United States
Department of
Agriculture

Forest
Service

Pacific
Northwest
Region

1996

Upper Sandy Watershed Analysis

Mt. Hood National Forest

Front cover photographs by Tom Iraci

Top photo:	Old Maid Flats and lower watershed as seen looking west from Bald Mountain
Bottom Photo:	Mt. Hood and upper watershed as seen looking east from Bald Mountain

Preface

Dear Reader,

This document describes an in-depth, comprehensive analysis of the Upper Sandy Watershed. Although the full logic of the analysis tracks from chapters one to seven, the document may be approached in more than one manner depending on your needs.

If you're interested in a summary of the watershed analysis, the Key Question discussions in Chapter 6 provide synthesized, interpreted results. Changes in ecological conditions and their probable causes are examined and explained, including implications for watershed management objectives. Chapter 7 displays recommendations for management activities.

For detailed information on conditions within the watershed, Chapter 4, Current Conditions and Trends, provides a comprehensive discussion. This chapter provides the supporting evidence to answer the Key Questions and develop recommendations. It also provides substantial information for further project planning. At the end of most sections within this chapter, there are conclusions or highlights listed which summarize the overall discussions.

In addition, since watershed analysis is an ongoing, iterative process, there are important components to our work that go beyond the pages of this document. These products are stored at the Zigzag Ranger District and include:

- **Databases:** A large array of data was organized and analyzed. These databases will be beneficial for further planning efforts within the watershed.
- **Spatial data layers:** Many layers representing spatial resource information (ARC-Info format) were compiled, refined or newly constructed.
- **Maps:** A large number of mylar and paper map layers have been produced from the electronic spatial data mentioned above. An aerial photo mosaic of the watershed was created as well.
- **Analysis file:** Includes additional written documentation of assumptions, methods, results, or background material.
- **Contributors:** Part of any work is the knowledge gained from the process. The analysis team members together with resource specialists, stewards, and outside contributors provide a valuable knowledge base of the Upper Sandy Watershed and of the tools and products mentioned above.

-- The Watershed Analysis Team

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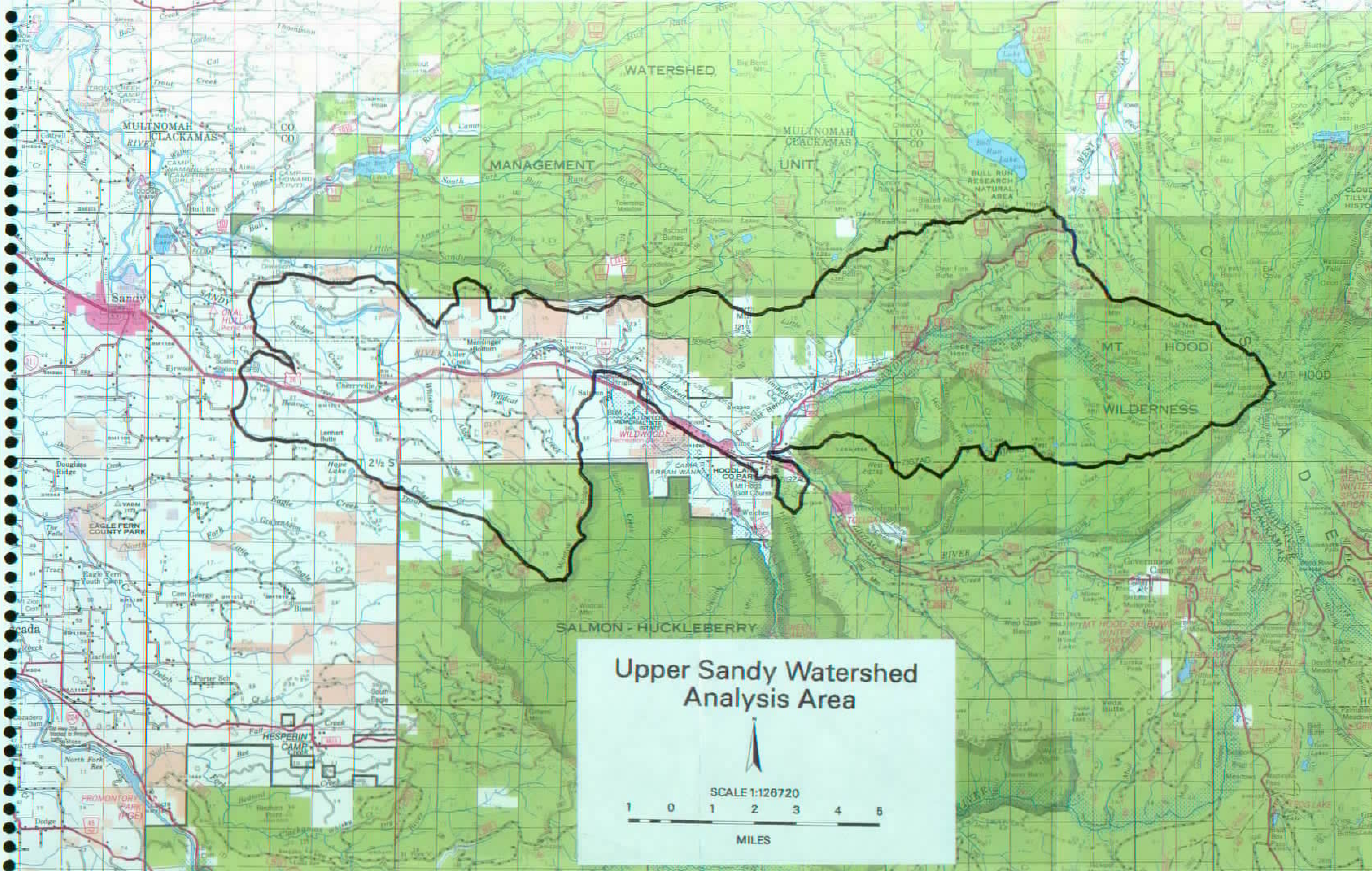
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Analysis Area
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MILES
WATERSHED
MANAGEMENT
UNIT
MULTNOMAH
CLACKAMAS
CO
CO
BULL RUN
RESEARCH
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AREA
Sandy
MT HOOD
WILDERNESS
MT HOOD
SALMON - HUCKLEBERRY
WILDWOOD
HOODLAND
CO PARK
HESPERIN
CAMP
EAGLE FERN
COUNTY PARK
PROMONTORY
PARK
(PGE)

Chapter 1 -- Introduction

Purpose of Watershed Analysis

Watershed Analysis is a procedure used to document a scientifically-based understanding of the ecological structures, functions, processes, and interactions that occur within a watershed -- providing a process to identify conditions, trends, and restoration opportunities.

Watershed Analysis essentially serves as ecosystem analysis at the watershed scale, providing the general type, location, and sequence of appropriate management activities within a watershed. Watershed Analysis, however, is not a decision-making process. It is, rather, the stage-setting process whose results establish the context for subsequent decision-making processes, including planning, project development, and regulatory compliance.

Watershed analysis is an ongoing, iterative process, therefore this report is a dynamic document. It is intended to be revised and updated as new information becomes available.

Watershed Analysis serves as one of the principal analyses for implementing the Aquatic Conservation Strategy (ACS) set forth in the Northwest Forest Plan (Record of Decision [ROD] for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, USDA, USDI 1994).

The interactions of various land ownerships in the watershed are considered, even though the Federal watershed analysis process is in no way intended to regulate non-Federal lands (Federal Guide for Watershed Analysis, August 1995). Consideration of these interactions is important to an overall understanding of ecological processes and cumulative effects, and may affect Federal land management decisions.

While Watershed Analysis cannot and is not intended to regulate non-federal lands, the Upper Sandy Watershed Analysis, with the propensity of private lands located within its analysis area, will consider the interactions of all land ownerships.

For the Upper Sandy Watershed, the level of analysis for non-Federal lands varied depending on whether or not data was readily available. For example, vegetation data was compiled for the entire watershed. Yet there was not specific road network information or stream survey data readily accessible for non-Federal lands.

Watershed Analysis Team

A core team from the US Forest Service took the lead in the Upper Sandy Watershed Analysis and included input from District interdisciplinary resource specialists. Representatives from the US Bureau of Land Management, U.S. Fish and Wildlife Service, and the City of Sandy helped the Watershed Analysis Team identify and explore a full range of management issues and resource concerns within the Upper Sandy Watershed.

Public Participation

A public meeting was held on October 1, 1996 to share highlights of the in-progress analysis and invite questions or additional information about the watershed. An additional key question was added to address concerns regarding municipal water quality for the City of Sandy. Letters and phone calls received from the public also provided input into the analysis.

Watershed Analysis Report Organization

As outlined in the *Federal Guide for Watershed Analysis* (August 1995), the following six-step process was used to conduct the Upper Sandy Watershed Analysis and provides the framework for this report:

Step One – Characterize the Watershed

This initial step identified the dominant physical, biological and human processes or features that affect the watershed's ecosystem functions and conditions. Significant land allocations, plan objectives and regulatory constraints that influence resource management within the watershed were identified. The Analysis Team described primary ecosystem elements which would require more detailed analysis in subsequent steps. *(Chapters One and Two)*

Step Two -- Identify Issues and Key Questions

To help focus the analysis, Key Questions were identified based on management objectives, human values, and resource conditions within the watershed. *(Chapter Three)*

Step Three -- Describe Current Conditions

Detailed information associated with the watershed's processes, conditions and Key Questions was developed. The current range, distribution, and condition of the relevant ecosystem elements were documented. *(Chapter Four)*

Step Four -- Describe Reference Conditions

How the watershed's ecological conditions have changed due to human influence and natural disturbance was explained. A reference was developed to compare current conditions with management objectives. *(Chapter Four)*

Step Five -- Synthesize and Interpret Results

Changes in ecological conditions and their probable causes were further examined and explained, including implications for watershed management objectives. *(Chapters Four through Six)*

Step Six -- Develop Recommendations

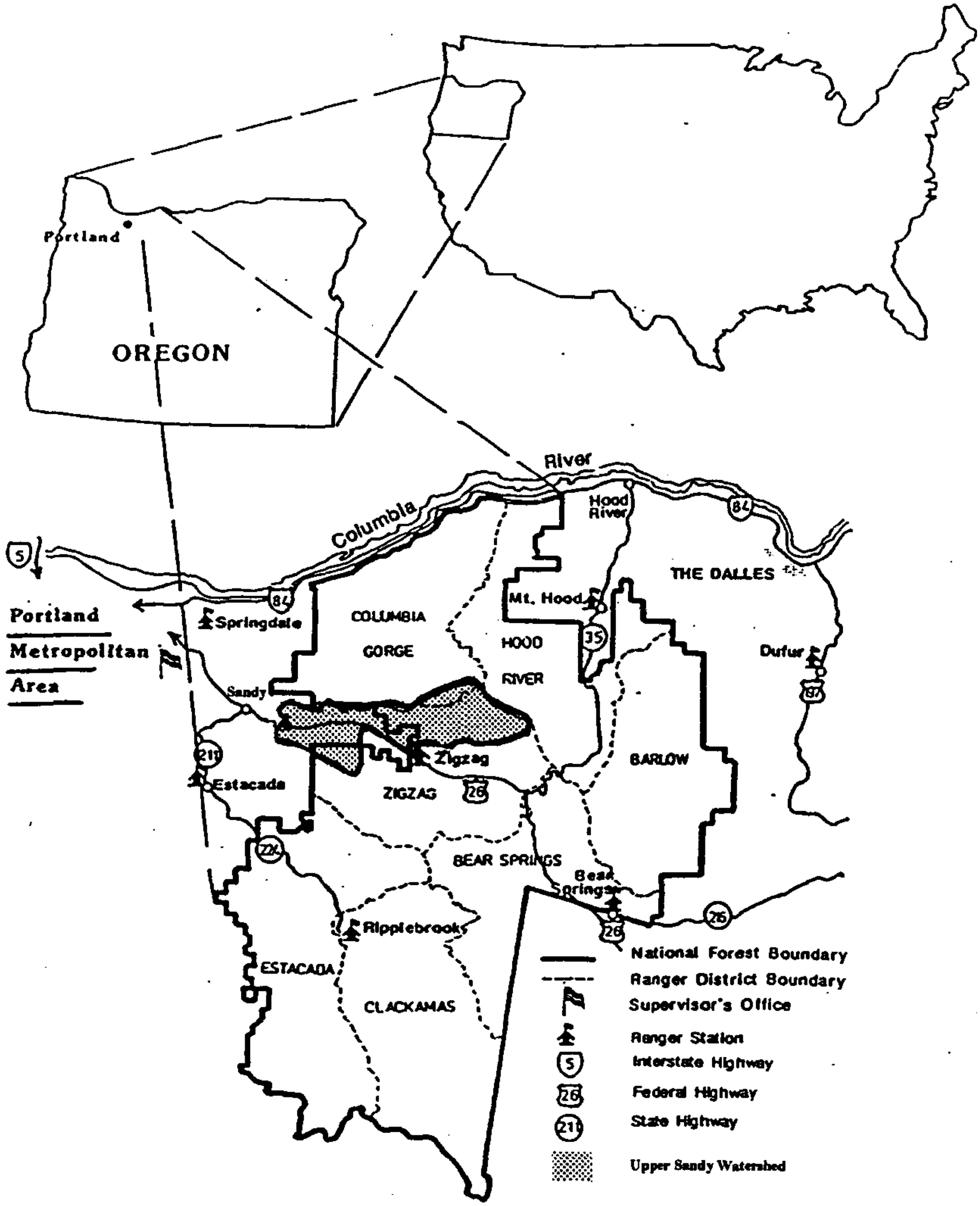
The Watershed Analysis Team applied the results from steps one through five and developed recommendations for management activities that are responsive to the issues and Key Questions from Step Two. *(Chapters Six and Seven)*

Watershed Characterization

Setting

The Upper Sandy Watershed is located just east of the City of Sandy and rises up to the western summit of Mount Hood at the crest of the northern Oregon Cascades (Figure 1-1 -- Mt. Hood National Forest Vicinity Map). All of the watershed's 67,816 acres are located in the northeast corner of Clackamas County.

Figure 1-1 -- Mt. Hood National Forest Vicinity Map



Elevations within the 106-square mile Upper Sandy Watershed range from 554 feet at the watershed's western boundary to 11,047 feet at its eastern border on Mount Hood's summit. Average elevation is 2,700 feet. Weather patterns in the watershed vary markedly, depending on elevation, exposure, and season. Precipitation ranges from 70 to over 100 inches annually within the watershed. Forty seven percent of the watershed is in the transient snow zone (2,400-4,800 feet) with six percent greater than 4,800 feet.

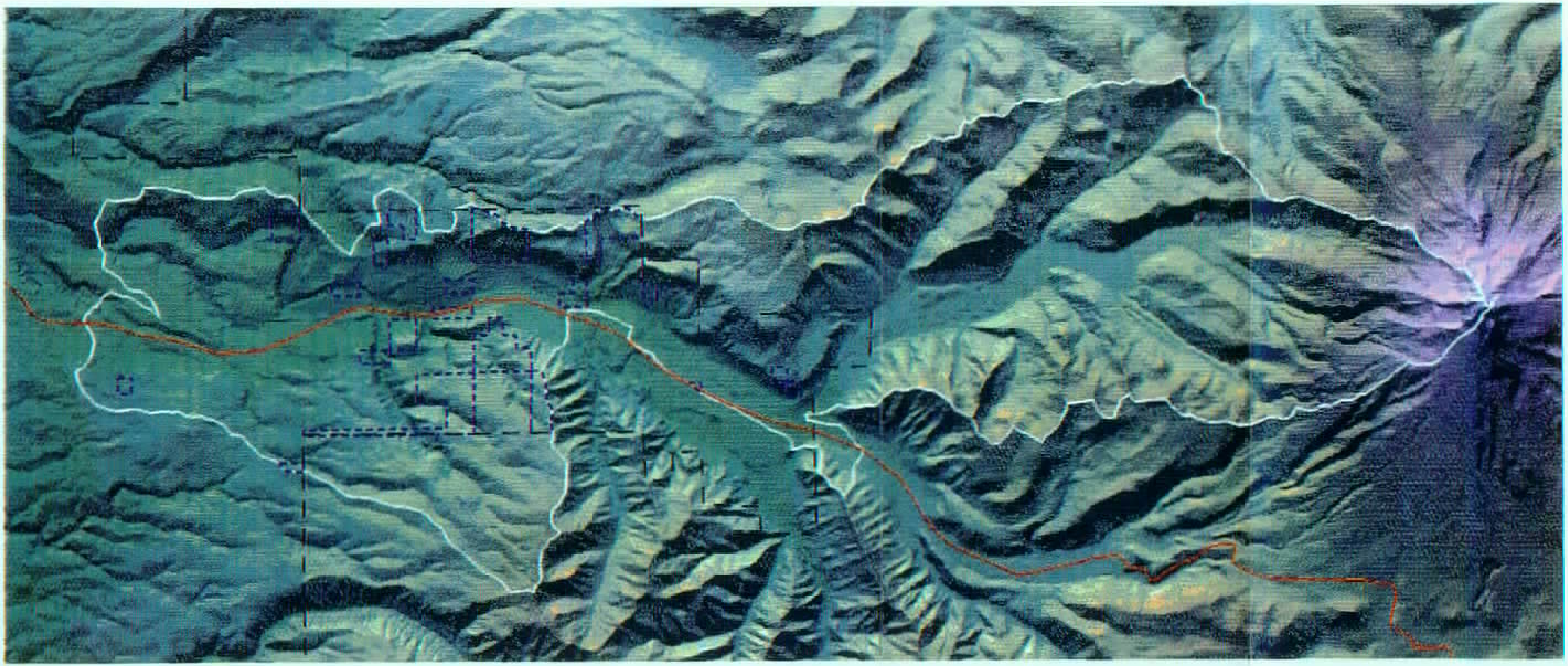
The eastern portion of the watershed is marked by steep slopes with gradients frequently in excess of 70%. In contrast, the western portion of the watershed has much flatter terrain with slope gradients typically less than 20% and rarely greater than 50%. The glacially carved Upper Sandy River Valley has been partially filled in by pyroclastic and debris flows to form a broad flat plain known as Old Maid Flat. Old Maid Flats exhibits a unique array of soil conditions and relatively rare -- especially for the western Cascades -- botanical communities. These include lodgepole pine and associated plants as well as edible mushrooms rare elsewhere within the Mount Hood National Forest.

From the Sandy River headwaters on Mount Hood to the analysis area's western edge, the watershed transects four distinct forest zones that represent major large-scale climatic differences. They include the Alpine/Subalpine Zone, Mountain Hemlock Zone, Pacific Silver Fir Zone, and the Western Hemlock Zone.

The changes in weather, soils, and elevation within the watershed reflect a broad diversity of vegetation. Common conifers include: Douglas-fir, western hemlock, Pacific silver fir, noble fir, western redcedar, and Englemann spruce. Dominant shrub species include: vine maple, salmonberry, salal, Oregon grape, rhododendron, and huckleberry species. Common ground cover species include: beargrass, bunchberry, swordfern, oxalis, trillium, and vanilla leaf.

The Upper Sandy Watershed also contains a diversity of increasingly rare and genetically important native fish stocks. The mainstem and its tributaries provide spawning and rearing habitat for early and late run coho, spring chinook, winter and summer steelhead, and native cutthroat trout populations.

Major sources of water in the watershed include glacial melt, spring-fed tributaries, and three small, high Cascade lakes. The presence of fine suspended sediment known as glacial silt or "flour" is particularly noteworthy in the Sandy River mainstem. This milky-gray material -- most apparent in mid to late summer during the peak of glacial melt -- originates from the grinding of rock under the tremendous weight of the Sandy's glaciers. Figure 1-2 -- Relief Map of the Upper Sandy Vicinity displays the topography of the Upper Sandy vicinity.



Upper Sandy Watershed Relief

- – – Mt. Hood National Forest Boundary
- - - - - - Bureau of Land Management Boundary
- —— Highway 26

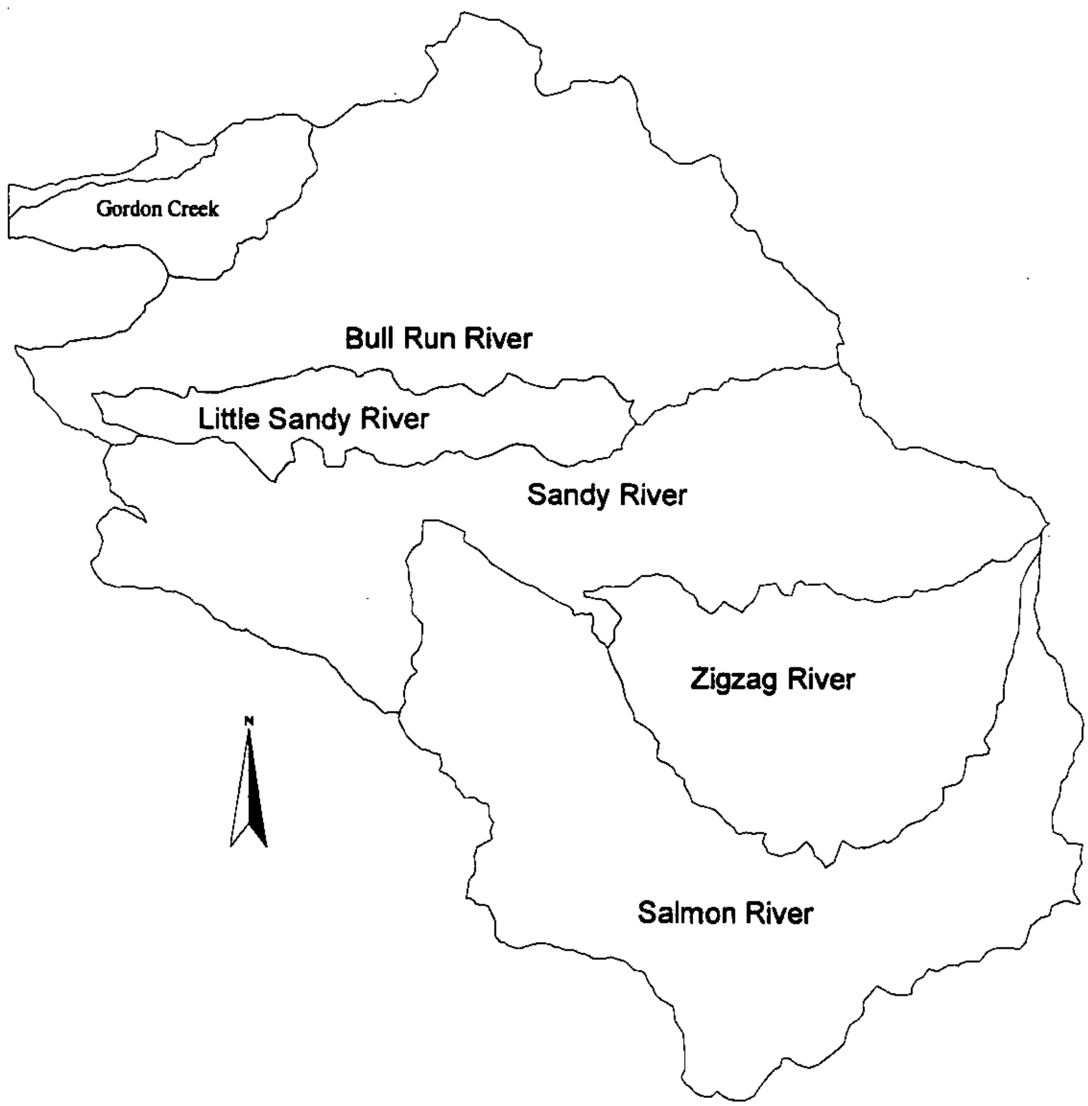
SCALE 1:126720

1 0 1 2 3 4 5

MILES

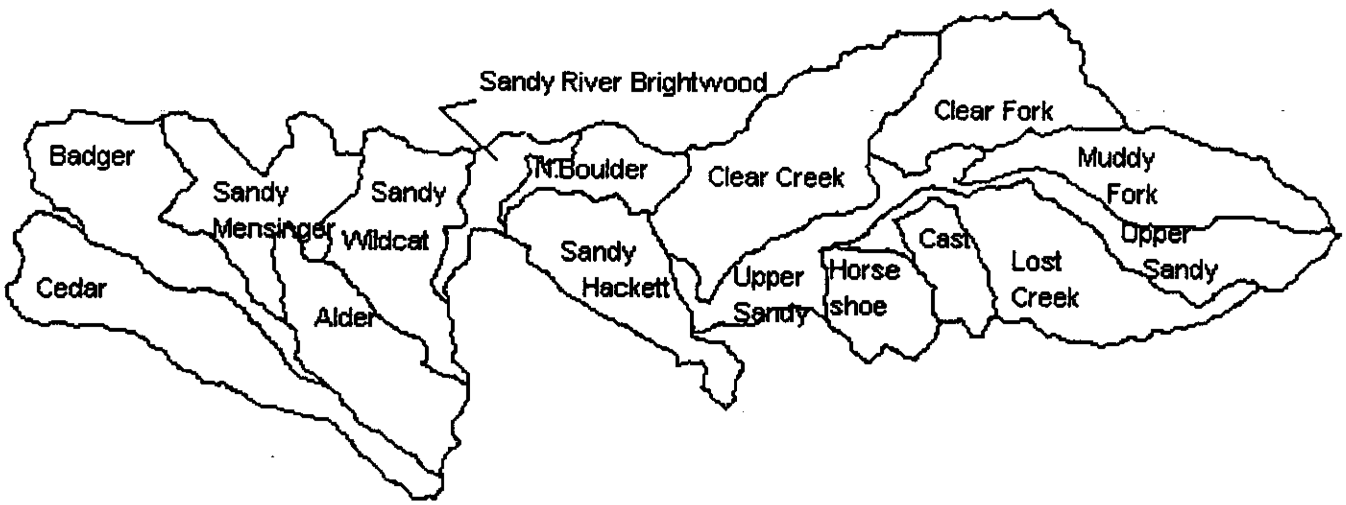
The Upper Sandy Watershed is one of five watersheds that make up the larger Sandy River Basin. Watersheds of the Sandy River Basin include: The Upper Sandy, Bull Run, Salmon, Zigzag, and Gorton Creek/Columbia Gorge East Tributaries. Figure 1-3 displays the location of the Upper Sandy Watershed in relation to the other watersheds within the Sandy River Basin.

