration harvest of 790 acres (1168-378) in Memaloose subwatershed over the next 3 decades will produce 1,238 MBF/year on the average. An additional 500 acres of regeneration harvest on priority mid seral stands over three decades across the watershed will produce 500 MBF/year. Commercial thinning on approximately 925 acres (1425-500) will produce 154 MBF/year.

Table 5-12. Estimated Conceptual Landscape Design watershed conditions

Seral Stage	Upper Matrix (acres)	East Matrix (acres)	Lower Matrix (acres)	Memaloose Matrix (acres)	Total Acres Matrix	PSQ* (MBF)
Early - 22%	210	210	115	756	1291	
Mid - 67%	627	640	350	2304	3921	2,549
Late - 11%	103	105	57	378	643	
ARP	90%	93%	96%	89%	5855	

* Thin volume based on average 7 MBF/ac; Regeneration harvest volume based on 38 MBF/ac

The desired condition is to have approximately 22% of the Matrix lands in an early seral condition (0-30 years old), 11% of the Matrix lands in late seral condition (120+ years old), and 67% of the Matrix lands in mid seral condition (30-120 years old). Desired conditions for late seral was based on 70% of the 15% green tree retention requirement on Matrix lands which are to be left in groups rather than individual trees. These retention stands are not calculated in the PSQ unless catastrophic damage occurs. To reach the Conceptual Landscape Design, regeneration harvest of late seral stands would need to occur over the next 3 decades at which time the majority of early seral will reach the mid seral stage. It is estimated that desired conditions as described under the Conceptual Landscape Design will be achieved within 30 years. Under the Conceptual Landscape Design, approximately 43 acres/year (1291/30 years) would be regeneration harvest and 130 acres/year (3921/60 years*2 thins) would be thinned with two thinning entries over the rotation of the stand.

The above calculated PSQs does not take into account other resource constraints that could limit acres actually treated, such as screen 3 or unstable (from the Mt. Hood Forest Plan), owl activity centers, unmapped Riparian Reserves and visual objectives. Nor does it take into account stand conditions not needing treatment such as non-overstocked stands due to previous heavy thins and low site potentials. Based on past field experience, an additional 10-20% reduction in PSQ can be expected from other resource constraints (table 5-13).

Table 5-13. Estimated probable sale quantity based on existing and desired conditions

Harvest	Estimated PSQ for next 3 decades	Estimated PSQ under Conceptual Ldscp Design
Intermediate Harvest (thins)	131 MBF/year	778 MBF/year
Regeneration Harvest	1,477 MBF/year	1,389 MBF/year
Total	**1,608 MBF/year**	**2,167 MBF/year**

Treatment of Riparian Reserves and Late Successional Reserves would also contribute to the yield and are not included in the above PSQ calculations. Currently, the watershed has 2,640 acres of stands in mid seral conditions in Riparian Reserves/Matrix (169 acres) and LSR(2,471 acres). If 50% of the Riparian Reserves are treated for one entry, 591 MBF total or 19 MBF/year may be produced over the next 3 decades. If 25% of the LSR mid seral stands are treated for one entry, 4,324 MBF total or 144 MBF/year may be produced over the next 3 decades.

DATA GAPS

- Stream temperature data for South Fork Clackamas River and Memaloose Creek
- Update and verify stream layer
- Water quality, including bacteriological levels, in Williams and Memaloose Lakes
- Biological surveys of wetlands and lakes in the watershed, particularly in the Upper South Fork subwatershed (Helen Lake)
- Population estimates of coho and steelhead that utilize the South Fork Clackamas River for spawning and rearing habitat, i.e., spawning and snorkeling surveys
- Presence or absence of C3 Survey and Manage species in the watershed
- Complete Level II Stream Surveys for East Fork of the South Fork Clackamas River, Oscar Creek, Cultus Creek, and Elbow Creek
- Update riparian condition for the anadromous portion of the South Fork Clackamas River (0.4 miles) post February 1996 flood
- Determine the upper limits of fish distribution for resident rainbow and cutthroat due to natural or human-made barriers
- Snag and down woody debris abundance and distribution at the watershed level
- Peregrine falcon use of cliffs in the watershed
- Deer and/or elk herd distribution and location within the watershed
- Macro invertebrate data

- Monitor, through snorkeling surveys and/or electro-shocking, possible brook trout escapement from Williams Lake into the South Fork Clackamas River.
- Monitor brook trout populations in Memaloose Creek
- Monitor long term temperature trends within the watershed's mainstem streams and tributaries. Highly impacted streams such as the headwaters of South Fork Clackamas River, and the confluence with the East Fork of the South Fork Clackamas River, may be an indicator of watershed recovery.
- Monitor down wood retention levels post harvest, fuel treatment, and firewood collection.
- Monitor Oregon City Waterworks tunnels for presence and type of use by Townsend's big-eared bat.
- Monitor cliff sites for Peregrine falcon use
- Validation monitoring for late seral species within LSR's
- Monitor Williams Lake area for biological and successional changes, especially in the quaking bog area
- Monitor wildlife structures (snags, DWD) following harvest activities and/or natural disturbance. Evaluate for density, use, and effectiveness.
- Monitor increases in target shooting activity if other areas of the National Forest are closed to target shooting.

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