Figure 1-3 -- Watersheds of the Sandy River Basin



The Upper Sandy Watershed can be stratified into 15 subwatersheds. Subwatersheds are often used in this report as a smaller scale stratification within the watershed for analyzing some processes or to summarize results. Figure 1-4 displays the names and locations of the 15 subwatersheds of the Upper Sandy Watershed.

Figure 1-4 – Subwatersheds of the Upper Sandy



Cultural Heritage

Prior to European contact, the Sandy River Watershed was probably used by one or more groups of native peoples. The first Willamette Valley-bound Euro-American settlers passed through the watershed on the historic Barlow Road, the last overland segment of the Oregon Trail. (Some of its original sections can still be located within the watershed today.) It was opened in 1845 only two years after the first major westward emigration of 1843. For seven decades this nationally-significant route served as a major transportation course over the Cascades.

The emigration of peoples from the East in the 1840s and 1850s is inarguably the most important event in Oregon history, shaping the future social and economic patterns of the State. The Barlow Road thus was directly associated with this historic event and remnants of this road in the 1990s constitute a cultural resource of paramount importance.

Stephen Dow Beckham
Barlow Road Survey Consultant

In the late-1800s, a logging railroad spur from the Portland-Cazadero line near Barton was constructed up to Wildcat Mountain. Sections of this historic railroad grade are still visible inside the watershed.

Social

With the growth of metropolitan Portland (35 miles to the west), land and home sites have become popular on private county lands within the watershed. Real estate sales and development have become well-established segments of the local economy -- once largely dependent on timber production and highway-oriented business. The private lands within the watershed provide people the opportunity to live in beautiful mountainous and rural settings. (Often referred to as the wildland/urban interface.) These residents have most likely been drawn by the allure of a more natural environment and all of its associated aesthetic attributes.

Certainly, from a recreational perspective, this popular watershed provides a myriad of physical and aesthetic opportunities. These activities include: mountaineering, sightseeing, wilderness hiking, backpacking, hunting and fishing, equestrian use, whitewater sports, off-road vehicle use, mountain biking, developed and dispersed camping, Nordic skiing, and snowmobiling. Once again, the watershed's close proximity to the population-dense Portland metropolitan area helps escalate and propel this year round recreation use.

By 2017, Metro expects 497,000 more people to live in the three-county region (Multnomah, Washington, and Clackamas counties) than currently. Today there are about 131,000 more people living in the three-county region than there were five years ago. Closer to the watershed, 1990 Census data reveal a nine percent population jump from 1980 within the Mt. Hood Corridor – which stretches from Brightwood up to Government Camp. During this decade, a 41% increase in housing units also occurred here. In 1988, an estimated 6,500 residents inhabited the area.

The (Mt. Hood) Corridor is faced with some seemingly insurmountable problems: sewage disposal, pollution of the streams, erosion of the hillsides, damage to the vegetation and trees, and proliferation of unsightly buildings, as well as the increasing problems of weekend ski traffic and parking for visitors. Unfortunately, these will continue to increase in geometric proportions, compounding present problems and creating new ones.

Clackamas County's 1976 *Mt. Hood Community Plan*

The watershed's outstanding remarkable values -- its scenery, recreation opportunities, fisheries, geology, and botany -- comprise an invaluable natural heritage that people today not only want to enjoy, but also want to conserve.

Land Use and Planning

Land use and ownership varies widely in this complex watershed. The diverse spectrum of land uses, with over 900 land owners, ranges from wilderness to timber emphasis; from agricultural pursuits to rural residential home sites; and from major highways to power line corridors. The Alder Creek subwatershed serves as the source of municipal drinking water for the City of Sandy.

Land ownership includes: U.S. Forest Service (Mount Hood National Forest), 37,303 acres; U.S. Bureau of Land Management (BLM), 3,720 acres; Clackamas County, 953 acres, and private, 25,066 acres. Land ownership patterns form a mixed patchwork of discontinuous parcels, especially in the watershed's western portion.

The Mt. Hood Forest Land and Resource Management Plan, Final Environmental Impact Statement, (Mt. Hood Forest Plan) was completed in 1990 and provides overall management direction for all National Forest Lands within the watershed. Direction from this plan is specific to land allocations within the watershed. (See Chapter Two for specific land allocations within the watershed)

In 1994, the *Northwest Forest Plan* amended existing Resource Management Plans for National Forests and BLM Districts within the range of the northern spotted owl.

The *Salem District BLM Resource Management Plan* provides management direction for BLM lands within the watershed. It was completed in 1995 and written to comply with the 1994 Northwest Forest Plan.

The portion of the Sandy River from its headwaters to the Mt. Hood National Forest Boundary was designated by Congress as a *Wild and Scenic River* through the Omnibus Oregon Wild and Scenic Rivers Act of 1988. A separate management plan was developed in 1993 to provide further direction for the management of the river corridor and its viewshed. This plan amended the Mt. Hood Forest Plan and was developed to provide for the protection and enhancement of resource values within the Sandy River corridor.

The *Clackamas County Comprehensive Plan* of June 1992 addresses activities on non-federal lands. Any development must meet the standards for the county's unincorporated areas as outlined in the comprehensive plan. These include restrictions and considerations for: natural hazards, slopes, stream corridors, wildlife and fish habitat, cultural and historic resources, and natural drainage channels. (The county's 1976 *Mt. Hood Community Plan* is tiered from this comprehensive plan. It acts as the planning guide for conservation and development in the Mt. Hood Corridor area -- which includes the Upper Sandy Watershed.)

The *Barlow Road Historic Corridor Background Report and Management Plan*, 1993, by Clackamas County, outlines proposed amendments to the Comprehensive Plan to preserve the historic values of the Barlow Road.

The *State Forest Practices Act* applies to any timber management activities on non-federal lands within the watershed.

The Oregon Department of Fish and Wildlife (ODFW) is responsible for managing and protecting Oregon's fish and wildlife resources. The Upper Sandy Watershed's fishery resources are managed under the direction of ODFW.

The Oregon Department of Environmental Quality (DEQ) is responsible for implementing the *Statewide Water Quality Management Plan*, which establishes water quality standards for the state. Beneficial uses of rivers and streams protected by the DEQ include: public, private, and industrial water supplies; anadromous fish passage; salmonid rearing and spawning; and resident fish and aquatic life.

The *Oregon Resource Conservation Act of 1996* includes proposed land exchanges involving Bureau of Land Management (BLM) lands and Longview Fibre lands within the Upper Sandy Watershed. Under this Act, and after the exchange is finalized, an additional 3,000 acres of land in the Mt. Hood Corridor will be managed by the BLM primarily for the protection of important scenic values.

Chapter 2:

Desired Conditions

Chapter 2 - Desired Conditions

The "desired conditions" for the Upper Sandy Watershed's National Forest lands are established in the Mt. Hood Forest Plan, as amended by the Northwest Forest Plan, and Salem District BLM Resource Management Plan. This chapter discusses these plans and explains their relationships by outlining:

- The relationship of Existing Plans and Standards and Guidelines
- Northwest Forest Plan Allocations
- Mt. Hood Forest Plan and Salem District BLM Plan Allocations
- General Management Objectives (derived from merging the Northwest Forest Plan and the other Resource Management Plans)

Relationship of Existing Plans and Standards and Guidelines

In 1994, the Northwest Forest Plan amended existing Resource Management Plans for National Forests and BLM Districts within the range of the northern spotted owl. The Northwest Forest Plan adds new resource management goals and objectives and several major land allocations, each with its own set of standards and guidelines. These land allocations overlay the 1991 Mt. Hood Forest Plan. The 1995 Salem District BLM Resource Management Plan as written, complies with the Northwest Forest Plan.

Each plan and its accompanying land allocations include specific management standards and guidelines that: govern appropriate activities within the land allocations, and prescribe the environmental conditions to be achieved and maintained.

Northwest Forest Plan standards and guidelines supersede all other direction -- with the exception of treaties, laws, and regulations which are more restrictive or provide greater benefits to late-successional forest related species (ROD pp. 12, A-6, C-1, also four exceptions are noted in ROD p. C-3). Standards and guidelines and land allocations in existing plans not directly superseded will remain in effect (ROD. A-2). Thus, standards and guidelines from the Mt. Hood Forest Plan apply when they are more restrictive than the Northwest Forest Plan.

Standards and guidelines from the Northwest Forest Plan do not apply where they would be contrary to existing law or regulation, or where they would require agencies to take actions for which they have no authority (ROD A-6, C-1).

Northwest Forest Plan Land Allocations

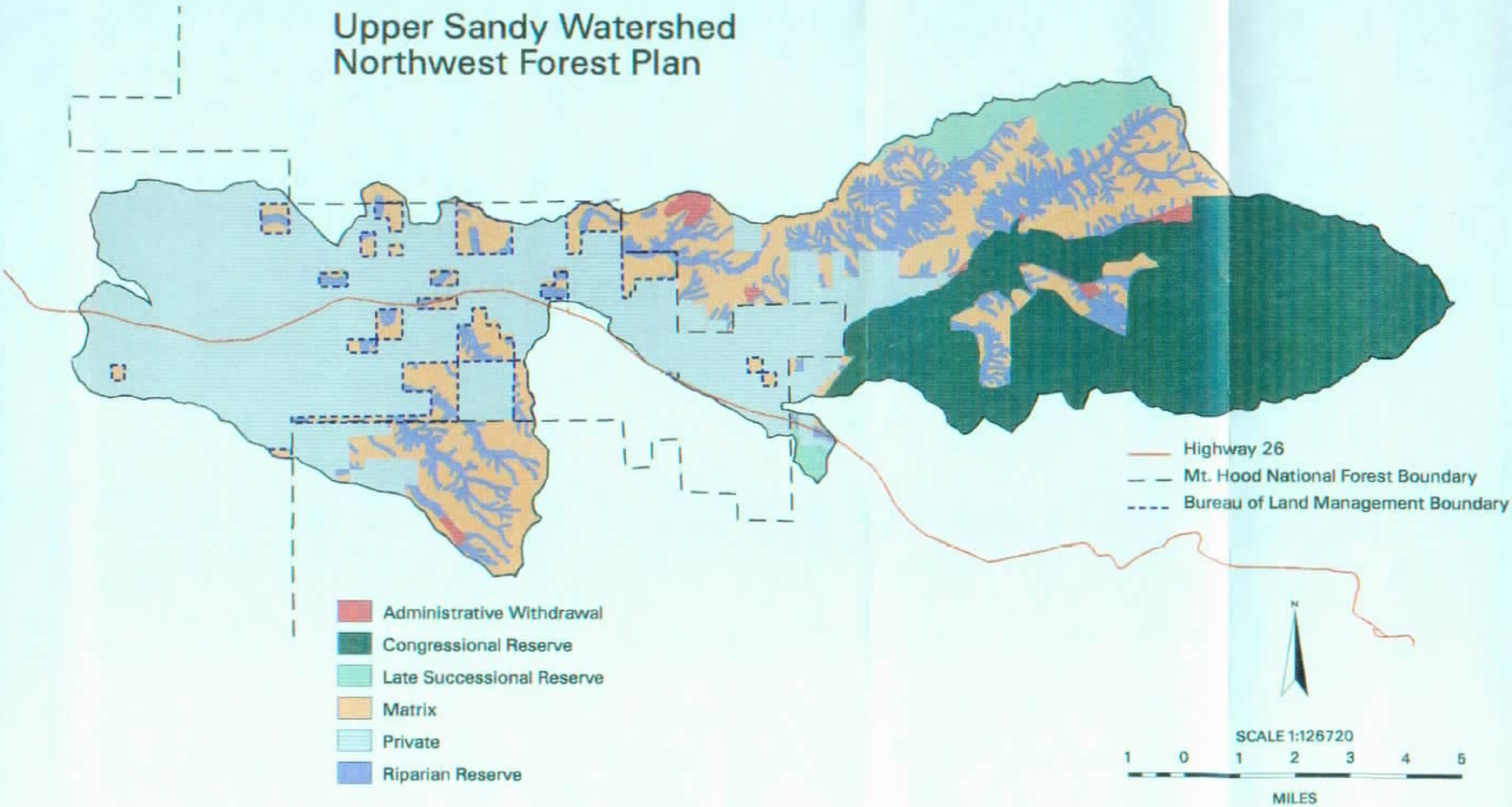
The Northwest Forest Plan overlays the following designated areas in the watershed: Late Successional Reserves, Riparian Reserves, and Administratively Withdrawn Areas. The Northwest Forest Plan applies the Matrix allocation to all the remaining federal lands within the watershed outside of these three designated areas. No Adaptive Management Areas, or Managed Late-Successional Areas are located within watershed.

Some overlap occurs within these designated areas, for example, Riparian Reserves within Late-Successional Reserves. For acreage and display purposes, the following mapping hierarchy is used: 1) Congressionally Reserved, 2) Late-Successional Reserves, 3) Administratively Withdrawn Areas, 4) Riparian Reserves, and 5) Matrix. (ROD A-5.). Table 2-1 displays the number of acres in the watershed by Northwest Forest Plan Allocation. Figure 2-1 -- Northwest Forest Plan displays the spatial location of these allocations within the watershed.

Table 2-1 – Northwest Forest Plan Land Allocations

Northwest Forest Plan Land Allocation	Acres in Watershed
Non-federal Land	25,866
Congressionally Reserved Areas	18,066
Matrix	12,595
Riparian Reserves	8,000
Late-Successional Reserves	2,760
Administratively Withdrawn Areas	482

Upper Sandy Watershed
Northwest Forest Plan



The watershed's private lands are not subject to federal Resource Management Plans. They are, however, subject to state and county laws and ordinances, including State Forest Practices Regulations.

Where land allocations overlap, the standards and guidelines of both designations apply. (For example, where Riparian Reserves occur within Late-Successional Reserves.)

Matrix lands within the Upper Sandy Watershed are all federal lands not in Congressional Reserve, Late Successional Reserve, Riparian Reserve or Administratively Withdrawn allocations. In Matrix lands, standards and guidelines from the existing Resource Management Plans apply, as well as Northwest Forest Plan standards and guidelines that apply to all land allocations.

The Upper Sandy Watershed is not designated as either a Tier 1 or Tier 2 Key Watershed.

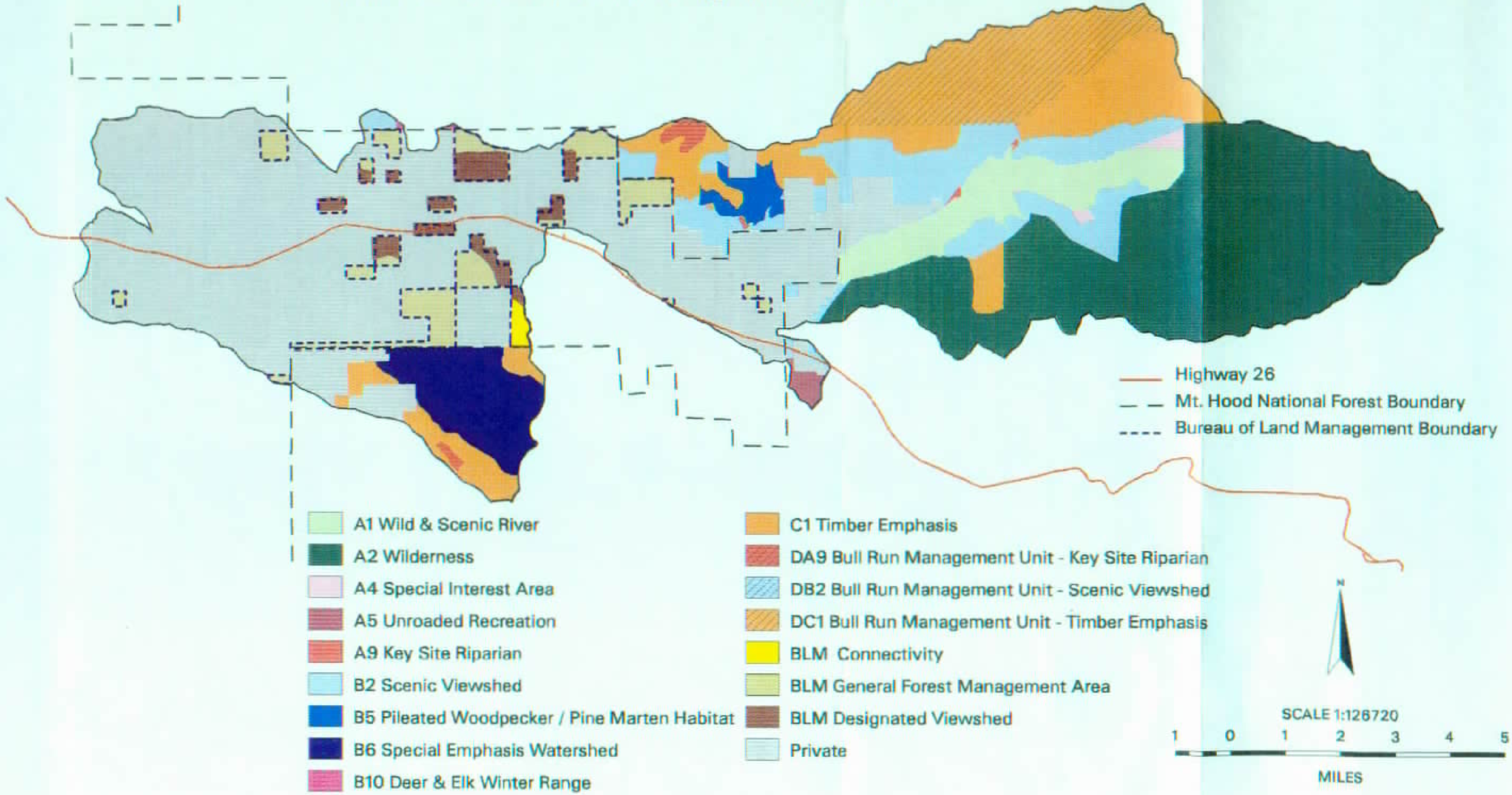
Mt. Hood Forest Plan and Salem District Plan Land Allocations

Table 2-2 -- Mt. Hood and BLM Plan Allocations, displays the number of acres by land allocation in the Upper Sandy Watershed based on the Mt. Hood Forest Plan and the Salem District BLM Resource Management Plan. Figure 2-2 -- Land and Resource Management Plan displays the spatial location of these allocations within the watershed.

Table 2-2 -- Mt. Hood and BLM Plan Allocations

Mt. Hood (LRMP) Allocation	Acres in Watershed
Non-federal Lands	25,866
A2 Wilderness	14,944
C1 Timber Emphasis	6,007
B2 Scenic Viewshed	5,357
DC1 Timber Emphasis	4,498
A1 Wild and Scenic River	3,122
B6 Special Emphasis Watershed	2,655
BLM -- General Forest Management Area	2,443
BLM --Scenic Viewshed	1,282
B5 Pine Marten, Pileated Woodpecker Habitat Area	625
A9 Key Site Riparian	296
A5 Unroaded Recreation	222
A4 Special Interest Area	193
BLM -- Connectivity	168
DA9 Key Site Riparian	32
DB2 Scenic Viewshed	32
B10 Deer/Elk Winter Range	27

Upper Sandy Watershed Land & Resource Management Plan



General Management Objectives

Because the Northwest Forest Plan allocations overlay land allocations designated in the Mt. Hood Forest Plan, "general management objectives" reflect and describe both plans. Two or more overlapping land allocations may occur on one site. In addition, when allocations overlap, more than one set of standards and guidelines may apply.

General management objectives are derived from these overlapping standards and guidelines. In most cases, the more restrictive standards and guidelines which provide greater benefits to late-successional forest-related species will generally take precedence.

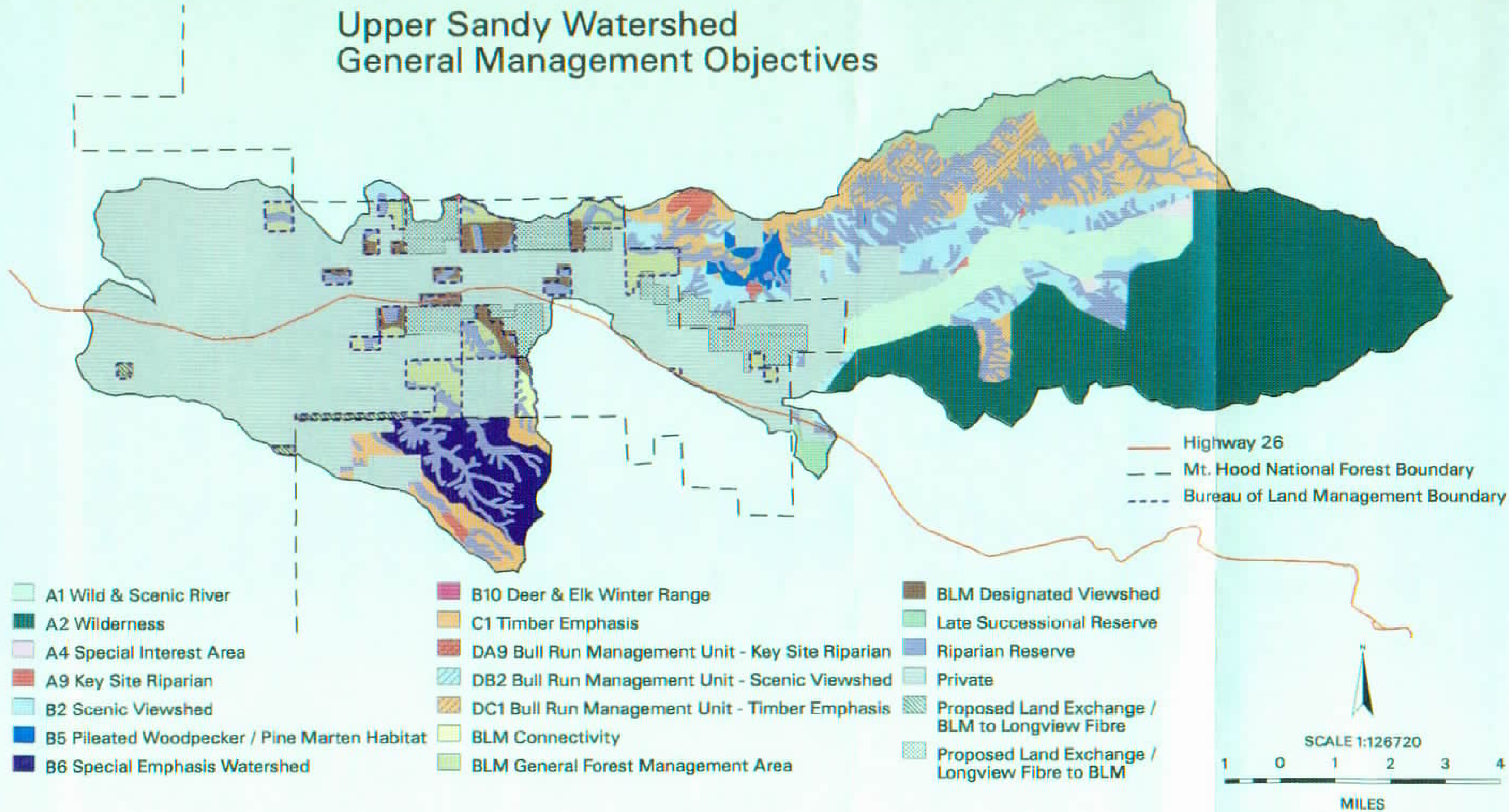
In general, Northwest Forest Plan standards provide greater benefits to late-successional forest-related species. The Mt. Hood Forest Plan and BLM's Resource Management Plan is often more site- specific and provides benefits to other resources. Standards and guidelines from the Northwest Forest Plan, however, do not apply where they would be contrary to existing law or regulation, or require agencies to take actions for which they have no authority (ROD A-6, C-1).

The land allocations presented in Table 2-3 -- General Management Direction and Figure 2-3 -- General Management Objectives, reflect a merger of the Plans. In addition to the summary table and map, underlying land allocations and their standards and guidelines also occur. Where two or more land allocations are generally consistent with each other, both allocations are shown.

Table 2-3 – General Management Direction

Land Allocations	Acres in Allocation	Percent of Watershed
Non-federal Land	25,866	38
A2 Wilderness	14,944	22
Riparian Reserves	8,000	12
C1 Timber Emphasis	3,376	5
B2 Scenic Viewshed	3,139	5
A1 Wild and Scenic River	3,122	5
Late-Successional Reserves	2,460	4
BLM -- General Forest Management Area	1,788	3
B6 Special Emphasis Watershed	1,670	2
DC1 Timber Emphasis	1,074	2
BLM -- Scenic Viewshed	941	1
B5 Pine Marten, Pileated Woodpecker Habitat Area	477	<1
Unmapped Late Successional Reserve	319	<1
A9 Key Site Riparian Area	296	<1
A4 Special Interest Area	193	<1
BLM -- Connectivity	119	<1
DA9 Key Site Riparian	32	<1
B10 Deer/Elk Winter Range	27	<1
DB2 Scenic Viewshed	7	<1

Upper Sandy Watershed General Management Objectives



Private Lands/ Non-federal lands

Over 900 landowners own land in the Upper Sandy Watershed. Uses include: commercial forest, residential, agricultural and more. Specific land management objectives of individual landowners were not analyzed during this watershed analysis. However, county zoning and tax lot data were used to make some assumptions in regard to land usage (see Chapter 4 Social/Historical). County lands are legally treated like private lands, therefore activities are subject and akin to State Forest Practices Act.

A2 Wilderness

These areas: promote, perpetuate, and preserve the wilderness character of the land; protect watersheds and wildlife habitat; preserve scenic and historic resources; and promote scientific research, primitive recreation, solitude, physical and mental challenge, and inspiration.

Riparian Reserves

As a key element of the Aquatic Conservation Strategy, the Riparian Reserves provide an area along all streams, wetlands, ponds, lakes, reservoirs, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis.

Riparian Reserves are also important to the terrestrial ecosystem, providing habitat within the riparian upland/transition zone, as well as providing connectivity within the watershed and among Late-Successional Reserves.

Desired conditions for Riparian Reserves:

- To attain a fully functional aquatic and riparian habitat area that meets the needs of riparian-dependent species.
- To serve as dispersal corridors for many terrestrial animals and plants.
- To enhance habitat for species that depend on the transition zone between upslope and riparian areas.
- To maintain and restore riparian structure and function of intermittent streams.

- To provide greater connectivity within the watershed and among LSRs.

Direction for designating Riparian Reserve widths is stated in the ROD (Standards and Guidelines, pages C-30 and C-31). For the Upper Sandy Watershed Analysis, measured site-potential tree heights within major vegetative zones were used to delineate the interim Riparian Reserve widths. (See Chapter Seven for detailed information on the assumptions used for developing the interim Riparian Reserve widths.)

The following is a summary of the interim Riparian Reserve widths used in this analysis. For the purpose of mapping, horizontal distances were used. On most lands (except steep slopes), the difference between slope and horizontal distance is minimal.

Major vegetative zones and their measured site-potential tree heights:

- Western Hemlock Zone -- Douglas-fir measured tree height 210'
- Pacific Silver Fir Zone -- Douglas-fir measured tree height 170'
- Mountain Hemlock Zone -- Use defaults from the ROD.

Unstable and potentially unstable areas should be field verified during project planning, and delineated by a soil scientist or geologist. Final location of all Riparian Reserves will be based on site-specific analysis.

Table 2-4 -- Interim Riparian Reserve Widths

STREAM/RIPARIAN ZONE TYPE	WESTERN HEMLOCK ZONE	PACIFIC SILVER FIR ZONE	MOUNTAIN HEMLOCK ZONE
Fish bearing streams (uses two site-potential tree heights)	420'/side 840' total	340'/side 680' total	300'/side 600' total
Non-fish bearing, permanently flowing streams (uses one site-potential tree height)	210'/side 420' total	170'/side 340' total	150'/side 300' total
Seasonally flowing or intermittent streams (uses one site potential tree height)	210'/side 420' total	170'/side 340' total	100'/side 200' total
Lakes and natural ponds (uses two site potential tree heights)	420' surrounding	340' surrounding	300' surrounding

STREAM/RIPARIAN ZONE TYPE	WESTERN HEMLOCK ZONE	PACIFIC SILVER FIR ZONE	MOUNTAIN HEMLOCK ZONE
Wetlands (uses one site-potential tree height)	210' surrounding	170' surrounding	150' surrounding
Unstable and potentially unstable areas (uses one site-potential tree height)	210' surrounding	170' surrounding	100' surrounding
Key Site Riparian	See Key Site Riparian comment below		

Figure 2-4 -- Riparian Reserve Network displays the Riparian Reserves of the Upper Sandy Watershed. *(Riparian Reserves are a federal land allocation only. Stream networks only are shown on non-federal lands.)*

A9 Key Site Riparian and DA9 Key Site Riparian

Key Site Riparian designations of the Mt. Hood Forest Plan are incorporated into the Riparian Reserve network. 328 acres of Key Site Riparian, however, extend beyond the widths presented in Table 2-4. In such instances, these Riparian Reserve widths would be increased to include these additional acres.

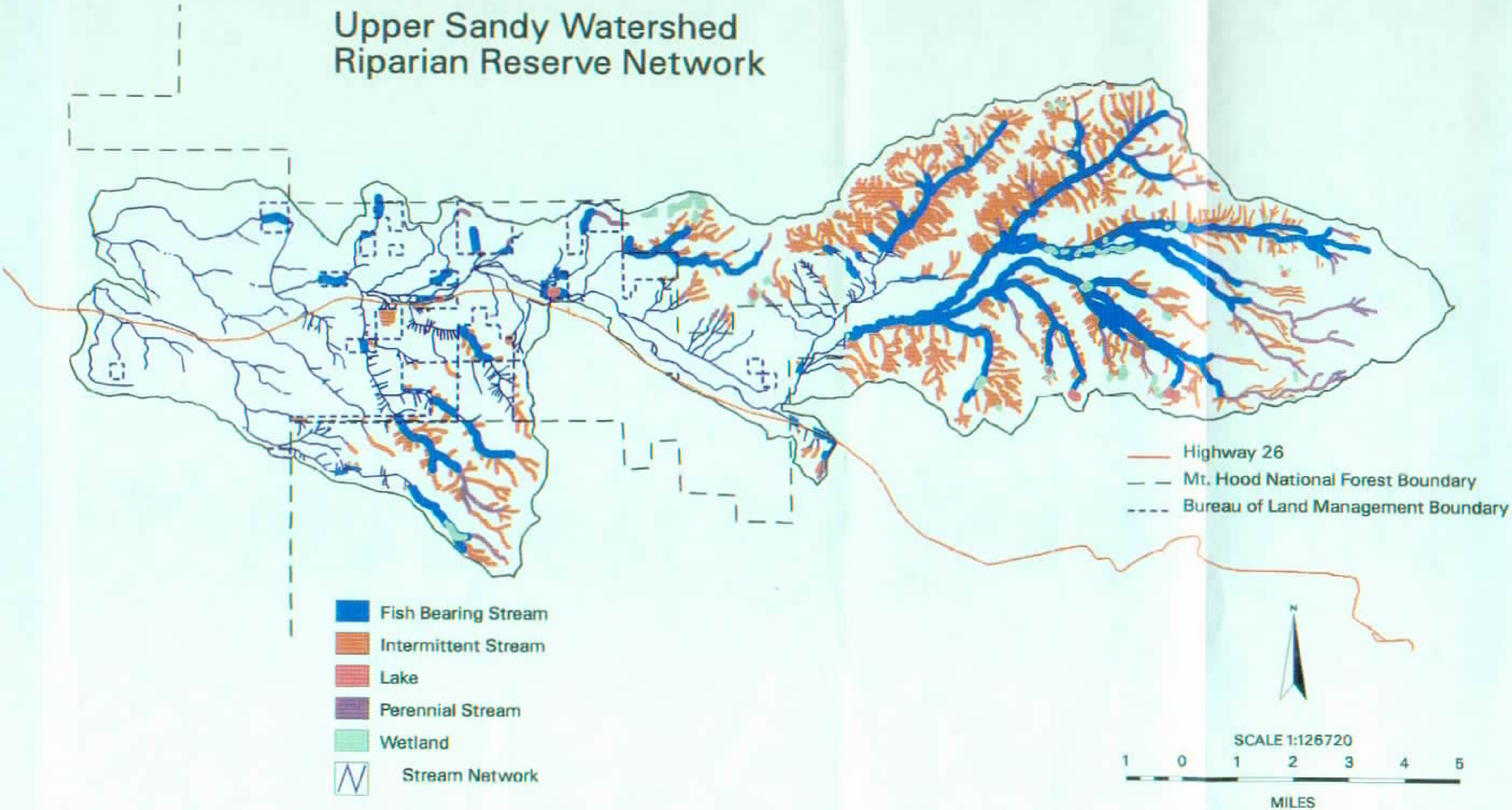
The goal of this allocation is to maintain or enhance habitat and hydrologic conditions of selected riparian areas that are notable for their exceptional diversity, high natural quality and key role in helping meet the needs of riparian-dependent species and riparian dependent resource values.

C1 Timber Emphasis

The principal objective of this allocation is to provide lumber, wood fiber, and other forest products on a fully 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 harvest.

B2 Scenic Viewshed

Scenic viewshed management objectives are to provide attractive, visually appealing forest scenery with a wide variety of natural-appearing landscape features. Vegetation management activities are used to create and maintain desired landscape character. The visual character of the landscape results from prescribed visual quality objectives within distance zones from selected view points.


Upper Sandy Watershed
Riparian Reserve Network
Highway 26
Mt. Hood National Forest Boundary
Bureau of Land Management Boundary
Fish Bearing Stream
Intermittent Stream
Lake
Perennial Stream
Wetland
Stream Network
N
SCALE 1:126720
1 0 1 2 3 4 5
MILES

A1 Wild and Scenic River -- Sandy River

This new management area was designated in 1994 with the implementation of the Upper Sandy National Wild and Scenic River Management Plan. This A1 status: better complies with the Wild and Scenic Rivers Act, protects identified outstanding remarkable values, and more closely follows identifiable and describable landmarks. Thus, it replaces the Upper Sandy River's B1 area location boundary in the Forest Plan. In addition, the Forest Plan's B2 Scenic Viewshed Management Area allocation boundary adjacent to the river corridor's lower portion has also been changed to coincide with this new A1 allocation.

Late-Successional Reserves

The objective of Late-Successional Reserves (LSR) is to protect and enhance conditions of late-successional and old-growth forest ecosystems which serve as habitat for late-successional and old-growth related species, including the northern spotted owl.

100-Acre Late-Successional Reserves (Unmapped Late-Successional Reserves)

100-acre LSRs are to be designated around each known (as of Jan. 1, 1994) spotted owl activity center not already protected by another reserve (ROD C-10). Three owl activity centers within the Upper Sandy Watershed are surrounded by 100-acre LSRs.

BLM -- General Forest Management Area

Within these Bureau of Land Management lands, objectives are to manage for timber production while providing for long-term site productivity, forest health, cavity nester habitat, and biological legacies. A variety of seral stages would be represented. During the next few decades, older forest seral stages would be retained, but the landscape in the long term would have a mosaic of even-aged stands ranging from young to 70-110-year-old stands.

B6 Special Emphasis Watershed

The goal of this allocation is to maintain or improve watershed, riparian, and aquatic habitat conditions and water quality for municipal uses and long-term fish production. Secondary goal is to maintain a healthy forest condition through a variety of timber management practices.

DC1 Timber Emphasis

The primary goal is for the continued production of pure, clear, raw potable water. The secondary management goal of this allocation is to provide lumber, wood fiber, and other forest products on a fully regulated basis, based on the capability and suitability of the land. An additional goal is to enhance other resource uses and values that are compatible with timber harvest.

BLM -- Scenic Viewshed

Only limited management activities may occur on these lands. Activities should be designed to reflect the natural features of the characteristic landscape. The viewshed lands described in the Oregon Resource Conservation Act of 1996 (S 1662 Sec 401) were not fully evaluated in this analysis as complete exchange data were not available.

A4 Special Interest Area

These lands: protect and -- where appropriate -- foster public recreational use and enjoyment of important historic, cultural, and natural aspects of our national heritage; and preserve and provide interpretation of unique geological, biological, and cultural areas for education, scientific, and public enjoyment purposes.

BLM -- Connectivity

Objectives in these Bureau of Land Management lands are to provide movement, dispersal, connectivity opportunities, and add to the richness and diversity of the landscape.

B10 Deer and Elk Winter Range

The principal management objectives of this allocation are to provide high quality deer and elk habitat for use during most winters, and to provide for a stable population of Roosevelt Elk on the west side of the Cascades. Secondary management objectives include maintenance of a healthy forest condition through a variety of timber management activities.

DB2 Scenic Viewshed

This management area is located in the Bull Run North Buffer. It is designed to maintain visual quality as viewed from the Columbia River Gorge National Scenic Area.

Oregon Resource Conservation Act of 1996

The Oregon Resource Conservation Act *(also known as the Opal Creek Wilderness and Opal Creek Scenic Recreation Act of 1996)* includes land exchanges involving federal lands and Longview Fibre lands within the Upper Sandy Watershed. The potential exchange lands in the Upper Sandy Watershed are displayed previously in Figure 2-3 -- General Management Objectives. Exchanges shall be consummated not later than one year after the date of enactment of this Act. Potential future effects of the exchange are discussed briefly in Chapter Five, Future Seral Stage and in Chapter Six, Key Question #2.

Lands offered for exchange to the U.S. Bureau of Land Management (BLM) include 2929 acres in the Mt. Hood Corridor. Much of this land is visible from Oregon State Highway 26. That which can be seen from the highway shall be managed primarily for the protection of important scenic values. Management prescriptions for other resource values associated with these lands shall be planned and conducted for purposes other than timber harvest, so as not to impair scenic quality.

Lands offered by the BLM include only 168 acres that lie within this watershed. Lands in other portions of the State are also involved in this exchange. *(Refer to Sec. 401. Land Exchange, Oregon Resource Conservation Act of 1996.)*

Chapter 3:

Key Question Development

Chapter 3 -- Key Question Development

One of the first steps in the Watershed Analysis process is to identify the Key Attributes most relevant to management questions, human values, and resource conditions within the watershed.

A Key Attribute was identified as:

- Having a stature in the watershed that cannot be ignored.
- An item of administrative or legislative significance (i.e. species addressed under the Endangered Species Act).
- Tied to the Northwest Forest Plan (*Record of Decision* [ROD] *for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl*, USDA, USDI 1994).
- Distinct or unique at the watershed, basin, or provincial scale.

Identified Key Attributes are then formulated into more specific Key Questions to help focus the analysis. Key Questions are also designed to:

- Focus on ecosystem elements that influence and are influenced by potential management activities.
- Be measured at the watershed scale.
- Promote integration among elements.
- Be answered during watershed analysis.

The Key Questions are then answered based on indicators most commonly used to measure or interpret ecosystem processes and conditions. For synthesis, these processes and conditions are analyzed and presented under the same Key Question in Chapter 6.

The Watershed Analysis team held a work meeting on July 9, 1996 with Zigzag Ranger District resource specialists and stewards, and representatives from the Bureau of Land Management. Meeting participants focused their efforts on identifying an inclusive list of Upper Sandy Watershed concerns and attributes that meet the aforementioned criteria. Afterwards, the Watershed Analysis Team reviewed this information for the most apparent themes. This information was then used to build a preliminary set of Key Questions. The key questions were *presented for public comment at an open house in the community of Sandy on* October 1, 1996. The final list of Key Questions includes revisions derived from this public input.

Key Questions and Rationale

Key Question #1: What are the influences and relationships between human development and ecosystem processes in the watershed?

Rationale: Land uses in the Upper Sandy Watershed vary widely: from wilderness to timber emphasis, agricultural and rural residential, to major highways and powerline corridors. This Key Question will evaluate how the watershed's land use patterns have changed over time, and how this has affected both vegetation potential and wildlife habitats.

This question stems from direction in the *Federal Guide for Watershed Analysis* which, on page one, states: "Watershed analysis is a procedure used to characterize human, aquatic, riparian and terrestrial features at the watershed scale." It is recognized that even though the Federal watershed analysis process is in no way intended to regulate non-Federal lands, watershed analysis will consider the interactions of various land ownership's within the watershed.

Federal land management decisions based on the results of watershed analysis need to consider conditions and activities on adjacent non-Federal lands. This enables the evaluation of cumulative effects as they affect public lands pursuant to: the National Forest Management Act (NFMA), the National Environmental Protection Act (NEPA), Endangered Species Act (ESA), Clean Water Act, laws governing Oregon & California railroad reserve lands, and other pertinent statutes (Federal Guide p. 11).

Key Question #2: How do conditions of the watershed affect terrestrial connectivity within the Sandy River Watershed and between adjacent watersheds?

Rationale: A pattern dominated by openings forms an east/west band across the watershed that divides large continuous forest landscape areas to the north from those to the south. This dramatic landscape-scale separation of forest connectivity may have implications to species linked to late-successional forests. This key question will examine the condition and effectiveness of vegetative connectivity within the Upper Sandy Watershed and its role between watersheds.

A primary goal of the Northwest Forest Plan is to provide for a functional and interconnected old-growth forest ecosystem. The Plan's strategy to meet the needs of late-successional forest species includes: Late Successional Reserves (ROD p. C-11, B-1); Riparian Reserves (ROD p. 7); and Matrix Lands that include small patches/components of late-successional forests (ROD p. B-1, C-44).

This Key Question will examine the effectiveness of vegetative connectivity within the watershed.

Key Question #3: What is the relationship between conditions of the watershed and recreational uses on federal lands?

Rationale: Federal lands in the Upper Sandy Watershed provide a wide variety of recreational opportunities, including: mountaineering, wilderness hiking and backpacking, mountain biking, hunting and fishing, developed and dispersed camping, snowmobiling, and Nordic skiing.

The area is easily accessed from metropolitan Portland; demand for recreational opportunities is high. Recreational use of the watershed serves as a dominant human process (particularly in the upper watershed) that affects ecosystem function and condition (Federal Guide p.1). Further, there have been a number of recent planning efforts associated with recreational use in the watershed (Wild and Scenic River, Wilderness Implementation Schedule, Limits of Acceptable Change process).

This Key Question will review the relationship between land management objectives, now coupled with the Northwest Forest Plan and landscape scale ecosystem processes.

Key Question #4: How do conditions of the watershed contribute to habitat needs for species of concern associated with aquatic, riparian, terrestrial and special habitats?

Rationale: The Northwest Forest Plan directs watershed analysis to characterize the aquatic, riparian, and terrestrial features within a watershed (ROD p.10, B-20 and B-21). Watershed analysis is also expected to address implementation of the Aquatic Conservation Strategy (ACS) and species of concern in riparian and aquatic habitats.

Survey and Manage species (ROD p. C-4) are often associated with unique habitats or special habitats within the watershed. Species of concern are tied to the Endangered Species Act (ESA), National Forest Management Act (NFMA) regulations, and Forest Service policy.

Key Question #5: How do conditions of the watershed affect the ability to meet the Aquatic Conservation Strategy Objectives?

Rationale: The Aquatic Conservation Strategy (ROD p. B-9) was developed to protect fish and other riparian-dependent resources and species. The watershed analysis process is also required to provide the basis for determining Riparian Reserves, and to develop the baseline from which to assess maintaining or restoring the watershed's existing condition (ROD p. B-10 and B-12).

Key Question #6: What is the relationship between federal land allocations, watershed conditions, and commodity production for: timber and other wood products, plant materials and minerals?

Rationale: The Upper Sandy Watershed contains approximately 5,174 acres of federal timber emphasis lands. An additional 6,482 watershed acres have been allocated for timber production to be a secondary management objective.

The Northwest Forest Plan land allocations and standards and guidelines should provide for a steady supply of timber sales and non-timber resources that can be sustained over the long term *without* degrading the health of the forest or other environmental resources (ROD p.3). The Northwest Forest Plan responds to multiple needs, with forest habitat and forest products serving as the two primary needs (ROD p.25).

Key Question #7: How do conditions of the watershed affect water quality in Alder Creek?

Rationale: The City of Sandy derives its municipal water supply from Alder Creek. Approximately 58% of the lands within the Alder Creek subwatershed are managed by the Mt. Hood National Forest and are designated as Riparian Reserve and "Special Emphasis Watershed". The primary management goal of a Special Emphasis Watershed is: to maintain or improve watershed, riparian and aquatic habitat conditions and water quality for municipal use. Nearly 30% of the lands in the Alder Creek subwatershed are privately owned. Many of these privately held lands are managed for timber production. The Bureau of Land Management manages 13% of the lands within the subwatershed as Riparian Reserve and Connectivity. The intake for the water supply is located below the National Forest boundary in T 2 S, R 6 E section 29.

Chapter 4:

Current Conditions and Trends

Chapter 4 - Current Conditions and Trends

Introduction

This chapter describes the condition of the Upper Sandy Watershed in terms of the processes and functions critical to addressing the Key Questions. Included is a description of the watershed's existing condition, the range of natural variation, and trends based on current management direction. How conditions have changed over time as a result of human influence and natural disturbances is also documented.

Social/Historical

Historical Background

Prior to European contact, the Sandy River drainage was probably used by one or more groups of Native peoples. Although information is scanty, Indians apparently continued to use the area through the 1800's, especially to gather huckleberries, fish and game. (Hoodland Tracts Resource Inventory, 1995). In addition, Indian peoples gathered cedar bark for baskets, clothing, bandages and other items. Peeled cedar trees can be found on several sites within the watershed. The watershed is still used by American Indians for traditional use, but at much lower levels of use than historically.

From approximately 1772 to 1840, limited exploration and fur trapping occurred within the watershed since trapping was more bountiful in the Willamette Valley. In 1843, the great immigration to the Oregon territory began. The Barlow Road was constructed in 1845 which basically was a one-way east to west route that delivered pioneer emigrants to the rich agricultural lands of the Willamette River valley. Some however chose to settle lands in the Upper Sandy River watershed along the trail. These early homesteads were minimal in size and scope in relationship to the watershed ecosystem.

By 1880, the Willamette Valley was becoming increasingly settled and people started to look towards the Cascades to provide some of their needs. Besides logging and shepherding, residents of the Willamette Valley recognized the recreation potential of the Cascades and ventured to the forest to camp, fish, hunt, and climb.

The growing population of the Willamette Valley and the Portland metropolitan area created a demand for lumber building products which by the turn of the century resulted in extensive timber harvest in the more readily accessible segments of the watershed. Logging companies constructed railroad spurs that reached as far as the headwaters of Cedar Creek. Lower elevations of Badger Creek were heavily logged as well in these early days. The community of Sandy owes its development, in part, to this logging activity. Harvested and cleared lands were converted to managed tree farms, agricultural farm lands, or in some cases allowed to regenerate naturally.

Development of the transportation corridor in the watershed may be the single most influential trend of human development in the watershed. The Barlow Road was basically only a one-way east to west route that delivered pioneer emigrants to the Willamette Valley. The growth of the agricultural economy east of the Cascades created the necessity for a road that could be used for both directions of travel. By the late 1800s, the Barlow Road was improved to accept travel in both directions and the use increased. Entrepreneurs recognized the market created by these travelers and developed accommodations and services along the road. Late arriving settlers eager to find land to settle established homesteads along the road. Those responsible for siting a Forest Service Ranger Station recognized the critical nature of this transportation corridor and identified the proximity to the Barlow Road a selection criteria for selecting the location of the Zigzag Ranger Station in 1907.

The Oregon National Forest was created in 1907 which later became the Mt. Hood National Forest in 1924. Forest management priorities stressed fire suppression and administration of grazing permits. Reforestation was done in earnest of both harvested areas and burns.

The demand for recreation opportunities by the growing population resulted in the completion of the Mt. Hood Loop Highway by the 1920s. This road provided a much improved access to the watershed. Improved access first led to the development of expanded recreation opportunities and recreation cabins and summer homes. As the highway continued to be improved, recreation residents were gradually replaced by permanent residents willing to commute daily and the human population in the watershed continued to grow.

The efforts of the Civilian Conservation Corps (CCC) and the Works Progress Administration (WPA) during the Depression-era of the 1930's had significant impact on the forest landscape. Campgrounds and trails were constructed as well as administration compounds and lookouts. Fire suppression methods were developed that resembled military actions.

The watershed was subject to the effects of the increased timber harvest levels on Federally managed lands following World War II just as in other watersheds of the Pacific Northwest. This level of harvest continued until recently and its effect is evident on a landscape scale. The recent reduced harvest levels on Federally managed lands has resulted in an increased harvest level of privately owned timberlands in the watershed.

Barlow Road

Within Forest Service managed lands in the watershed, there is only one extant trace of the historic Barlow Road near Marmot. There is documentary evidence that an early route passed through the Zigzag Ranger Station compound , but no physical evidence remains.

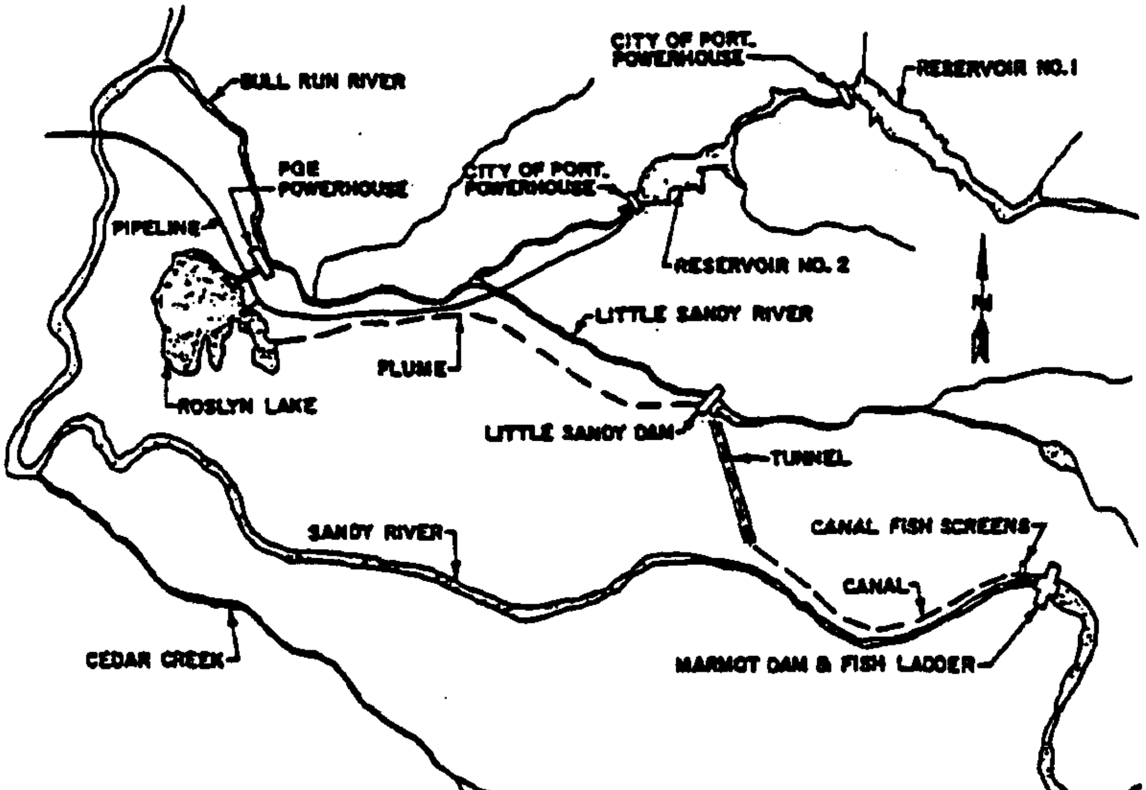
The Clackamas County Plan, (Barlow Road Historic Corridor Background Report and Management Plan, 1993), identifies other segments as highly significant and eligible for inclusion on the National Register of Historic Places. These include Rock Corral and Barlow Road South Alternate (Wildwood entrance) which are on BLM lands and the Devils Backbone segment near Marmot.

The Clackamas County Plan includes a number of management recommendations. Of particular interest is the recommendation that the viewshed be maintained as an open rural setting, with the exception of the already existing high density residential developments. The scenic views along Marmot Road overlooking the Sandy River and the foothills of the Cascades are identified as particularly significant.

Bull Run Hydroelectric Project

In 1907 the Forest Service issued the Mt. Hood Railway and Power Company a "special privilege agreement" for operation of the Bull Run Hydroelectric Project. The agreement allowed construction of a conduit to transport water diverted from the Little Sandy River to a power plant for operation of the company's electric railroad. The company eventually merged with a predecessor of the Portland General Electric Corporation (PGE), which now maintains the hydroelectric project's facilities and operation. Initial power generation began on September 22, 1912 using Little Sandy River water. Construction of the Sandy River diversion dam, canals, and tunnels was not completed until April 30, 1913 (PGE, 1995).

Today, and as originally designed, flows are diverted on the Sandy River at Marmot Dam. This diverted water then flows through a complex series of concrete canals and lengthy tunnels toward the Little Sandy Dam on the Little Sandy River. Sandy River water is then combined with water in the Little Sandy River for a short distance after which both river flows are diverted into a wooden box flume. The diverted water flows for three miles in this wood-box flume before it discharges in Lake Roslyn. From Lake Roslyn, water flows to the Bull Run Powerhouse and into the Bull Run River. In addition, surplus water has been purchased from the City of Portland since 1958. This water is diverted from Bull Run reservoirs into Roslyn Lake adding additional power generation.



BULL RUN PROJECT

On average, the annual power generation from the Bull Run Project is enough to supply the electric needs of more than 8,000 average PGE households for an entire year. The Federal Energy Regulatory Commission, FERC, reissued license for the Bull Run Project on May 23, 1980 for a period of 30 years, expiring November 16, 2004.

Lake Roslyn has become a popular site for group picnics, swimming, boating, and fishing. Recreation facilities at the lake, which date from 1956, have been periodically improved to meet growing public demands.

Cultural Heritage

Evidence of the watershed's history can still be found in its existing cultural resources.

Lookouts were constructed across the watershed to help detect wildfire. The Bald Mountain Lookout was constructed in the 1930's with remains existing today. The historic Hickman Butte Lookout was constructed in 1931. The current lookout, which is still seasonally staffed, was constructed in 1952. The North Mountain Lookout was constructed in 1933. It was determined to be ineligible for inclusion on the National Register of Historic Places (NRHP) and in 1994, all that was left standing was the outhouse.

The Zigzag Ranger Station compound dates to 1907 when the site was selected for a location of a Ranger's headquarters. R.S. Shelley was given the assignment to find the best location for the Ranger Headquarters of the Bull Run Ranger District of the newly named Oregon National Forest. At the time, a major trail crossed Lolo Pass and joined the Barlow Road near the confluences of the Zigzag, Sandy and Salmon Rivers. It was with great foresight that Shelley selected this site to best serve the public given its location on both the Barlow Road and the Lolo Pass.

Much of the current Zigzag Ranger Station compound and many of its individual structures were constructed by the Civilian Conservation Corps during the 1930s. The Zigzag Ranger Station was placed on the National Register of Historic Places on April 8, 1986. The historical significance of the Station was identified as its architecture, its role in the administrative history of the Forest Service, its role in the recreation history of Oregon, and its association with the historic Barlow Road.

The Upper Sandy Guard Station was constructed in 1935 by the Forest Service with cooperating funds from the City of Portland. The objective was to provide housing for a Bull Run watershed guard. The Timberline Trail had just been completed and provided access into what was then part of the City of Portland watershed preserve. Prior to this trail, the area had limited access. The watershed guard was to ensure that users of the trail stay on the trail and not degrade water resources. A draft determination concludes the cabin is eligible for inclusion on the NRHP.

Current Zoning and Tax lots

The Clackamas County Comprehensive Plan of June 1992 is a planning guide for the next twenty years. As an official policy statement of the County, the Plan directs future decisions on land use actions, ordinance amendments, zone changes, capital expenditures, procedures and programs (Board of County Commissioners, 1992). Reviews and revisions of this plan are to occur every five years.

An additional Mt. Hood Community Plan (1976) recognizes the unique character of the Mt. Hood Area. It states that the economy of the community is dependent upon the conservation of the environment, which creates the setting so attractive to both residents and visitors. These two plans provide guidelines so that development potential is consistent with the need for environmental conservation.

Some findings of these plans in relation to the watershed are as follows:

- Clackamas County is an area of rapid growth, urbanization pressures, and diverse rural activities.
- The county's economy was traditionally dominated by natural resource-oriented industry, but has become increasingly diversified, especially in the urban area.
- Half of the county's residents commute out of the county to work.
- The county's economy was traditionally dominated by natural resource-oriented industry, but has become increasingly diversified, especially in the urban area.
- Timber-related employment declined substantially in the 1980s and is expected to remain relatively low because of increasing productivity and the limited timber supply.
- Decline in natural-resource related employment could be offset somewhat by improved management in some classes of timber lands, fully processing timber materials now considered waste, and increased secondary processing of wood products.

Zoning

Zoning assigns various land use designations (agricultural, residential, commercial) to particular geographical areas, describes the uses permitted, and establishes certain development and criteria and standards (lot sizes, setbacks, parking requirements, etc.)

Zoning districts are consistent with state, regional and County goals. Forest Service land allocations and management plans are applied to the Mt. Hood National Forest lands.

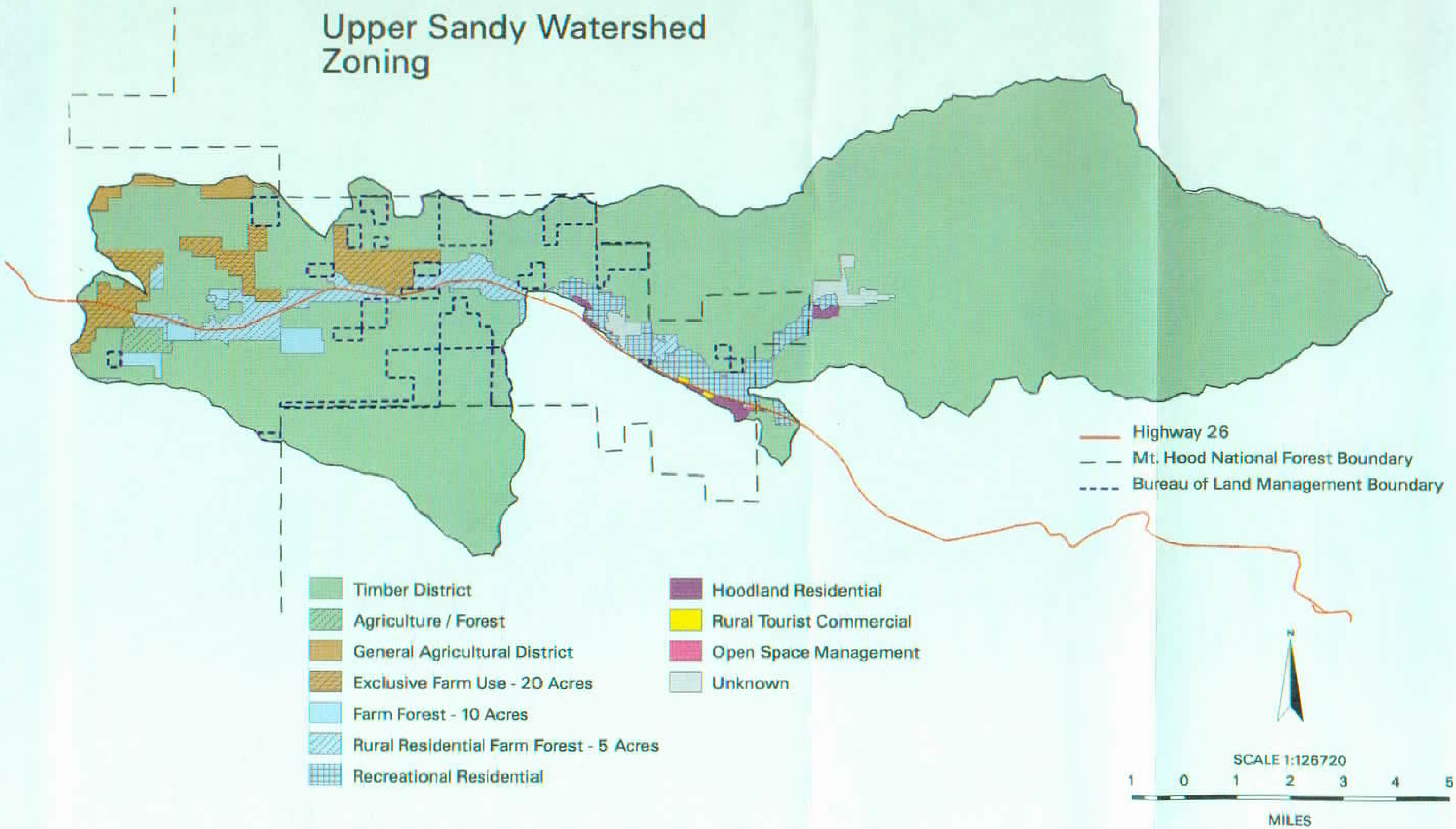
Non-urban zoning designations are divided into four categories:

- **Rural Centers** recognize and protect communities which provide commercial and industrial services to surrounding rural areas.
- **Rural** lands are designated to perpetuate the rural atmosphere and are suitable for sparse settlement, small farms or acreage home sites.
- **Agricultural** lands are suitable for farm use due to soil fertility, suitability for grazing, potential for irrigation, land use patterns, or are necessary to permit farming to be undertaken on nearby lands. Housing is not a use permitted outright.
- **Forest** lands are lands which are suitable for commercial forest uses and other forested lands needed for watershed protection, wildlife and fish habitat, recreational uses and scenic corridors. Housing is not a use permitted outright.

Zoning designations within the Upper Sandy Watershed are displayed in Table 4-1 Zoning Designations and Figure 4-1 Clackamas County Zoning. These figures were received from a GIS layer from Clackamas County. Federal forest lands are included in the category Timber District, but as mentioned above - follow federal land allocations.

Table 4-1 Zoning Designations

Zone	Sum of Acres
Timber District (Forest)	58,771
Exclusive Farm Use - 20 acres	2,327
Rural Residential Farm Forest - 5 acres	2,159
Recreational Residential < 2 acre parcels	1,759
Farm Forest - 10 acres	538
General Agricultural District - 20 acres or larger	415
Agricultural/Forest 20 acres or larger	267
Hoodland Residential - maximum density of 4 units/acre	237
Rural Tourist Commercial	42
Open Space Management	12
Unknown	504


Upper Sandy Watershed
Zoning
Highway 26
Mt. Hood National Forest Boundary
Bureau of Land Management Boundary
Timber District
Agriculture / Forest
General Agricultural District
Exclusive Farm Use - 20 Acres
Farm Forest - 10 Acres
Rural Residential Farm Forest - 5 Acres
Recreational Residential
Hoodland Residential
Rural Tourist Commercial
Open Space Management
Unknown
N
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MILES

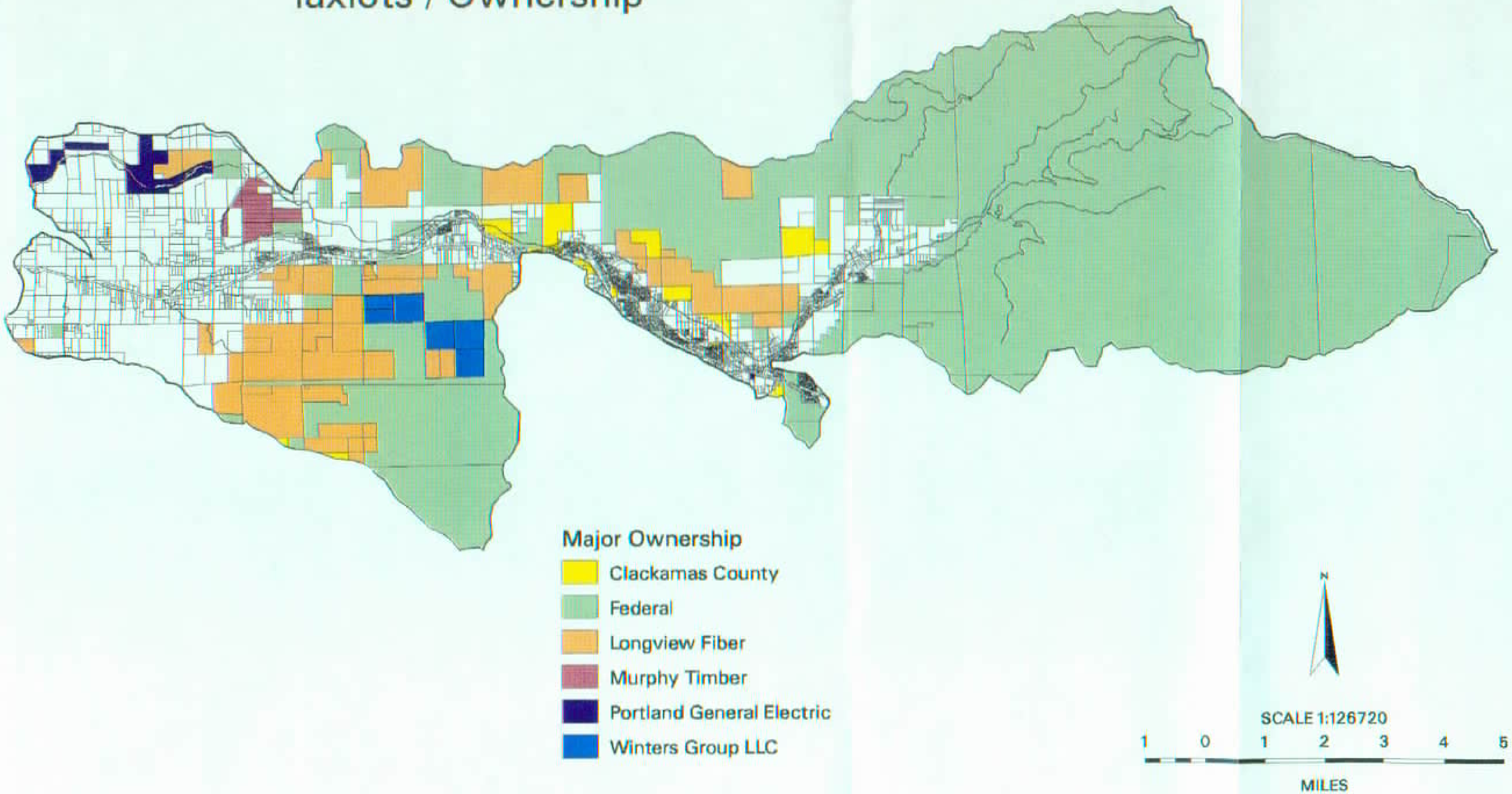
As displayed, the vast majority of the watershed, 88%, is zoned in Timber District (Forest). Of the 58,771 acres, approximately 41,000 are in federal ownership and therefore subject to Forest Service and BLM land allocations. The remaining 18,000 acres of Timber District zoned lands are non-federal ownership.

The remaining zoning designations allow for smaller parcels of land for agricultural and farm use, rural and recreational residences, and a small amount of rural tourist commercial. Five percent of the watershed is in zoning designations with minimum parcel size of ten or twenty acres or larger. Another six percent of the watershed is in zoning designations of five acres or less. The majority of these are in the Mt. Hood Corridor.

Tax lots

In addition to zoning, tax lots is another method to roughly assess how the landscape of the Upper Sandy Watershed has been divided Figure 4-2 Taxlots/Ownership very graphically displays the parceling of land within the watershed.

Upper Sandy Watershed
Taxlots / Ownership



Subwatersheds with a high density of small tax lots are displayed in Table 4-2. The Sandy River - Hackett subwatershed has over 2,400 tax lots with an average size of two acres.

Table 4-2 High Density Subwatersheds

Subwatershed	Acres	# of tax lots	Avg. tax lot size (acres)
Badger Creek	5,183	390	13
Sandy River - Brightwood	1,565	133	12
Sandy River - Hackett	4,454	2,450	2
Sandy River - Mensinger	4,644	495	9
Sandy River - Wildcat	4,712	436	11
Upper Sandy River	6,989	570	12

Population Trends

By 2017, Metro expects 497,00 more people to live in the three-county region (Multnomah, Washington, and Clackamas counties) than currently. Today there are about 131,000 more people living in the three-county region than there were five years ago. The rate of growth equates to 75 additional people every day. Or, as Metro likes to say, "We'll have 75 more people here by dinnertime than we had at breakfast." (Metro 2040 Planning , Fall 1996).

The Bureau of Population Research and Census at Portland State University states that the three counties grew by 20,600 people in 1995-96. Howard Wineberg, of the Bureau, projects that the Portland area will grow by about 20,000 a year for the next 5 to 15 years. Oregon's population as a whole grew by an estimated 49,000 people in 1996, with the three county area accounting for 40 percent of the increase. These increases, however, are substantially less than the first three years of the 1990s when Oregon's population increased by about 60,000 per year. According to Wineberg, the population change in Oregon appears to have stabilized at about 48,000 per year. Yet the migration to Oregon could drop sharply if the economy weakens or if California's economy performs better than Oregon's.

Closer to the watershed, 1990 Census data show a 9 percent population increase from 1980 in the Mt. Hood Corridor area. During this decade, a 41 percent increase in housing units also occurred inside the corridor. A high "quality of life", a temperate climate, and numerous job opportunities in the Portland Metropolitan area led to this substantial population increase. Between 1970 and 1980 Clackamas County grew by 45.7 percent, while the City of Sandy, near the western boundary of the watershed, experienced an 88.1 percent increase in population (Oregon Employment Division, 1992).

A severe recession in 1981-1982 brought about a decline in the annual rate of population growth as compared to the 1970's. This recession was cyclical in nature, the result of a business downturn which left an inadequate demand for workers in the economy. Between 1980 and 1990 Clackamas County expanded by 15.3 percent, while the City of Sandy expanded by 42.9 percent. Population trends returned to pre-recession patterns in the late 1980's as a result of Portland's strong economy in 1988-1990 (Oregon Employment Division, 1990).

Geology

The age of geologic surfaces and the mechanisms of their formation are the basis of landforms and processes seen today in the watershed. The watershed is dominated by Tertiary (3 - 65 million years before present) and Quaternary (0-3 million years before present) volcanic andesites, basalts and tuff breccias. The upper watershed has been and continues to be altered by glaciers. The Rhododendron formation is the most extensive unit, comprising over 12,000 acres along midslopes from the mouth of the Clear Fork westward through the watershed. The upper and lower members of the Sardine formation dominate the slopes below Wildcat mountain in the Alder, Cedar and Badger subwatersheds. Basalts and andesites cap the ridges forming the northern and southern watershed boundaries in the eastern portion of the watershed. The individual geologic units found in the watershed are described in more detail below.

Sandy River Lahars

Within the last 10,000 years, three significant periods of eruption from Crater Rock on Mt. Hood have produced volcanic mudflows (lahars). Mudflow deposits form these eruptive periods are still visible within the watershed.

The Timberline eruptive period occurred between 1400 and 1800 years before present and produced mudflows that traveled the length of the Sandy river to its confluence with the Columbia. The Zigzag eruptive period took place 400-600 years before present. Zigzag age deposits are found in a small area of Old Maids Flat. The Old Maid eruptive period delivered coarse sands down the Sandy river to the Columbia between 200 and 300 years before present. Old Maid Age deposits form a veneer on the surface of the Timberline age mudflows.

The Sandy river lahars filled the Sandy river valley with coarse sandy deposits ranging from a few to several tens of feet thick, and buried the old growth forests along the river. The Old Maid Flats area contains deposits from the three recent eruptive periods and is a contemporary reminder of the volcanic nature of Mt. Hood. The mudflow deposits in Old Maid Flat are a mix of sand, gravel boulders and cobbles. Soils are young and poorly developed. The vegetation on Old Maid Flats reflects the droughty and nutrient limited nature of these deposits.

Glaciation

The Sandy River begins high on the west slopes of Mt. Hood, fed by the Sandy glacier. Three major tributaries to the upper Sandy River originate from neighboring glaciers. Lost Creek and Rushing Water Creek drain part of the Zigzag Glacier, just south of the Reid Glacier, and the Muddy Fork drains the Sandy Glacier in the next valley north of the Ried Glacier.

The present glaciers are small remnants of the ice tongues of the 15,000 years ago that joined the upper Sandy River valley and advanced to the Horseshoe Ridge area. In the previous ice ages, about 100,000 years ago, the glacial ice advanced southwest to the Zigzag River valley and continued as far as Brightwood. The Sandy River valley side slopes east of Horseshoe Ridge are steeper and have a sharper slope break where they meet the valley floor than the valley sideslopes to the west of Horseshoe Ridge, reflecting the age difference of the glacial erosion that occurred there. West of Horseshoe Ridge, several large, ancient landslides that occurred after the older glaciation have changed the appearance of the valley walls considerably and have narrowed the valley floor.

Within the last several hundred years the Reid, Sandy and Zigzag Glaciers have advanced and retreated short distances several times. At present, the glaciers seem to be in a period of retreat. The Zigzag Glacier within the Sandy River watershed may have extended down to about 6900 feet. The Sandy and Reid Glaciers may have reached about 5800 feet.

Geologic Units

The analysis area represents a junction of the Western Cascade and High Cascade geologic provinces. The young, glaciated upper slopes and valley walls below Mt. Hood break to the more recent mudflow deposits of the upper Sandy River valley. The ridgetops of the eastern portion of the watershed are capped by older (Tertiary) basalts and andesites. On the midslopes below these ridges are old and weak andesitic tuffs and breccias of the Rhododendron formation. The Rhododendron formation is the single largest geologic unit within the watershed. Approximately 2 miles east of North Mountain, ridge capping basalt gives way to the Rhododendron formation. The geology south of the Sandy river in the western portion of the analysis area is dominated by the deeply weathered andesitic tuff breccias and andesitic lava flows of the Sardine formation. The valley bottoms throughout the watershed are forming in mudflow deposits and alluvium.

Overall, there are 31 geologic units identified during mapping by Meyer, (1979), Schliker and Finlayson (1979), Sherrod (unpublished, 1985), and Sherrod and

Scott (unpublished, 1995). The geologic unit descriptions are summarized in the analysis file.

Hillslope Geomorphology

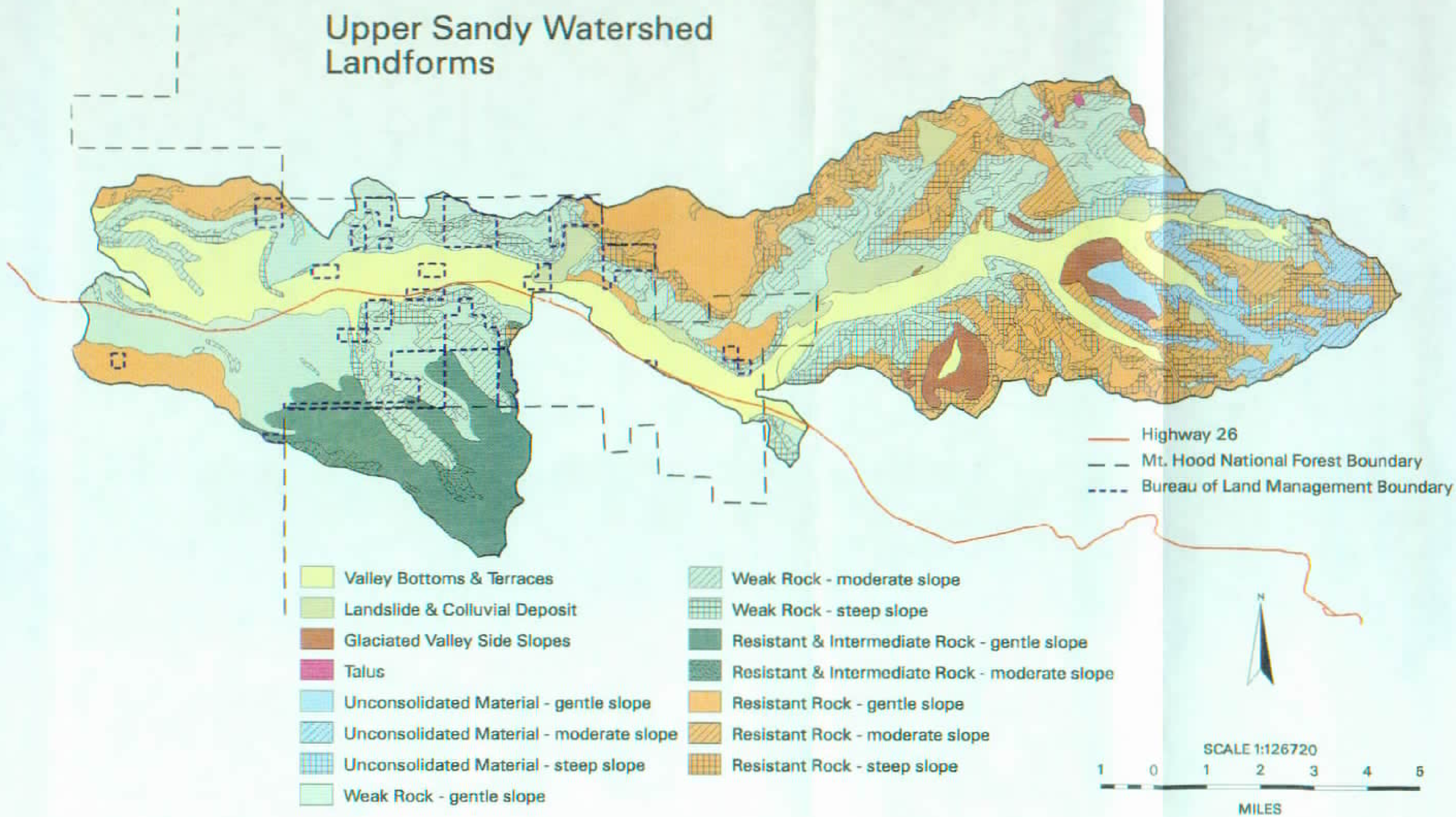
Landforms

For analysis purposes, the geologic units were broadly grouped into fourteen landform types based on resistance to weathering, slope angle, drainage density and susceptibility to landsliding. The grouping facilitates analysis based on similar geologic features. The landform types are listed in Table 4-3 below.

Table 4-3 Landform Characterstics

LANDFORM UNIT	GEOLOGIC TYPE	PHYSICAL CHARACTERISTICS
Resistant rock steep slopes (RRSS)	Fine-grained basalt and basaltic andesite flows, slightly porphyritic Lava with minor flow breccia, basaltic and andesitic / dioritic intrusions	Slope angles typically exceed 50%. Found on ridgetops and upper slope positions above 3000 feet elevation in the eastern half of the watershed.
Resistant rock moderate slopes (RRMS)	Fine-grained basalt and basaltic andesite flows, slightly porphyritic lava with minor flow breccia, basaltic and andesitic / dioritic intrusions	Slopes range form 3~50%. Generally found on shoulder slopes and in headwalls above 2500 feet elevation in the eastern half of the watershed.
Resistant rock gentle slopes (RRGS)	Fine-grained basalt and basaltic andesite flows, slightly porphyritic lava with minor flow breccia, basaltic and andesitic / dioritic intrusions	Slopes range from 0-25%. Found on hillslopes below Devils Backbone, Lenhart Butte, North Mountain and scattered uplands in the upper and midslope positions of the western portion of the watershed.
Resistant and Intermediate Rock moderate slopes (RIRMS)	Fine-grained basalt and basaltic andesite flows, slightly porphyritic lava with minor flow breccia, basaltic and andesitic / dioritic intrusions; pyroxene andesite lava flow;	Slopes range from 30-50%. Located on sideslopes of Cedar creek above 2000 feet elevation and in the headwaters of Alder Creek.
Resistant and Intermediate Rock gentle slopes (RIRGS)	Fine-grained basalt and basaltic andesite flows, slightly porphyritic lava with minor flow breccia, basaltic and andesitic / dioritic intrusions; pyroxene andesite lava flows Andesitic tuff breccia, fluvial volcaniclastic sandstone and minor siltstone;	Slopes range from 0-25%. Located in the uplands west of McIntyre ridge above 2000 ft. elevation in the upper portions of the Cedar and Alder creek drainages.
Weak rock steep slopes (WRSS)	Andesitic tuff breccia, fluvial volcaniclastic sandstone and minor siltstone;	Slope angles typically exceed 50%. Generally found on shoulder slopes below Yocum ridge, Clear Fork Butte, Last Chance and Zigzag mountains and sideslopes of Alder, Wildcat creeks and the lower Sandy river.
Weak rock moderate slopes (WRMS)	Andesitic tuff breccia, fluvial volcaniclastic sandstone and minor siltstone;	Slopes range form 30-50%. Generally found on sideslopes in the eastern half of the watershed and sideslopes of Clear creek and the Clear Fork / Lolo pass area.
Weak rock gentle slopes (WRGS)	Andesitic tuff breccia, fluvial volcaniclastic sandstone and minor siltstone;	Slopes range from 0-25%. G~nerally found on lower slope positions in the eastern half of the watershed and on sideslopes of Clear creek and

LANDFORM UNIT	GEOLOGIC TYPE	PHYSICAL CHARACTERISTICS
		in the Clear Fork / Lolo Pass area.
Unconsolidated material steep slopes (UMSS)	Poorly-sorted dacite pebbles, cobbles, and boulders in sand matrix with silt and fine sand interbeds; may include deposits of hydrothermally altered material;	Slope angles typically exceed 50%. Found in headwalls and upper slope positions (generally above 3200 feet elevation) in the eastern portion of the watershed on the flanks of Mt. Hood.
Unconsolidated material moderate slopes (UMMS)	Poorly-sorted dacite pebbles, cobbles, and boulders in sand matrix with silt and fine sand interbeds; may include deposits of hydrothermally altered material;	Slopes range form 30-50%. Found in headwalls and upper slope positions (generally above 3200 feet elevation) in the eastern portion of the watershed on the flanks of Mt. Hood.
Unconsolidated material gentle slopes (UMGS)	Poorly-sorted dacite pebbles, cobbles, and boulders in sand matrix with silt and fine sand interbeds; may include deposits of hydrothermally altered material;	Slopes range from 0-25%. Located on subalpine uplands near the flanks of Mt. Hood.
Valley Bottom Terraces (VBT)	Generally poorly sorted deposits of sand, gravel, and re-worked ash;	The most prominent landform in the watershed, follows the gently sloping valley bottoms of Lost Creek, Old Maid Flat and the mainstem of the Sandy river.
Landslide and Colluvial Deposits (LCD)	Poorly sorted deposits of slumps and large debris slides; may also include ancient debris flow channels that have not recurred in the historical record;	Generally located on south facing valley walls in the North Boulder, Hackett creek upper Clear Creek and Muddy Fork drainages. Also found along toeslopes and sideslopes at the confluence of Clear creek and the mainstem of the Sandy.
Glaciated Valley Side Slopes (GVSS)	Generally unsorted compacted deposits of detritus, from silt to boulder sized material;	Slope angles typically exceed 50%. Located in the headwaters of Horseshoe creek, and upper slope positions in Lost creek as well as southwesterly slopes of Last Chance mountain
Talus (TAL)	Blocky to platy, coarse-grained detritus; typically forms aprons beneath steep rock outcrop	Located on moderately sloping, south facing hillsides below Hiyu mountain.


Upper Sandy Watershed
Landforms
Highway 26
Mt. Hood National Forest Boundary
Bureau of Land Management Boundary
Valley Bottoms & Terraces
Landslide & Colluvial Deposit
Glaciated Valley Side Slopes
Talus
Unconsolidated Material - gentle slope
Unconsolidated Material - moderate slope
Unconsolidated Material - steep slope
Weak Rock - gentle slope
Weak Rock - moderate slope
Weak Rock - steep slope
Resistant & Intermediate Rock - gentle slope
Resistant & Intermediate Rock - moderate slope
Resistant Rock - gentle slope
Resistant Rock - moderate slope
Resistant Rock - steep slope
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MILES

Landslide Potential

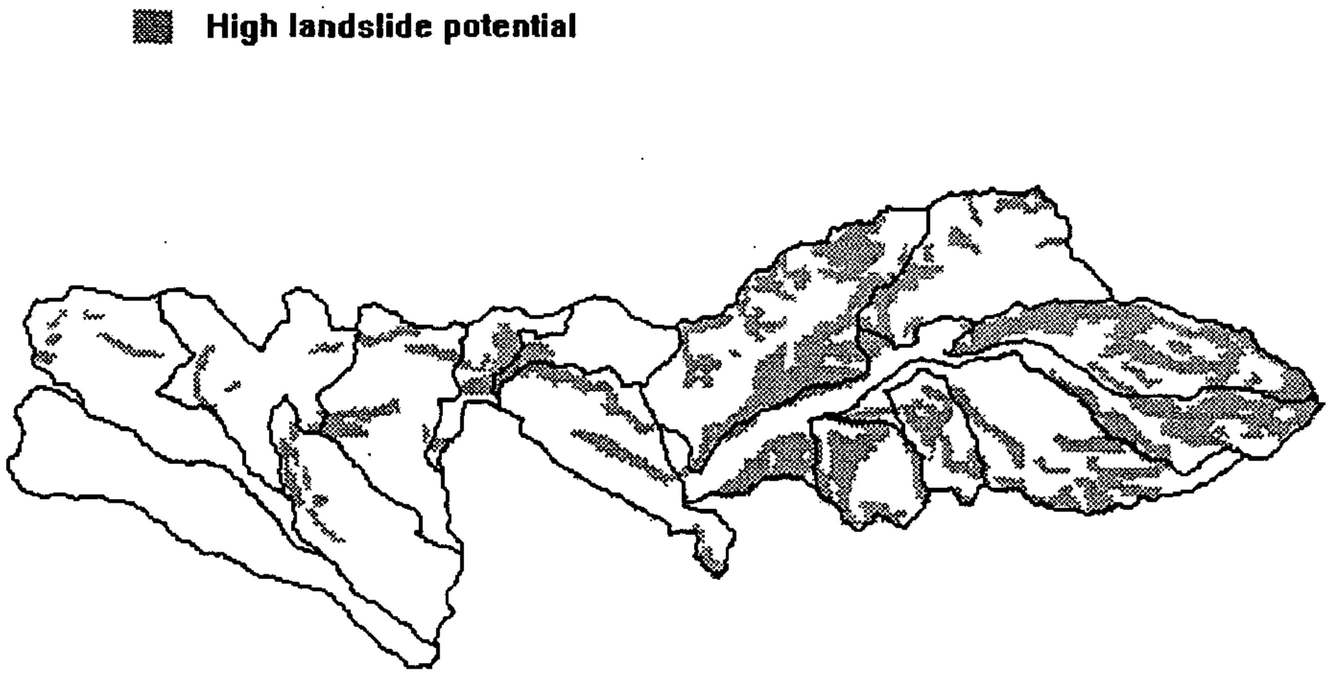
The fourteen landform types are qualitatively rated (high, moderate, low), as to their relative potential for the two major types of landsliding: shallow planar landslides, such as debris flows and debris slides; and deeper landslides, such as slumps and earthflows. These ratings are based on personal knowledge of the watershed, a landslide inventory of the watershed, and studies made by Beaulieu (1974) and Schulz (1980) in the neighboring Bull Run River watershed.

During an aerial photo inventory of landslides in the watershed, debris flows were by far the most common landslide feature identified. From field work conducted in adjacent watersheds, stream bank failures and inner gorge failures appear to be vastly under-represented in the landslide inventory. Stream bank failures and inner gorge failures may actually be the most common type of landslide in the area. Stream bank failures tend to be small and are often concealed by riparian vegetation. They are therefore, difficult to detect on aerial photographs. In addition while debris flows and debris slides tend to have return intervals of a few years to a few decades, stream bank failures have much shorter return intervals, and may account for a majority of the sediment delivered to streams by landslides.

Table 4-4 Landslide Potential

LANDFORM UNIT	PERCENT OF WATERSHED	DEBRI SLIDE / DEBRIS FLOW POTENTIAL	SLUMP / EARTHFLOW POTENTIAL
Resistant Rock Steep Slopes	8	HIGH	LOW
Resistant and Intermediate Rock Moderate Slopes	<1	MODERATE	LOW
Resistant and Intermediate Rock Gentle Slopes:	7	LOW	LOW
Weak Rock Steep Slopes	7	HIGH	HIGH
Weak Rock Moderate Slopes	14	MODERATE	HIGH
Weak Rock Gentle Slopes	16	LOW	LOW
Valley Bottoms and Terraces	16	MODERATE	MODERATE
Glaciated Valley Side Slopes	2	MODERATE	MODERATE
Landslide and Colluvial Deposits	3	HIGH	HIGH
Unconsolidated Material Steep Slopes	1	HIGH	LOW
Unconsolidated Material Moderate Slopes	3	MODERATE	LOW
Unconsolidated Material Gentle Slopes	2	LOW	LOW

Figure 4-4 High Landslide Potential -- Upper Sandy Watershed.



The Upper Sandy watershed is characterized by a generally low landslide frequency. As Figure 4-4 illustrates, areas of high landslide potential are concentrated in the steeply sloping, upper reaches of the watershed. The more stable subwatersheds are Cedar, Badger, and Alder creeks and Sandy River, Messinger subwatersheds. High landslide potential by subwatershed is summarized in Table 4-5.

Table 4-5 High Landslide Potential by Subwatershed

SUBWATERSHED	SUBWATERSHED ACRES	HIGH LANDSLIDE POTENTIAL ACRES	HIGH LANDSLIDE POTENTIAL PERCENT OF SUBWATERSHED
Alder Creek	4,602	215	5
Badger Creek	5,185	173	3
Cast Creek	1,731	479	28
Cedar Creek	6,417	00	0
Clear Creek	7,496	2,680	36
Clear Fork	5,162	379	13
Horseshoe Creek	2,263	1,689	75
Lost Creek	5,701	1,672	29
Muddy Fork	4,851	2,193	45
North Boulder Creek	2,023	193	10
Sandy River Bridge	1,559	405	26
Sandy River, Hacked	4,458	682	15
Sandy River, Messinger	4,651	163	4
Sandy River, Wildcat	4,708	474	10
Upper Sandy River	7,010	2,645	38

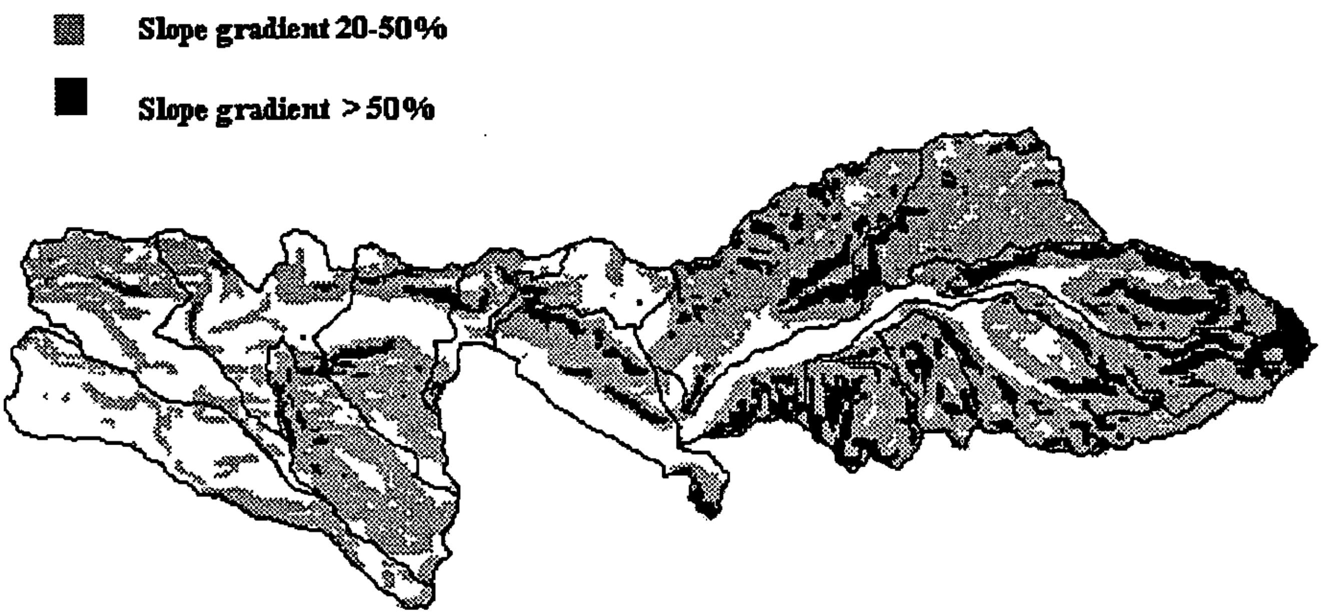
Landform mapping is also useful to compare relative stability between watersheds. Table 4-6 compares the landslide potential of the Upper Sandy watershed to other watersheds m the Sandy basin. Figure 4-5 is similar to the landform maps produced for other watersheds of the Mt. Hood National Forest. The polygon types represent areas of approximately equal mass wasting potential and sediment delivery potential. This methodology enables comparison within and between watersheds on the forest.

Table 4-6 Landslide potential of Sandy Basin Watersheds (percent by watershed)

WATERSHED	HIGH	MODERATE	LOW
Upper Sandy	21%	19%	53%
Bull Run / Little Sandy	17%	27%	55%
Salmon River	62%	18%	20%
Zigzag River	20%	35%	45%

Cross reference illustrates the slope classes in the watershed. Steep slopes (those greater than 50% gradient) encompass 13 percent of the entire watershed area. Slopes less than 50% dominate, comprising 87% of the watershed area.

Figure 4-5 Slope gradient



Sediment Production

Mass Wasting Potentially unstable hillslopes comprise approximately 20% of the watershed. The unstable lands are concentrated in steeply sloping, weak geologic units m the headwaters and midslopes of the upper watershed. In addition to geology and slope gradient, there are a number of additional conditions within the watershed that contribute to slope instability. These include but are not limited to:

- *contacts between weak rock and resistant rock on steep slopes*
- along stream banks and the inner gorge areas of steeply sloping landforms
- along the margins and scarps of Quaternary landslide deposits
- on slopes with gradients in excess of 60 % where shallow soils overlie less permeable materials

Surface Erosion

Surface erosion in forested watersheds has been attributed to exposed and compacted surfaces where mineral soil has been disturbed. Timber harvest, prescribed fire and road construction are common forest practices that can increase surface erosion rates in forested watersheds.

Field reconnaissance in the neighboring Bull Run Watershed by LaHusen (1994) found that stream channel processes were the dominant sources of sediment m the watershed. In the Bull Run watershed, roads and harvest units were not found to be large contributors to the sediment budget of the watershed. One exception noted by LaHusen were steep, unvegetated road cuts adjacent to stream crossings.

For the watershed analysis, the potential surface erosion from roads and recent timber was modeled. Methods used to evaluate the potential for altered surface erosion rates within the watershed closely follow those described in the Washington Forest Practices Board Manual: Standard Methodology for Conducting Watershed Analysis (DNR, 1993). Road erosion rates were calculated for road surfaces only. The location and extent of unvegetated road cuts was not available for this analysis.

Roads

Research on the effects of forest roads on surface erosion concludes that paving of roads effectively prevents sediment production from road surfaces (Reid and Dunne, 1994; Burroughs and King, 1989). The majority of roads in the watershed have some type of surface covering from aggregate to asphalt. Depending on the depth and quality of the aggregate surfacing, Burroughs and King (1989) found that aggregate surfacing can reduce erosion from roadbeds by up to 79%.

Table 4-7 summarizes the modeled rates of road surface erosion and transport within the watershed. Road miles and road densities are shown for federal roads only. Data was not available for all roads on non-federal lands within the watershed. A comparison of similarly modeled erosion rates for other watersheds m the basin follows in cross reference Table 0-6.

Table 4-7 Estimated Road Related Sediment Contribution

SUBWATERSHED	TOTAL ROAD MILES	ROAD DENSITY	MILES WITHIN 300 FEET OF STREAMS	ESTIMATED ROAD SEDIMENT (tons/year)
Alder Creek	17.97	2.5	4.90	38.00
Badger Creek	6.11	0.8	1.39	6.64
Cast Creek	1.43	0.5	.91	20.84
Cedar Creek	17.38	1.7	5.70	28.92
Clear Creek	22.02	1.9	11.53	110.08
Clear Fork	33.50	4.2	17.42	84.46
Horseshoe Creek	2.64	0.7	1.89	97.50
Lost Creek	8.21	0.9	2.42	31.14
Muddy Fork	.62	0.1	.13	.20
North Boulder Creek	6.06	1.9	1.20	2.35
Sandy River Bridge	9.25	3.8	2.41	8.50
Sandy River Hackett	14.42	2.1	4.34	11.19
Sandy River Messinger	13.63	1.9	3.93	15.21
Sandy River Wildcat	23.29	3.2	6.89	41.70
Upper Sandy River	41.24	1.4	5.93	79.00
WATERSHED TOTAL	445.42	1.8	70.98	575.73

Table 4-8 Sandy Basin Road Erosion

WATERSHED	ACRES	TOTAL ROAD MILES	MILES WITHIN 300 FEET OF STREAMS	ROAD SEDIMENT (tons / year)
Bull Run / Little Sandy	88,947	320.20	98.48	344
Salmon River	74,240	150.01	38.44	1832
Upper Sandy River	67,816	191.91	70.98	576
Zigzag River	37,730	80.01	34.78	1349

Harvest

Site recovery following disturbance to surface soils varies within the watershed. On the more productive sites, vegetative recovery is rapid, resulting in a one to two year potential for surface erosion following activities such as timber harvest or broadcast burning. In other areas, recovery of effective ground cover to prevent surface erosion may take up to 5 years. While forest practices may expose soil to erosive forces, the mechanisms of transport and delivery to stream channels must be engaged in order to affect water quality. Where vegetated buffer strips are left in place along stream channels, effective filtering of eroded material can limit impacts to water quality. Harvest adjacent to streams within the last 5 years was used to approximate erosion rates in Table 4-9. Even as calculated erosion rates from harvest units are low, this method likely over estimates sediment delivery to streams from harvest as it was not able to separate out harvest units that included some vegetated riparian buffers.

Table 4-9 Estimated Surface Erosion from Recent Timber Harvest

SUBWATERSHED	ACRES	EROSION (tons per year)
Alder Creek	37.05	9.3
Badger Creek	24.70	1.60
Cast Creek	0	0
Cedar Creek	7.41	.48
Clear Creek	0	0
Clear Fork	27.17	3.15
Horseshoe Creek	0	0
Lost Creek	14.82	2.41
Muddy Fork	17.29	3.60
North Boulder Creek	0	0
Sandy River Bridge	0	0
Sandy River Hackett	0	0
Sandy River Messinger	0	0
Sandy River Wildcat	0	0
Upper Sandy River	7.41	1.20
WATERSHED TOTAL	135.85	21.74

Table 4-10 Summary of Estimated Sediment Yield (tons / year)

SUBWATERSHED	HARVEST	ROADS	TOTAL
Alder Creek	9.30	38.00	47.30
Badger Creek	1.60	6.64	8.24
Cast Creek	0	20.84	20.84
Cedar Creek	.48	28.92	29.40
Clear Creek	0	110.08	110.08
Clear Fork	3.15	84.46	87.61
Horseshoe Creek	0	97.50	97.50
Lost Creek	2.41	31.14	33.55
Muddy Fork	.20	3.60	3.80
North Boulder Creek	0	2.35	2.35
Sandy River Bridge	0	8.50	8.50
Sandy River Hackett	0	11.19	11.19
Sandy River Messinger	0	15.21	15.21
Sandy River Wildcat	0	41.70	41.70
Upper Sandy River	0	79.00	80.20
WATERSHED TOTAL	21.74	575.73	597.47

Conclusions: Hillslope geomorphology

- Landform and hillslope stability vary throughout the watershed.
- The extent of unstable lands within the watershed is low (21%).
- Surface erosion from undisturbed forest lands is low.
- Erosion rates from disturbed forest lands is highest on unsurfaced roads on steep sideslopes within the watershed.
- Total erosion rates for powerline access roads were calculated for this analysis and are quite high. Data was not available to estimate delivery to streams.

Stream Geomorphology

Channel morphology and condition reflect the input of sediment, water, and wood to the channel, relative to the channel's ability to either transport or store these inputs (Sullivan et al., 1987). Systematic and local differences in transport capacity, coupled with the nature and magnitude of inputs through a channel network, result in a distribution of different channel types throughout a channel network. This reflects spatial differences in channel slope, flow, depth, sediment supply, and the availability of large woody debris. Because of these differences, certain channels are more or less sensitive to similar changes in these input factors (Washington Department of Natural Resources [DNR], 1993).

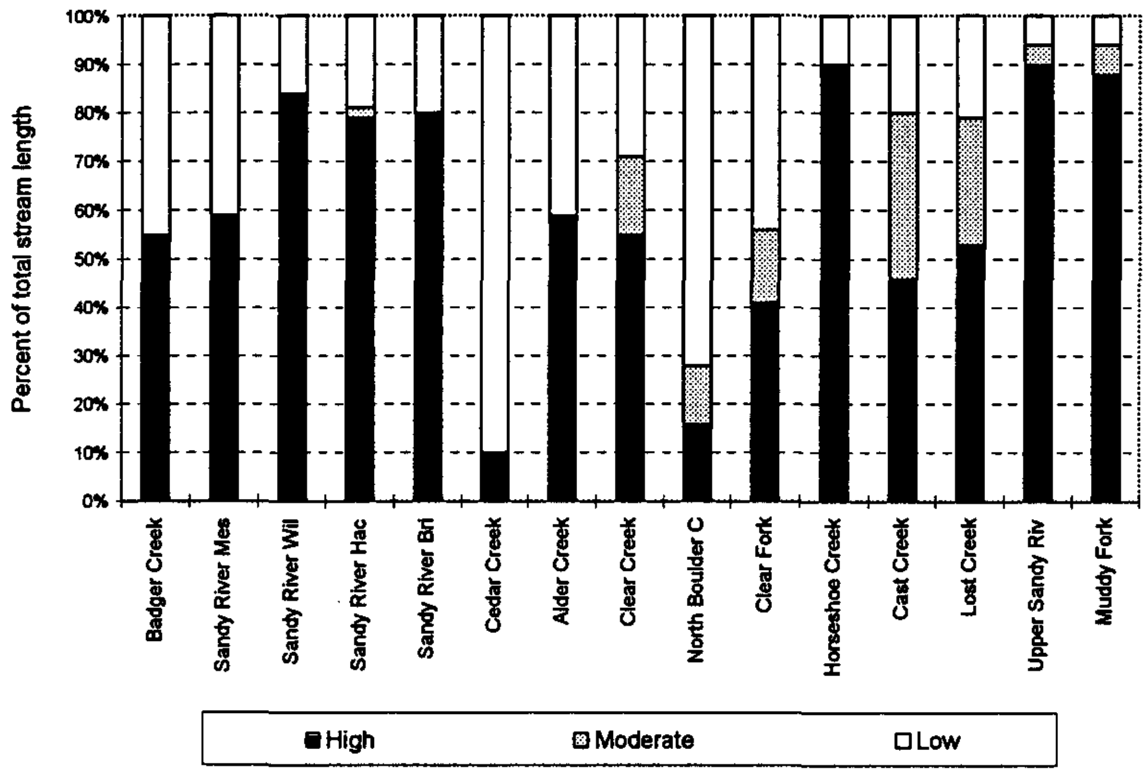
Stream Stability

To determine stream stability, the stream's layer was intersected with underlying geology. The combination of streams and associated geology was used to determine the stream stability with respect to in-stream erosional processes. This assessment includes all stream orders.

In a study completed by the U.S. Geological Survey that assessed variations in stream turbidity within the adjacent Bull Run Watershed (LaHusen 1994), it was determined that the most visible sites of erosion are stream channels, streambanks, and roadside ditches. For the Upper Sandy watershed this would be relevant in areas outside the influence of glacial silt.

Stream channels with high streambank or inner gorge failure potential are considered sensitive to disturbances associated with altered streamflows or sediment inputs.

Chart 4-1 Streambank and Inner Gorge Failure Potential



Upper Sandy Watershed
Stream Channel Stability

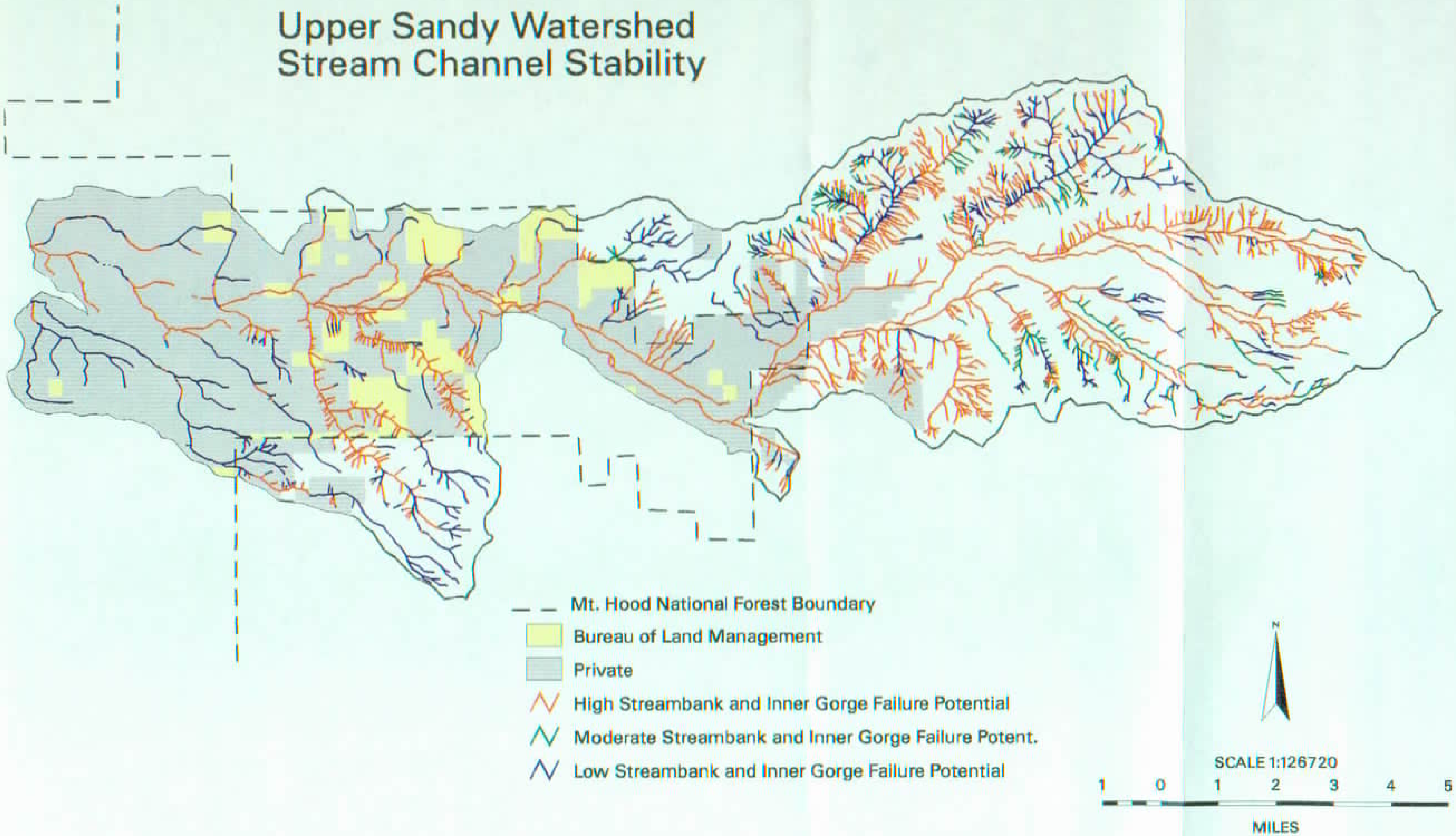
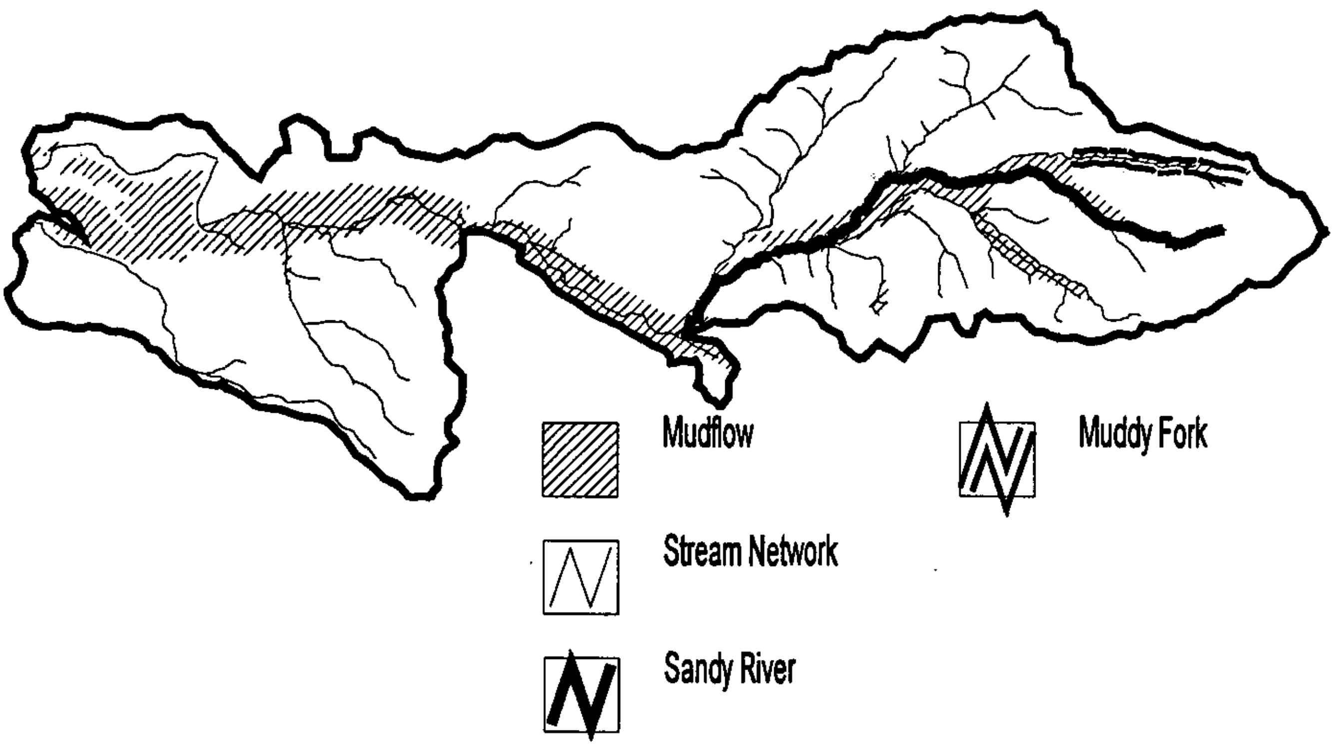


Chart 4-1 and Figure 4-6 identify a large portion of the streams in the Upper Sandy Watershed as having a high streambank and inner gorge failure potential. The high streambank and inner gorge failure potential is evident in the mudflow deposits that the Sandy River and Muddy Fork of the Sandy cut through from the headwaters throughout the watershed. Alder Creek subwatershed is influenced by the sardine formation lower units which is composed of deeply weathered andesitic lavas an indurated pyroclastics resulting in stream channels with high streambank and inner gorge failure potential.

There are two distinct processes present with stream channel stability within this watershed. Those areas within the mudflow deposits are subject to a chronic high level of sediment associated with small streambank failures and glacial silt from Ried and Sandy glaciers..

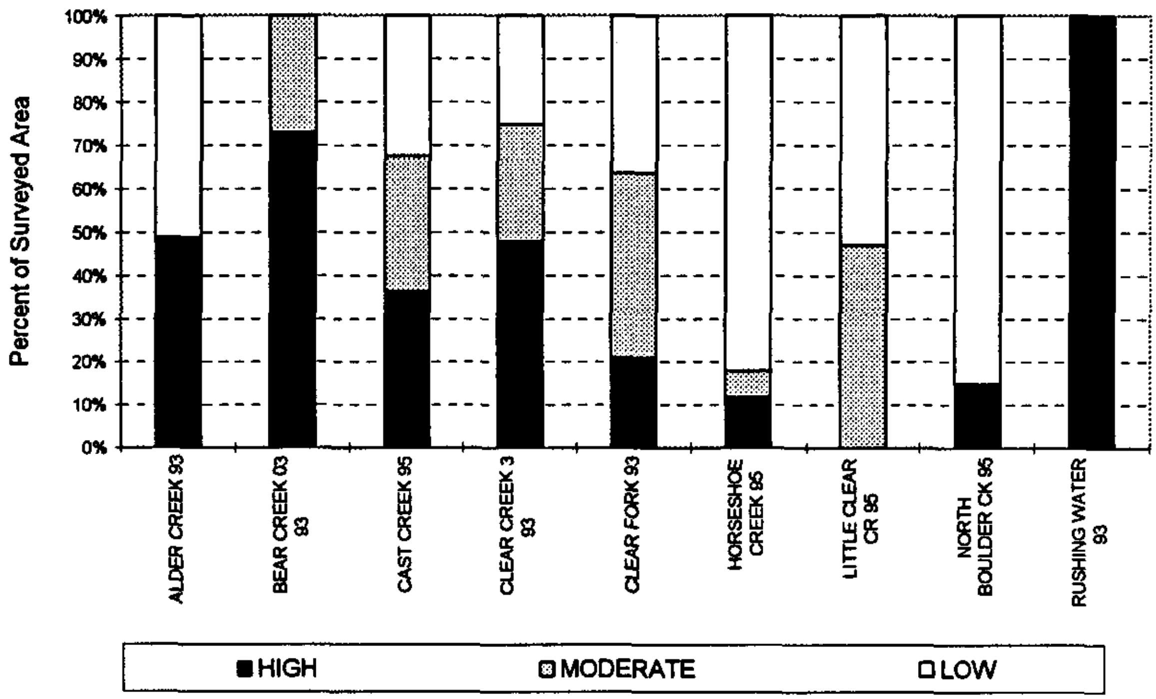
Figure 4-7 Mudflow Deposits



Areas of unstable streams outside of the mudflow are more likely to have pulses of activity triggered by flood events.

Rosgen (Rosgen, 1996) developed a channel classification system utilizing channel morphological indices in defining stream types. Rosgen stream types for the Upper Sandy Watershed were identified from stream surveys . By understanding these stream types, critical habitat and future restoration opportunities can be identified. This awareness of stream type sensitivity to management can also influence the width of Riparian Reserves.

Chart 4-2 Stream Channel Sensitivity to Disturbance (interpreted from field data and based on Rosgen channel classification)



The unstable stream channels are considered sensitive to disturbances associated with altered streamflows and to sediment inputs with the potential to alter in-stream erosional processes.

The sensitivity to disturbance displayed in Chart 4-2 applies to the channel that is identified on the chart and does not give an indication of the stability of the first and second order channels within the subwatershed, so classifications in Chart 4-2 and Chart 4-1 may not agree because the classification in Chart 4-1 considers all the streams within a subwatershed.

Within the upper watershed ephemeral streams may be 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.

Depositional Areas

Areas of unstable stream channels with the potential to generate sediment through streambank and streambed erosion have been identified. Any sediment generated in these areas has the potential to be routed downstream to depositional stream reaches, and to thereby affect water quality and aquatic habitat.

The Sandy River is noted for the the presence of fine suspended sediment associated with the glaciers on the Sandy and Muddy Fork rivers. The Muddy Fork, is aptly named and contributes a high proportion of suspended sediments as a result of bank erosion and landslides associated with steep, unstable volcanic mudflow deposits through which the river flows (Upper Sandy National Wild and Scenic River Environmental Assessment, 1993).

Depositional stream reaches are defined as areas with less than 2% channel gradient.

Figure 4-8 – Depositional Reaches

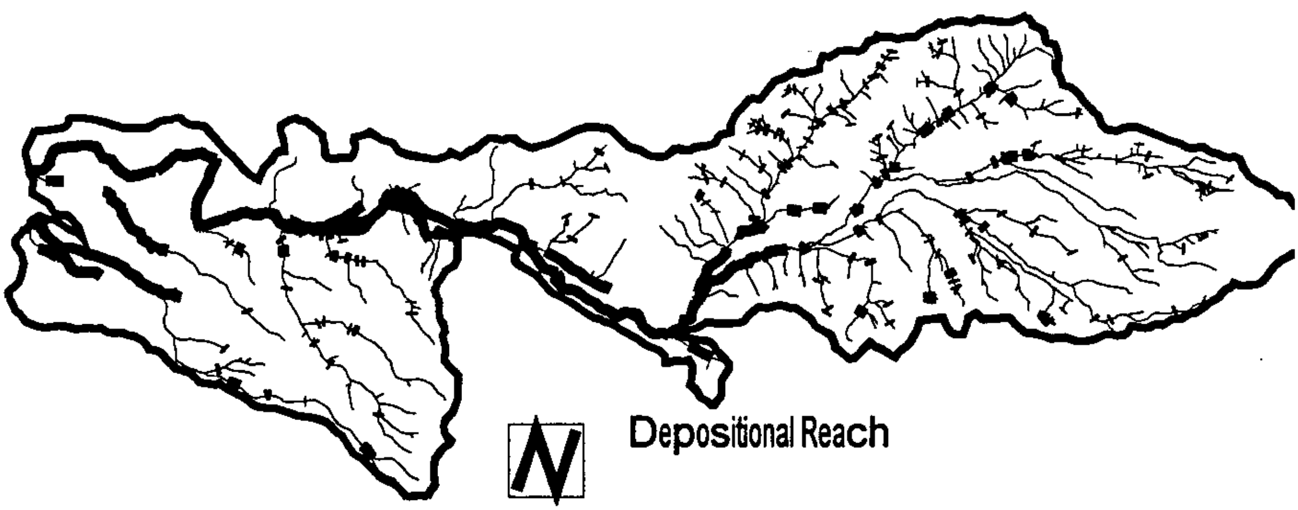


Figure 4-8 identifies depositional areas in the lower section of most of the major tributaries within the watershed. These same areas are habitat for anadromous fish.

Debris Torrents

Using the definition of a debris torrent as rapid movement of a large quantity of materials (wood and sediment) down a stream channel during storms or floods results in scouring of streambed there have been three debris torrents of significance (resulting in the loss of infrastructure or fish habitat) within the Upper Sandy Watershed in the last 10 years.

Two of the debris torrents have been in Clear Creek. In February 1986 there was a flood event which triggered a fill failure of Road 1820 near the Bull Run Watershed Management Unit boundary. This debris torrent resulted in channel scour in the lower sections of Clear Creek. The second debris torrent occurred in conjunction with the February 1996 flood and resulting in the damming of Clear Creek for a short time. This debris torrent originated in an unmanaged area and the whole area from the slide origin to Clear Creek was unmanaged.

The debris torrent in Little Clear Creek also occurred during the February 1996 flood. This debris torrent originated from a logging road on private land in the area from river mile 0.4 to 0.8.

Soils

Soil Productivity

Soil productivity in the watershed varies from highly productive agricultural and forest soils to newly forming soils in surficial mudflow deposits. Soil productivity is a function of soil depth, organic matter content and soil texture. Environmental factors such as elevation, aspect and climate also influence the capacity of a site to grow vegetation. The most productive soils are found in the western portion of the watershed, at lower elevations primarily on non-federal lands. These deep, well drained soils support a variety of agricultural crops and forest production. Younger soils, found in Old Maid Flat and on the upper slopes of Mt. Hood, are generally much lower in productivity. The vegetation found on these sites is a reflection of limited nutrient and moisture retention properties of the underlying soils.

In Table 4-11 and Table 4-12, environmental and soil properties were used to evaluate soil productivity. The environmental factors considered include: slope gradient, elevation and aspect. The soil properties examined were: organic horizon, surface texture and soil depth. The more productive soils on Mt. Hood National Forest lands are listed in Table 4-11, those off-Forest in Table 4-12. There is considerable variation in productivity even among soils in Table 4-11 and Table 4-12. The environmental and soil factors are included to assist in further differentiating the soils in these two tables. Figure 4-9 displays the productive soils in the Upper Sandy Watershed - stratified into two relative productivity ratings.

Soil productivity information can be used in planning and in site specific decision making. Long term maintenance of soil productivity is accomplished through land management practices that maintain soil organics and limit soil erosion, displacement and compaction.

Table 4-11 Soil Productivity, National Forest Lands

SOIL TYPE /1	ACRES	SLOPE	ELEVATION	ASPECT	ORGANIC HORIZON DEPTH (INCHES)	SURFACE TEXTURE	DEPTH (INCHES)
312	1497	0-30	500-1800	ALL	3-4	v.stony and cobbly silt loams and clay loams	49-60
313	825	30-60	500-1800	N + E	1-2	v.stony and cobbly silt loams and clay loams	37-44
316	343	30-60	1800-3000	N + E	.5-1.5	v.cobbly loams	28-34
330	1223	0-30	1800-3500	ALL	1-2	v.stony loam	34-65
338	371	0-30	500-2500	ALL	1-2	v.stony silt loam	26-70
339	40	30-60	500-2500	N + E	.5-2	v.stony silt loam	20-55
340	3	30-60	500-2500	S + W	.5-1	v.stony silt loam	19-47
341	3285	0-30	2000-4000	ALL	2-3	v.gravelly and cobbly loams and silt loams	37-65

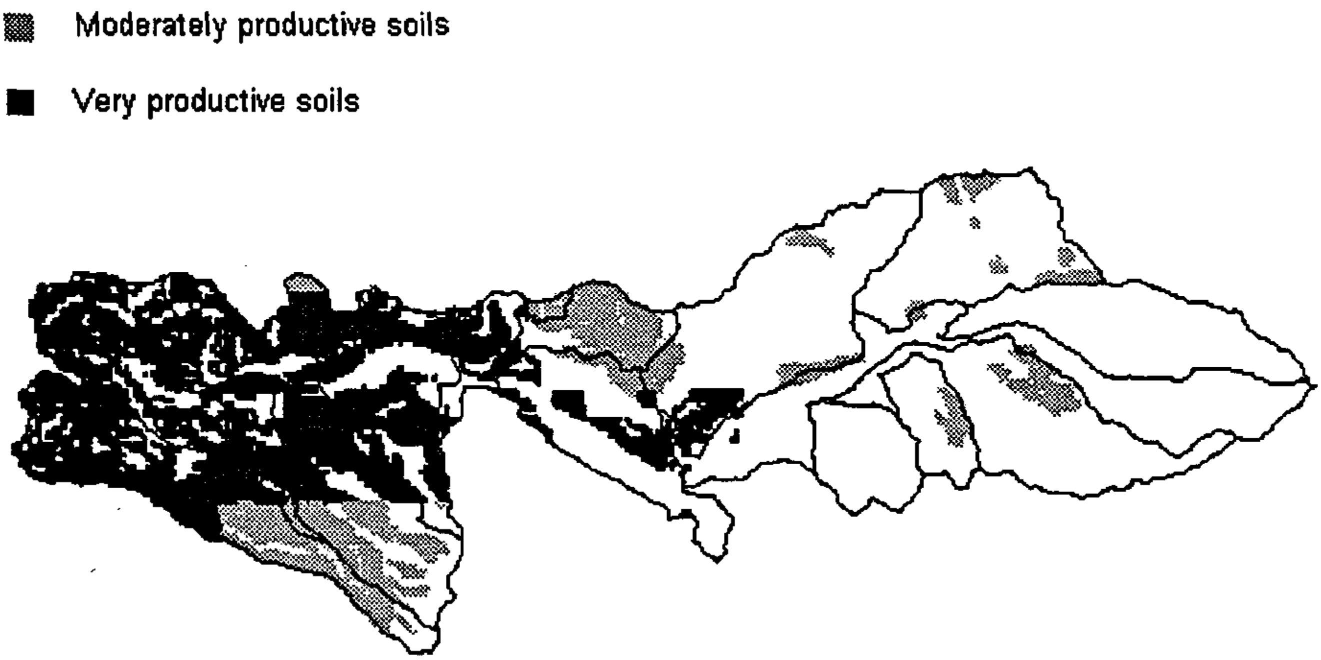
/1 From Mt. Hood Soil Resource Inventory

Table 4-12 Soil Productivity, other lands

SOIL TYPE/2	ACRES	SLOPE	ELEVATION	ASPECT	ORGANIC HORIZON DEPTH (INCHES)	SURFACE TEXTURE	DEPTH (INCHES)
2B	32	2-8	800-1800	ALL	info. not available	clay loam	>60
2C	30	8-15	800-1800	ALL	"	clay loam	>60
2D	89	15-30	800-1800	ALL	"	clay loam	>60
5D	3359	5-30	500-2000	ALL	"	cobbly loam	>60
5E	4671	30-60	500-2000	ALL	"	cobbly loam	>60
6F	1561	60-90	1000-2000	ALL	"	cobbly and v.gravelly loam	>60.
9B	2929	3-8	500-2000	ALL	"	silt loam	>60
9D	3814	8-30	500-2000	ALL	"	silt loam	>60
9E	208	30-60	500-2000	ALL	"	silt loam	>60
44B	333	0-5	500-1700	ALL	"	loam	>60
47C	855	3-20	1000-2000	ALL	"	cobbly loam	40-60
47E	27	20-50	1000-2000	ALL	"	cobbly loam	40-60
94D	1798	5-30	1800-3000	ALL	"	gravelly loam	>60

/ 2 From Clackamas County Soil Survey (USDA SCS)

Figure 4-9 Productive Soils in the Upper Sandy Watershed



Soil Limitations

Soil properties that pose limits to forest management are those restrict vegetation potential or are prone to instability or surface erosion. Talus slopes, rock outcrops and unstable hillslopes are intermingled with productive forest lands throughout the watershed. (see vegetation) In all, 31% (21,000 acres) of the watershed have soils or landforms that limit tree growth. The majority of these 21,000 acres are areas of perpetual snow and ice and other non forested lands on the upper slopes of Mt. Hood.

Soils were considered limiting if their rooting depth was less than 20 inches, had high rock content,were poorly drained, droughty during the growing season or unstable. Table 4-13 lists the soil types in the watershed and their limits to timber management

Table 4-13 Soil Limitations on forested lands within the watershed

SOIL TYPE	SOIL DEPTH	ROCK CONTENT	SLOPE STABILITY	SURFACE EROSION	SOIL MOISTURE / SITE CLASS
12	non-soil	talus			
12-13	non-soil	talus/felsenmeer			
13	non-soil	felsenmeer			
13-12	non-soil	felsenmeer/talus			
13-6	non-soil	felsenmeer/talus			
13-7	non-soil	felsenmeer/rock outcrop			
15	non-soil	unstable drainage	mass wasting	severe	
3		wet meadows			poorly drained
313-12	shallow	skeletal-rock outcrop			
315-5	shallow	skeletal-rock outcrop			
316-5	shallow	skeletal-rock outcrop			
326	shallow				non-forest
341-6		skeletal-rock outcrop			
342-6		skeletal-rock outcrop			
343-6		skeletal-rock outcrop			
344-12		skeletal - talus			site 5
344-2		unstable sideslopes	mass wasting	severe	site 5
344-6		skeletal - talus			site 5
344-7		skeletal-rock outcrop			site 5
345-6		skeletal - talus			site 5
345-7		skeletal-rock outcrop			site 5
377-12	shallow	skeletal-talus			site 5
5	non-soil	rock outcrop			
6	non-soil	talus			
6-13	non-soil	talus-felsenmeer			
6-7	non-soil	talus-rock outcrop			
7	non-soil	rock outcrop			
7-345	non-soil	skeletal-rock outcrop			site 5
7-6	non-soil	rock outcrop-talus			
9	shallow	talus and stones			
10C					poorly drained
26B					high water table winter/ droughty summer
63B					high water table winter/ droughty summer
73					high water table winter/ droughty summer
75		skeletal			non forest

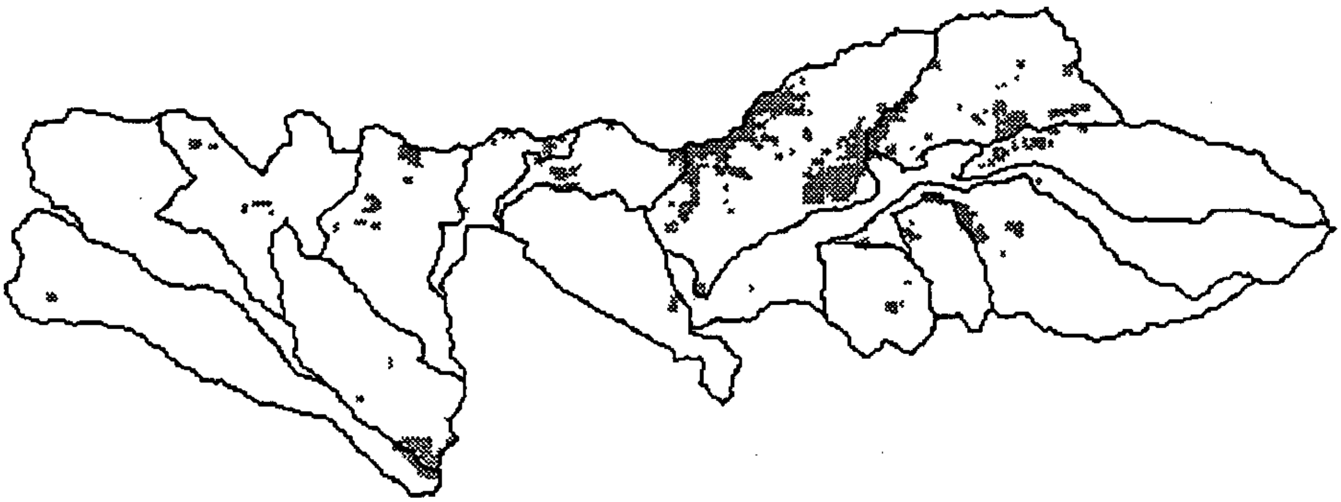
Table 4-14 summarizes the soil limitations on federal timber management lands within the watershed. The Clear Creek subwatershed has the highest per unit area of limiting soils. In the entire Upper Sandy watershed, four percent of the federal timber management lands (National Forest lands B, C and DC1; BLM GFMA and BLM DV), have limiting soils. Figure 4-10 displays the location of the limiting soils in the watershed.

Table 4-14 Soil Limitations on B, DC1 and C1 Lands by Subwatershed

WATERSHED	ACRES OF LIMITING SOILS	SUBWATERSHED ACRES	PERCENT SUBWATERSHED
Alder Creek	165.49	4,601.61	3.60
Badger Creek	0.00	5,184.53	0.00
Cast Creek	39.52	1,731.47	2.28
Cedar Creek	69.16	6,417.06	1.08
Clear Creek	1207.83	7,496.45	16.11
Clear Fork	370.50	5,162.30	7.18
Horseshoe Creek	27.17	2,262.52	1.20
Lost Creek	172.90	5,700.76	3.03
Muddy Fork	91.39	4,851.08	1.88
N.Boulder Creek	116.09	2,022.93	.49
Sandy R. Bridge	39.52	1,558.57	2.53
Sandy R. Hackett	17.29	4,458.35	.39
Sandy R. Messinger	37.05	4,651.01	.80
Sandy R. Willamette	121.03	4,707.82	2.57
Upper Sandy R.	19.76	7,009.86	.28
TOTALS	2494.70	67,816.32	3.67

Figure 4-10 Potential Soil Limitations -- Upper Sandy Watershed

B, C1, DC1 and BLM-GFMA, BLM-DV lands with potential soil limitations Upper Sandy Watershed



Additional soil information is available for soils within the watershed. Electronic data (including select soil properties and interpretations) from the Mt. Hood Soil Resource Inventory, the Clackamas County Soil Survey and the Bull Run / Sandy Soil Survey is available as a tool for additional planning within the watershed.

Fire

For thousands of years fire has served as an important disturbance factor throughout Pacific Northwest forests. Indeed, fire has been a major natural disturbance regime affecting ecological values within the Upper Sandy Watershed.

Fire History

While detailed fire history studies are not available for the Upper Sandy Watershed, one was recently completed for the adjacent Bull Run Watershed (Krusemark et al. 1996). Even though much of the Upper Sandy Watershed contains vegetation zones similar to the Bull Run, some factors such as precipitation are not analogous. Such variations must be accounted for when extracting information from the Bull Run study area to adjacent watersheds such as the Upper Sandy.

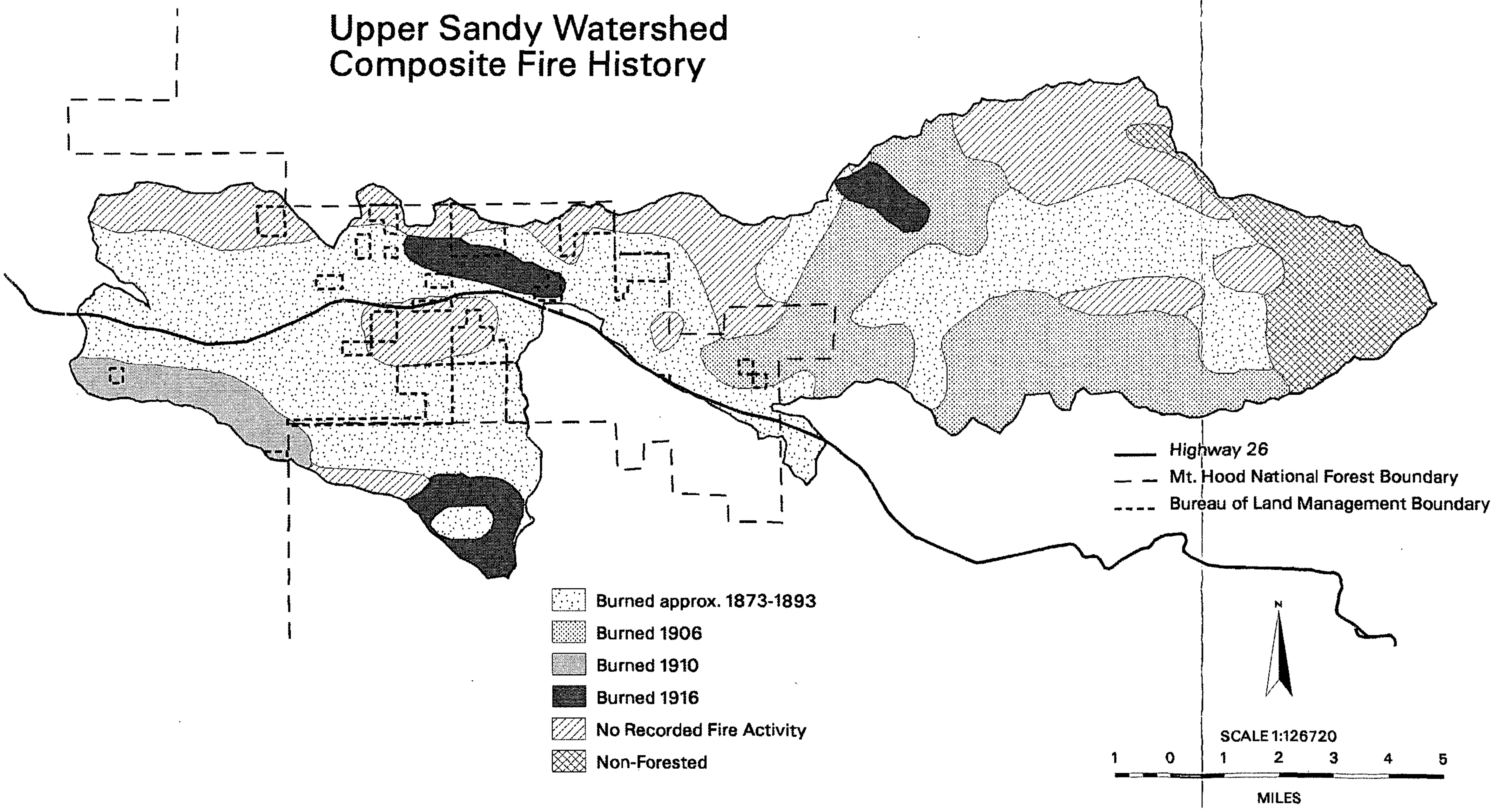
Approximately 500 years ago, a large fire event covered the entire Bull Run area (Krusemark et al. 1996). This event undoubtedly had effects on the adjacent Upper Sandy Watershed. For example, old-growth stands inhabiting the Upper Sandy Watershed's North Mountain area may have been initiated after this event.

According to the Krusemark study, large fires also occured in 1663 (Bull Run Lake area) and in 1693 (southwestern end of Bull Run Watershed). Both of these fires occurred adjacent to -- and most likely burned into -- the Upper Sandy Watershed.

Between 1873 and 1881, much of the Bull Run's western lowland and southern portions burned. These fires may have represented the northern border of much larger fire events that originated south of the Bull Run Watershed. In fact, according to fire history maps, at the turn of the century approximately half of Clackamas County County south of the Bull Run area -- including the Upper Sandy Watershed -- was classified as burned. The widespread dominance of Upper Sandy Watershed forest stands near 100 years in age seems to support this *(Note: Krusemark et al. list a large event in 1873, another source suggests 1893).*

In the time period between 1873 to 1920 nearly three-fourths of the Upper Sandy Watershed had been burned by stand replacing fire

The following composite fire history diagram (Figure 4-11) displays areas burned by stand- replacing fire events and time period. This information is based on interpretations from forest cover survey data from 1914, 1936 and 1948, as well as personal accounts from Forest employees stationed in the area in the early 1900's.


Upper Sandy Watershed
Composite Fire History
Highway 26
Mt. Hood National Forest Boundary
Bureau of Land Management Boundary
Burned approx. 1873-1893
Burned 1906
Burned 1910
Burned 1916
No Recorded Fire Activity
Non-Forested
N
SCALE 1:126720
1 0 1 2 3 4 5
MILES

Although difficult to collaborate, large historic fires that burned very large areas, specifically the 1873/1893 event, could have been triggered via a combination of multiple fire starts sparked from lightning storms. These multiple starts may have smoldered for extended periods until east wind events caused the fires to to burn together into consolidated large fires.

Natural Fire Rotation

Although detailed fire rotation studies are not available for the Upper Sandy Watershed, fire frequency was calculated for a large portion of the nearby Bull Run Watershed by Krusemark, et. al. (1996) using the Natural Fire Rotation (NFR) method.

This method uses age class data and assumptions about reconstructing past fire events. NFR for areas within the Bull Run's Little Sandy drainage -- in stand types similar to those of the majority of the Upper Sandy Watershed -- was estimated between 250-300 years.

Fire Severity Regimes

Across the Pacific Northwest, the frequency, intensity, and extent of fires differ considerably. These differences are categorized into three broad fire severity categories: "high" "moderate" and "low", where the high end implies less frequent, more intense fires. Krusemark et al. (1996) determined the Bull Run was characteristic of a high fire regime and moderate fire regimes were more common to the immediate north and south (including the Upper Sandy Watershed). Moderate fire regimes are represented by more frequent (100 years or less) and less intense fires that tend to leave more residual forest than high intensity fire regimes.

Current Fire Documentation

Available Mt. Hood National Forest historical fire occurrence records consist of: documented fires from 1908-1930 in the *Mt. Hood N.F. Fire Atlas*, fire lookout panoramic photos from 1930-1934, and fire history maps that date back to the 1870s. In 1960, the Forest began documenting fire records for wildfires.

These reference materials reveal at least 52 fires occurred in the Upper Sandy Watershed so far this century -- 27 from 1908-1959, and 25 from 1960-1995. The escalation of human impacts within the Upper Sandy Watershed makes it a primary source for many past -- as well as future -- fire starts. It should be noted, however, that the ability to quickly detect and respond with appropriate suppression resources in this area is excellent. Of the 25 1960-1995 fire events, the majority were suppressed and contained at 1/4 acre or less in size and none were over ten acres in size.

Existing fire data confirms most fire starts in the region that includes the Upper Sandy Watershed occur during June through October. September and October, which historically experience the greatest percentage of east wind events of all summer months, account for the preponderance of large fires.

Fire Ecology Groups

A team of fire specialists developed the report *Fire Ecology of the Mid-Columbia* (Evers et al. 1995), which summarized current available fire ecology and management information for the mid-Columbia area of Oregon and Washington -- including the Mt. Hood National Forest.

Fire ecology groups were developed based on plant associations and species' *response to fire, as well as these species' roles during succession.* Occurrence and extent of the fire groups were determined by field sample data of plant associations. Each fire ecology group includes a variety of information, including fire management considerations and suggestions for resource managers to consider for incorporation into land management objectives. These fire ecology groups can also be used to describe and predict fire's potential impact on an ecosystem. (For detailed descriptions of these groups, see Evers et al. 1995.)

Fire Ecology Groups of the Upper Sandy Watershed

One dominant and two minor fire ecology groups are represented within the Upper Sandy Watershed. Fire Group 8 encompasses nearly one half of the watershed, with scattered inclusions of fire groups 6 and 9 comprising most of the remaining area.

Fire Group 8

Fire Group 8 includes the watershed's moist and wet western hemlock and Pacific silver fir plant associations. This fire group generally lacks fine fuels through most of the stand history. While wet sites with devil's club and skunk cabbage may contain very heavy fuel buildups, the presence of water maintains conditions of closed canopy overstories of large trees over lush understories, indicating infrequent disturbance. Deep duff and large logs are typical in this group, resulting in "low" to "moderate" wildfire hazard -- depending on weather conditions and canopy gaps.

Fire Group 8 lands include the following potential scenarios:

- Prolonged drought (of at least three years) may dry the forest floor enough to allow fires to ignite and spread.

- Smoldering combustion and creeping rates-of-spread are most common until dry east winds spread the flames into a much higher intensity fire.

- Fire frequencies average 50-200+ years.

- Average fire return intervals in sites with devil's club and skunk cabbage may easily exceed 300 years.

- The highest fire danger occurs from mid-September through October.

- Little or no hazard exists from natural fuel accumulations until stands reach mature or overmature status, or some other natural event occurs -- such as wildfire or windthrow.

- Fire exclusion may have had minor effects on the typical fire behavior and fire size.

- To avoid soil damage and seedbank scarification caused by prolonged smoldering, burning for hazard reduction should occur when duff moisture is relatively high.

- Heavy equipment can cause compaction and erosion problems when used for either fuel treatment or wildfire suppression.

- Many sites can withstand "moderate" to "low" severity burning quite readily with little or no effect expected on long-term productivity. "High" severity burning, however, may emit too much nitrogen to maintain site productivity.

- The relatively high decomposition rates typical of these plant associations suggest that non-burning fuel treatment methods may adequately address the higher hazards associated with logging slash.

Fire Group 9

Fire Group 9 consists of dry western hemlock plant associations typically located within the watershed's south to southwest slopes at low to mid elevations. Within this group, drier conditions in the understory in late summer provides live fuel in the form of cured grasses and shrubs with fine twigs. In more open canopies, tree crowns can reach closer to the ground, providing a ladder for fire to reach into the canopy.

Fuel loadings in this fire group are highly variable, depending on individual stand and site conditions. Generally, this fire group does not contain duff as deep as Fire Group 8. Large logs, however, are common. Fire Group 9 sites may dry out sufficiently and contain enough fine fuels to carry fires in late August.

Fire Group 9 lands include the following potential scenarios:

- Communities where fire frequency would average between 25-150 years, depending on specific location.

- In the absence of east winds, topography and rockiness tend to control fire size and shape. This fire group, however, is also surrounded by the more moist Fire Group 8, which could also influence behavior.

- In the presence of east winds, low to moderate rates-of-spread and fireline intensities dominate fire behavior. During most years, this fire group tends to carry a higher risk of fire than Group 8.

Fire Group 6

Fire Group 6 encompasses cool sites on upper slopes and ridgetops above 3200 feet. According to Krusemark et al. (1996), many of the small fire events in the Bull Run Watershed were concentrated in such rim environments -- possibly due to the higher likelihood of lightning.

Current evidence suggests that Fire Group 6 experiences -- almost exclusively -- high-intensity stand-replacing fires. Except for during prolonged drought periods, the understory in this fire group does not support fire. Fire exclusion probably has not altered the typical fuel loading and fire behavior. The heavy shrub loading still serves as a heat sink, preventing the start and spread of most fires during average burning conditions.

Fire Group 6 lands include the following potential scenarios:

- Except in stands at or near the climax state, little or no wildfire hazard exists from natural fuel accumulation.
- Fire protection may be critical during extreme burning conditions, particularly around active timber sales and in northern spotted owl habitat.
- Because soils tend to be nutrient poor, to maintain site productivity, slash treatment methods should remove as little organic matter as possible.
- Conifer establishment occurs very slowly or, in extreme cases, not at all.
- Slash protects the area from frost and reduces the expansion of aggressive forbs.

Ecological Effects of Wildfire

Wildfire has been and will continue to be the most influential factor affecting ecosystem development. Virtually all ecosystem resources are affected either directly or indirectly by fire.

Wildfire changes forest ecosystems and interacts with geomorphic processes, climate, and land form. Thus, in a variety of ways, wildfire alters the landscape. In addition, it temporarily increases the potential for erosion by exposing readily erodible material. Fire can also increase the hydrologic energy available to move this material.

Wildfire directly affects water quality through short-term and long-term temperature increases by removing overstory vegetation, as well as increasing stream turbidity by removing the protective duff-litter layer, which also increases soil erosion.

Fire is an inherent part of the disturbance and recovery patterns to which native species have adapted. Wildfire affects wildlife primarily through effects on habitat.

Wildfires exceeding several hundred acres in size, especially under an east wind influence, could potentially have major air quality impacts to the Portland metropolitan area airsheds.

Fire Risk and Hazard

Hazard and Risk are important terms to understand in the context of wildfire prevention. Wildfire loss can be reduced by one of two strategies: eliminate or reduce the sources of ignition (risk management); or remove or modify the fuel to reduce its flammability and intensity (hazard management).

Risk

"...burns have taken place in all parts of the reserve (now Mt. Hood National Forest), and are so distributed that their occurrence can not be attributed to any particular cause, but rather demonstrates the fact that wherever men go fires follow."

-excerpt from Cascade Range Forest Reserve Report,
H.D. Langille, 1903.

It is virtually impossible to eliminate all wildfire risk (from such things as lightning, campfire, and smoking starts). Some level of risk, therefore, must always be accepted. This acceptable level of risk should be determined by the existing level of fuel hazard and values to be protected.

Most fires that occur on public lands are associated with public recreational activities. Dating back to the days of the Barlow Road, human presence in this watershed has been high and ever-increasing. The risk of human associated fire starts is thus, also high. Highway 26 and to a lesser extent Lolo Pass Road, are major corridors that carry people through and within the watershed. Many people also live within the watershed. These factors give this watershed a high amount of "wildland/urban interface", which in turn makes fire protection complex.

Although little can be done to reduce the risk of ignition by lightning, human associated risks can be reduced by modifying behavior. Measures such as restricting public entry or activities within certain areas during periods of high fire danger may be used. Coordination between federal and state agencies and local communities and homeowners is critical for effective protection within the wildland/urban interface areas of the watershed. Outside of this interface area and on federal lands, an understanding of the role of fire as a critical natural process must also be a part of appropriate suppression policy. Given the complexity of fire protection and management within the Upper Sandy Watershed, it is important to point out that the ability to quickly detect and respond with appropriate suppression resources is also high in this watershed.

The Bull Run Watershed Management Unit (includes 4,579 acres of the Upper Sandy Watershed) is closed to the general public, and has the lowest fire frequency and risk of any other federal forest lands within the watershed.

Hazard

Where values are high and risk cannot be sufficiently reduced, an alternative may be to reduce the fuel hazard. "Hazard" is a rating assigned to a fuel complex that reflects its susceptibility to: ignition, the fire behavior and severity it would support, and the suppression difficulty it represents. Hazard reduction can be planned to decrease wildfire incidence and severity, lessen rate of spread and intensity, and make extinguishing fire easier and less costly.

Current Fire Management Objectives

Fire management activities include presuppresion (such as construction and maintenance of fuelbreaks, helispots, water sources, etc.); prevention; suppression; detection; and treatment of both natural and harvest activity fuels. Over 900 land owners have land in the Upper Sandy Watershed which is further dissected by various zoning and land allocations. Table 4-15 -- Fire Protection Responsibilities displays which agency has primary fire response duties within the watershed.

Table 4-15 -- Fire Protection Responsibilities

Land Area	Suppression Responsibility
Mt. Hood N.F. Forest Lands	USFS
BLM Lands	Oregon Dept. of Forestry
Private and County Lands	Oregon Dept. of Forestry
Structures	Hoodland/Sandy Rural Fire Depts.

Federal Wildland Fire Management Policy

Firefighter and public safety remains the first priority. Once people are safe, the second protection priority is property and natural/cultural resources, based on their relative values. This is a change from previous priorities and must be coordinated with local partners.

Fire and fuels management direction vary by land allocation. More specific standards and guidelines by allocation follow:

Late Successional Reserves: Silvicultural activities are permitted to reduce the risk of large-scale catastrophic disturbances. Activities should focus on younger stands and avoid degrading suitable spotted owl habitat and late-successional forest conditions. Activities in older stands are permitted under certain conditions. Treatments should be designed to provide effective fuel breaks. Associated fuel treatments should promote the use of minimum impact suppression tactics during wildfires. The goal of wildfire suppression is to limit the size of all wildfires. Prescribed natural fire may be considered. *(Note: see also Bull Run Management Unit guidelines as this pertains to this same land area).*

Riparian Reserves: Fire and fuel management activities should meet the Aquatic Conservation Strategy objectives and minimize disturbance of riparian ground cover and vegetation. Management strategy should recognize the role of fire in the ecosystem and identify where fire suppression or fuels management activities could damage long term ecosystem function. As with Late-Successional Reserves, the goal is to limit the size of all wildfires and "prescribed natural fire" may be considered.

Matrix Lands: Until specific models are developed, fuel treatments should leave 240 linear feet of logs per acre greater than or equal to 20 inches in diameter. Logs less than 20 feet in length cannot be credited toward this total (ROD p. C-40). Retain as many of the existing downed logs as possible. Fuel treatments will need to protect retained green-tree patches in harvest units. Prescribed burning should minimize consumption of community or stand condition. Additional wildfire hazard reduction activities may occur in coordination with local governments, agencies and landowners in the wildland/urban interface.

Wilderness: Preference shall be given to those suppression methods and strategies resulting in the least practicable area burned, commensurate with cost effectiveness, and having the least effect on wilderness values. Currently a fire management plan does not exist for the Mt. Hood Wilderness. When the fire management plan has been completed, naturally occurring ignitions could be managed as a prescribed fire unless declared a wildfire *(a "prescribed natural fire" is declared a wildfire when the burning conditions or weather conditions* *exceed the parameters established in the Wilderness Fire Plan*) The use of motorized equipment for fire suppression within a wilderness is strictly forbidden unless approval has been obtained from the Forest Supervisor (see Forest Service Manual 2324.2).

Bull Run Watershed Management Unit: *The Bull Run Final Environmental Impact Statement* (1979) clearly establishes that the ten acre fire control policy will remain in effect for the Bull Run Watershed Management Unit. The objective of this ten acre control policy is to plan for and implement suppression actions that control all wildfires at ten acres or less. Additionally, obectives should: reduce the probability of catastrophic wildfire by reducing wildfire risk; protect the Management Unit with all the fire suppression resources necessary and available at the time of the incident; and promptly extinguish all wildfires.

Scenic Viewshed (B2): Prescribed burning may occur for wildlife forage enhancement, but broadcast burning should not occur within foreground areas. Use of handpile prescriptions should be emphasized in near-foreground areas. Exceptions to the downed woody Standards and Guidelines may occur within near-foreground areas with Retention and Partial Retention Visual Quality Objectives.

Additional fire management direction for the Upper Sandy Watershed can be found in the *Mt. Hood National Forest Appropriate Suppression Response (ASR) guide* and the *Mt. Hood Forest Plan.* For portions of the watershed within the Bull Run Management Unit refer to: the *Bull Run Planning Unit Final Environmental Statement* (1979), and the *Bull Run Fire Management Plan* (June 1992).

National Fire Management Analysis System

In 1993, the Mt. Hood National Forest completed its portion of a national initial attack fire suppression response study, the *National Fire Management Analysis System* (NFMAS). The study divided the Forest into initial attack zones and developed the optimum mix of initial attack resources that could economically be deployed using: the integration of production rates for initial attack resources; the value of resource at risk of being lost to wildfire; the historical fire occurrence rate; and the cost of initial attack resources. The study's main shortcoming proved to be that the timber resource was the only resource that had a value assigned to it for calculating loss to wildfire. For instance, the loss of: water quality, wildlife habitat, and Late Successional Reserves (old-growth), was not computed into the NFMAS study's "loss tables." Updating the model to include additional resource values should be explored.

Conclusions: Fire

- Nearly three-fourths of the Upper Sandy Watershed has been burned by stand replacing fire between 1873 to 1920 (see Figure 4-11 -- Composite Fire History).
- The Natural Fire Rotation for the watershed is estimated to be between 250-300 years.
- The fire regime is estimated to be moderate.
- The risk for large fires is greatest in September and October.
- Three Fire Ecology Groups occur in the watershed, but the warm, moist, *fire group eight* is most widespread.
- The risk of human associated fire starts is high
- The ability to quickly detect fires and respond with appropriate suppression resources is high in the watershed.

Vegetation

This section provides an overview of four key elements of vegetation: **Potential Vegetation, Structure, Seral Stage,** and **Landscape Pattern**. It outlines how these key elements are expressed -- currently and historically -- within the landscape of the Upper Sandy Watershed. Information derived from examining these key elements will be integrated with other processes and functions of the watershed within this Watershed Analysis.

Potential Vegetation

When vegetation is undisturbed for long periods of time, it tends to stabilize with a predictable species composition. Potential Vegetation is vegetation which develops on a site and, in the absence of disturbance, is capable of self-perpetuation. To describe vegetation based on its potential provides an opportunity to readily understand and communicate environmental gradients, including limitations and opportunities, inherent to the site.

Potential Vegetation can be stratified broadly within "forest zones," and defined more specifically by groupings called "plant associations." Whereas Stand Structure, Seral Stage, and Landscape Pattern can vary widely over time and space, the site's Potential Vegetation (forest zone and plant association) remains relatively stable. Climatic shifts which often take many centuries, or catastrophic events such as volcanic eruptions that change a site's physical character (*Old Maid Flats Mudflow for example*), may permanently alter or shift Potential Vegetation.

Forest Zones

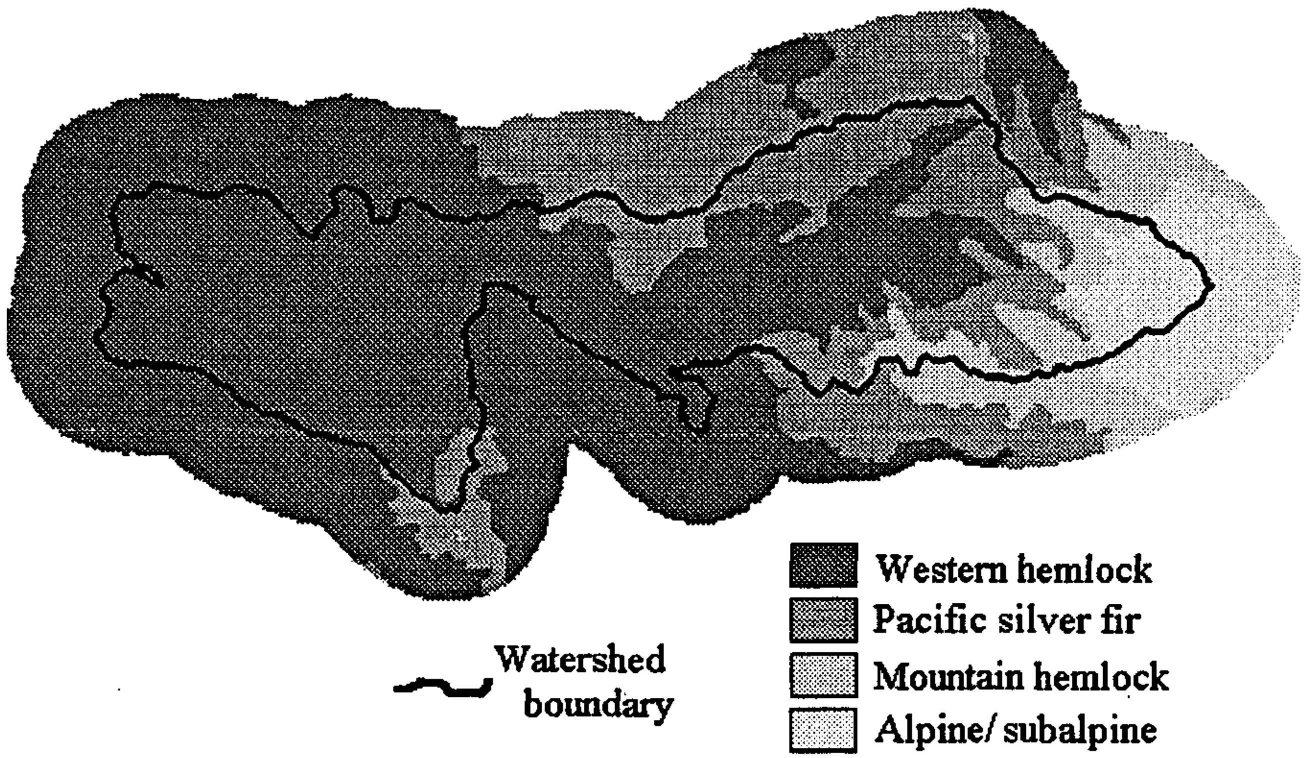
The Western Hemlock Zone covers 66% of the Upper Sandy Watershed, the Pacific Silver Fir Zone covers 23%, the Mountain Hemlock Zone covers 6% and 5% is in the Alpine/Subalpine Zone.

From its headwaters on Mt. Hood to the western edge of the analysis area, the Upper Sandy Watershed crosses four distinct forest zones which is expressed in the diversity of plant communities.

Forest zones are of interest because they generally represent major large-scale climatic differences within a region. They are defined based on the dominant tree species that would eventually dominate an area in a long-term absence of disturbance. Therefore, forest zones are named after dominant tree species that persist in stable, mature stands approximating climax conditions.

Figure 4-12 displays the locations of the forest zones within and adjacent to the watershed.

Figure 4-12 – Forest Zones of the Upper Sandy Watershed



Western Hemlock Zone

The Western Hemlock Zone is that area in which western hemlock is the major tree species that will replace itself over time. It occurs on warm, moist sites relative to other forest zones and tends to be the most productive in terms of rapid and large tree growth. Douglas-fir and western redcedar are also common species within this zone. Even though Douglas-fir is shade-intolerant, it is very long-lived (750 years+) and thus can dominate many of the stands in the Western Hemlock Zone (Halverson et al. 1986).

The Western Hemlock Zone occupies lower elevations and dominates the western half of the watershed. It also follows the Sandy River and its adjacent slopes along most of its length. Within the watershed, the average elevation of this zone is 1943 feet. The elevation range in the watershed extends from 554 to 4176 feet. The average slope of this zone within the watershed is 22%.

Pacific Silver Fir Zone

The Pacific Silver Fir Zone represents the area where Pacific silver fir is the major tree species that will replace itself over time. Within this zone, temperatures tend to be cooler than within the Western Hemlock Zone. Summer frost in upper elevations is common, particularly on gentle topography. Winter snowpack also tends to be persistent within the Pacific Silver Fir Zone. In addition, this zone represents an area in which periodic warm winter rains may cause rain-on-snow events.

Douglas-fir is also prevalent in this zone, but not as common as in the Western Hemlock Zone. Even though forests are typically dominated by Douglas-fir and noble fir following large fires, these species are eventually replaced by Pacific silver fir.

The Pacific Silver Fir Zone's tree layer is often quite diverse. It commonly includes: noble fir, western white pine, mountain hemlock, western hemlock, and western redcedar (Hemstrom et al. 1982). Trees are generally slower-growing in this zone and are commonly smaller than within the Western Hemlock Zone.

The Pacific Silver Fir Zone is concentrated on upper slope and ridge positions in the upper half of the watershed. In general, it occurs on higher and harsher sites than does the Western Hemlock Zone. Average elevation of this zone within the watershed is 3518 feet. The elevation range of the Pacific Silver Fir Zone within the watershed is 2323 to 5541 feet. Average slope is 33%.

Mountain Hemlock Zone

The Mountain Hemlock Zone occurs above the Pacific Silver Fir Zone in harsher climatic conditions. Snowpacks prevail much of the year and frost can occur during the growing season. Biological processes are slow and result in fragile ecosystems. Trees grow slowly and attain smaller sizes in this zone.

Within the Upper Sandy Watershed, the Mountain Hemlock Zone is not widespread and occurs on the flanks of Mt. Hood and Zigzag Mountain between 2920 and 6069 feet elevation (the average elevation of this zone in the watershed is 4398 feet, and the average slope is 38%).

Alpine/Subalpine Zone

As elevations increase and continuous forest canopies diminish, the Mountain Hemlock Zone gives way to subalpine and alpine plant communities. This zone is present at high elevations on Mt. Hood beginning at timberline. Elevations of this zone in the Upper Sandy Watershed range from 3816 to 11046 feet in the vicinity of Reid and Sandy Glaciers, the source of the Sandy River. (Average elevation of this zone in the watershed is 6758 feet and average slope is 49%).

Subalpine park areas consist of stringers or clumps of trees intermixed with shrub, forb or grass meadows. Dominant tree species are subalpine fir, mountain hemlock, whitebark pine and Alaska yellow cedar. Very short growing seasons and deep snowpacks preclude tree development on much of the area. The highest, harshest sites have very little soil development, are very rocky and have sparse assemblages of *pincushion* plants, species of small stature that are specifically adapted to the harsh alpine conditions.

Plant Associations

Plant associations are groupings of plant species which re-occur on the landscape within particular environmental tolerances. They are a relatively stable grouping of plant species that, over time, come into equilibrium with the physical, chemical and biological environment on a given site.

Plant associations, classified and described for the much of the Upper Sandy Watershed, provide a means to infer a great deal about a site's characteristics (Halverson et al.1986; Hemstrom et al. 1982). More than 158 well-distributed field samples (plots) of plant association or plant community information have been documented for the Upper Sandy Watershed. These provide insights to: habitat potential; fire regime; management limitations and opportunities; and other important landscape and ecosystem components.

Plant Association and Management Guides applicable to the watershed, including keys, descriptions, environment indications, and management limitations and opportunities, are available through the Mount Hood National Forest Supervisor's Office. (Halverson et al. 1986; Hemstrom et al. 1982; Diaz and Mellen 1996) Additional information that relates plant associations to fire regime and includes management implications by fire ecology groups (briefly outlined in this chapter's Fire section) can be found in Evers et al. (1995)

For actual lists of known associations, refer to the analysis file. Brief descriptions of groups of plant associations present in the watershed follow.

> Plant associations found on productive soils and moist sites are fairly common in the Upper Sandy Watershed. Oxalis and foamflower are

common in the understory of moist associations which are rich in herbaceous species and ideal for rapid and large tree growth.

Wet plant associations which are extremely productive are indicated by the presence of devils club or skunk cabbage. Such sites are somewhat limited in the watershed, but when present are good indicators of riparian conditions such as intermittent flows or impeded drainage (year-round saturated soils).

Relatively dry sites which support drier fire regimes are somewhat common in the watershed (fire ecology group nine). These dry to mesic sites are identified by the dominance of broadleaf evergreen shrubs, specifically salal and dwarf Oregon grape, and are often low in nitrogen. These associations are almost always located on south to west slopes.

Plant associations that are dominated by rhododendron are fairly common in the watershed. These sites also are most likely low in nitrogen.

Some plant associations within the Pacific Silver Fir Zone and Mountain Hemlock Zone in the watershed indicate especially cool and cold sites. Common plant species present include big huckleberry, fool's huckleberry, beargrass, rhododendron, and Cascade's azalea. These upper elevation sites represent fire ecology group six.

Conclusions: Potential Vegetation

- The Upper Sandy Watershed crosses four major vegetation zones which results in a diversity of plant communities within the watershed
- The productive Western Hemlock Zone dominates the land area of the watershed at 66%. Other zones include Pacific Silver Fir (23%), Mountain Hemlock (6%) and Alpine/Subalpine Zone (5%).

Structure

For this Watershed Analysis, forest vegetation was stratified by both Structure and Seral Stage (discussed in the following section), often key determinants of habitat for various species of plants and animals. Both affect a range of landscape processes.

The Integrated Satellite Vegetation Database (ISAT, USDA 1993) was used as a base for extracting current forest stand information. ISAT data is derived through a process that scans a 1989 satellite pixel classification to produce a representation of vegetation types -- based on canopy cover, size structure, and species groups.

ISAT data was available for much of the watershed. To complete the data coverage two other sources of vegetation data were used: BLM vegetation layer for Federal lands not covered by ISAT and ERDAS data (Cohen et al. 1995) for non-federal lands not covered by ISAT. The coverage was then updated for timber harvest that occurred between 1989 and 1995. (Updating focused primarily on federal lands). ISAT structure classes were grouped into categories that best approximate those in the Mt. Hood National Forest's wildlife habitat relationship database. This database uses the widely-recognized wildlife habitat classes based on tree size and canopy closure from Hall et al. (1985).

Detailed documentation that describes how the various data from the sources mentioned above were grouped into Structure Class and Seral Stage as used in this analysis can be found in the Upper Sandy Watershed "Analysis File". A basic description of criteria used is presented below for structure and in the next section for seral stage.

Structure Classes

The Upper Sandy Watershed currently consists of the following structure classes: 7% Large Conifer, 59% Small Conifer, 18% Open, and 12% Semi-open.

Structure classifications were based on tree size and canopy closure. Two levels of structural categories were used in this analysis:

1. Coarse splits into ***Open, Small Conifer***, and ***Large Conifer***.
   (Note: dbh = diameter at breast height -- 4 1/2 feet)
2. Finer breaks based primarily on canopy closure within these three classes.

Open: Vegetated areas that currently function as openings. These include:

- Grass/forb/shrub (GFS) (including grass/forb/shrub/advanced): Dominated by early-seral vegetation and tree seedlings with less than 40% total tree canopy cover (5024 acres).
- Open Sapling/Pole (OSP): sapling and pole size trees dominate (<9" dbh) and canopy cover is 70% or less. Shrubs may be well established (6941 acres).

Semi-open: This category represents a portion of ERDAS data that was not well adapted to other commonly used structure categories. This structure type may have canopy covers from 30-85% but generally consists of young open canopy forest patches dominated by hardwoods; or open, semi-developed areas with scattered trees (such as around homes, farms, recreation sites, major road corridors) (7874 acres).

NOTE: Approximately 2200 acres of the watershed is in non-forest agriculture use which is included within the Open and Semi-open classes.

Small Conifer: Stands that have tree canopy closure over 40% and are dominated by tree sizes between 9-21" dbh, or sapling/pole stands over 70% closure. These stands include:

- Closed Sapling Pole (CSP): trees up to 9" dbh dominate the stand; canopy closure is greater than 70%. Early-seral understory vegetation begins to decline (622 acres).

- Open Small Conifer (OSC): trees 9-21" dbh dominate the stand; canopy closure is 70% or less. This structure type includes: much of Old Maid Flat area; rocky lands with sparse forest; and stands that have been recently thinned. In addition, the semi-open class includes many patches of small sized open-canopy forests, but exact amounts could not be separated out nor included in this total (8067 acres).

- Closed Small Conifer (CSC): trees 9-21" dbh dominate the stand; canopy cover is over 70%. A range of stands are represented -- from dense young single-story stands with little understory vegetation to older stands with multiple layered canopies. At 31,241 acres, this structure type is the most widespread in the watershed (46% of the watershed).

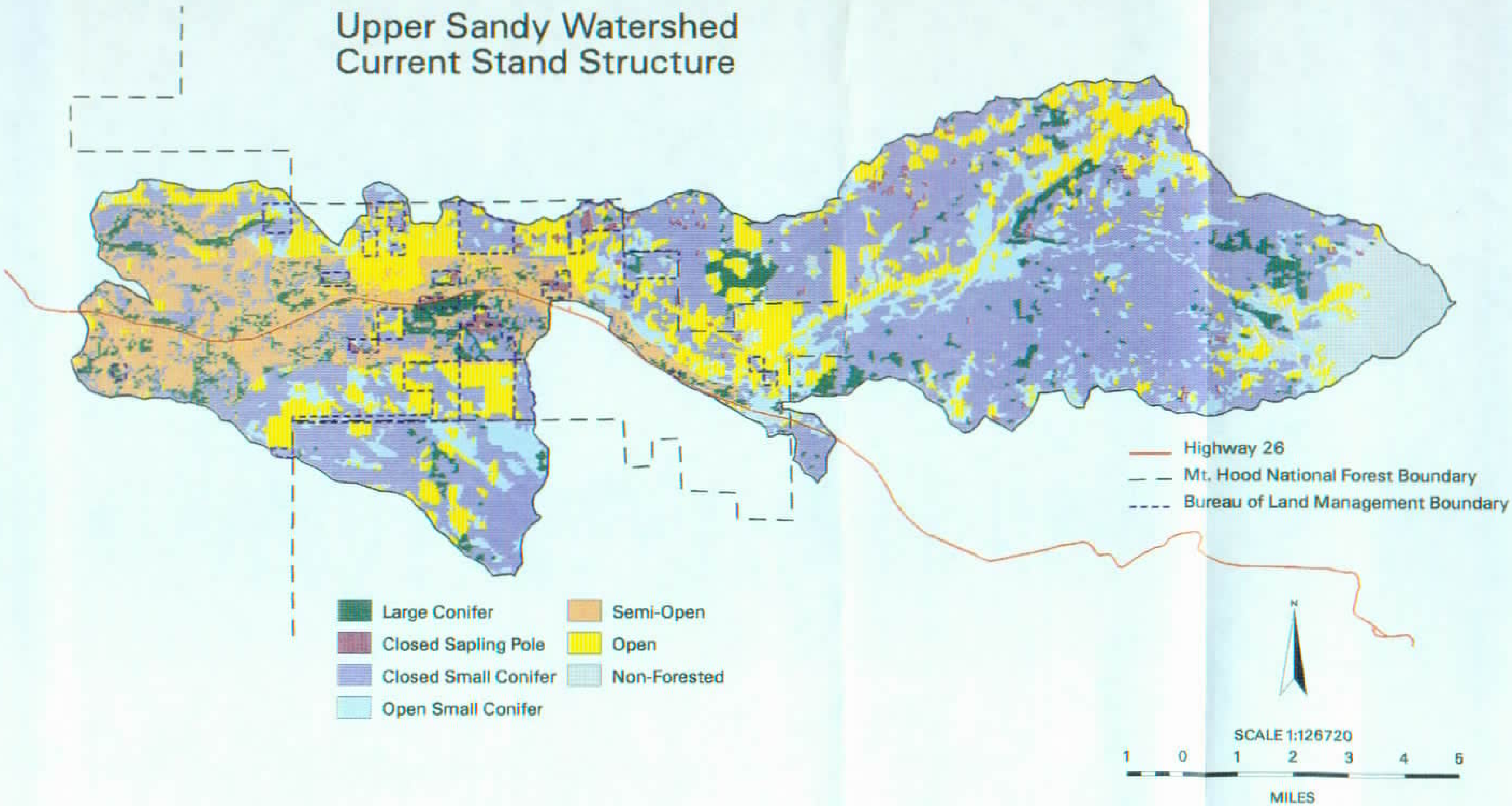
Large Conifer: Stands that have tree canopy closure of 40% or more and are dominated by trees greater than 21" in diameter. This structure type is currently uncommon in the watershed, representing only 7% of the area. These stands include:

- Open Large Conifer (OLC): trees over 21" dbh dominate the stand, and canopy cover is 50% or less (128 acres).
- Closed Large Conifer (CLC): trees over 21" dbh dominate the stand and canopy cover is over 50% (4,767 acres).

Large Conifer stands, at present, are not common in the Upper Sandy Watershed, and occupy only 7% of the watershed area.

Figure 4-13 -- Current Stand Structure, displays the spatial arrangement of dominant stand structures across the watershed.

Upper Sandy Watershed
Current Stand Structure



The watershed's Open stands have resulted from human development activities including agriculture, recent timber harvest, and power line corridor maintenance. Minimal fire activity has occurred during the past 80 years.

Small conifer stands in the watershed include: high elevation stands originating from past stand-replacement fires (currently transitional to late-seral forest); old-growth stands on poor sites (primarily Pacific Silver Fir and Mountain Hemlock Zone); established plantations on productive sites, and old, unproductive, off-site plantations. Old-growth stands that exist at higher elevations may contain smaller tree sizes than those in the lower elevational Douglas-fir dominated stands, however, they too provide important ecological functions as described below.

Most Large conifer stands in the watershed tend to display old-growth characteristics such as large live trees, standing dead trees, multiple layered canopies, and large down logs. The Large class may also include mature stands beginning to develop characteristics of old-growth. Stands of Large Conifer are predominantly found on sites with the highly productive, moist plant associations. In the Upper Sandy Watershed, stands of Large Conifers are infrequent and generally found in isolated patches and canyon bottoms. These scattered patches provide habitat for old-growth related species of plants and animals. They are especially important for maintaining local populations of species that are poor dispersers by providing a source to repopulate future or adjacent stands. Some old-growth species such as certain species of lichens may take hundreds of years to colonize a site. Thus, as these remnant patches become infrequent their importance to landscape diversity becomes critical.

Historic Stand Structure and Trends

Information from 1940's county forest cover surveys (USDA, 1944) provides a snapshot of stand structure information for a period 50 years prior to this analysis. Circa 1948, the Upper Sandy Watershed included: 33% Open (including 4% in agricultural), 45% Small Conifer, and 17% Large Conifer. Approximately 5% of the watershed's area was attributed to rock, snow or water.

Table 4-16 – Stand Structure: 1948 v.s.1996 by Percent of Watershed

Structure Class	1948	1996
Large	17	7
Small	45	59
Semi-open	N/A	11
Open	33	18
Non Veg.	5	5

Notable changes from 1948 to present include a decrease in the amount of Open stands as stands continue to recover from past fires (also providing an increase in the Small class). Harvest activities and perhaps additional development activities account for some of the reduction in the Large Conifer class.

Reasons for the stand structure trends presented in Table 4-16, include:

1. *Growth:* The most noticeable change is in areas of past fire activity that were largely still classed as Open in 1948 and have subsequently grown into the Small Conifer class. This includes extensive areas around Horseshoe Ridge, McIntyre Ridge, and the area around Little Clear Creek up to Hickman Butte. In addition areas that had recent harvest as of 1948 have grown into the Small Conifer class.

2. *Development:* Power line corridor construction and maintenance would have converted some Large and/or Small conifer stands to Open. Additional development of private lands may have converted some forested areas to Open or Semi-open.

3. *Timber harvest:* Regeneration harvest, in particular, has converted primarily Large Conifer stands to Open structure, some of which have subsequently regrown into the Small conifer class.

4. *Different data sources:* Although some inconsistencies between the 1948 and 1996 data sets were readily rectified, minor differences still exist.

Altered conditions and ecological processes may exist in subwatersheds that are both low in late-seral forests and dominated by aggregated openings from harvest units or development.

Even within a somewhat high severity fire regime as found in the Upper Sandy Watershed, some snags, downed trees, large remnant trees and forest patches were left after stand-replacing fires. These components of the preceding stand provided structural diversity within the newly created openings that was carried into the new stands that followed. Some areas of the watershed that had historical stand replacing fires were followed by reburns that most likely removed much of the remaining stand structure. Many of the existing early-seral stands in the watershed, however, were created following timber harvest activities and lack the structural components left behind by most natural fires. *(Harvest activities on federal lands since the late 1980's, however, tended to leave more structural components behind. Current Northwest Forest Plan standards and guidelines require even higher levels of these structural components to be retained after harvest, ROD p. C-39 to C-44.).* Altered conditions and ecological processes may exist in subwatersheds that are low in late-seral forests *(see next section)* especially when dominated by aggregated harvest units and/or when not dispersed among adjacent areas that are high in structural diversity.

Conclusions: Stand Structure

- Stands of Large Conifer are not common. They occur on only 7% of the watershed in isolated patches and canyon bottoms (see Figure 4-13).
- Remnant patches of Large Conifer are critical to maintaining landscape diversity
- The amount of Large Conifer Stands has decreased since 1948 in the watershed.
- Some stands of Small Conifer at upper elevations are actually quite old. These stands are classed as late-seral for seral stage *(next section).*

Seral Stage

Seral Stage serves as an important ecological driver within the watershed that affects a variety of ecosystem functions, including: hydrologic function, wildlife species use, nutrient cycling, production of snags and woody debris, and disturbance processes (fire, windthrow and landslides, among others). In this Watershed Analysis, current (1996) Seral Stage is determined using *both* stand structure data *and* forest zone data. Forest zone helps to account for differing productivity potentials. This stratification beyond structure alone was done to recognize that old stands serve ecological roles that young stands of similar tree size may not. Both situations occur in the Upper Sandy Watershed.

Three categories of forest Seral Stage were utilized in this analysis (*these classifications are used when assessing Northwest Forest Plan standards and guidelines that refer to seral or successional stages*):

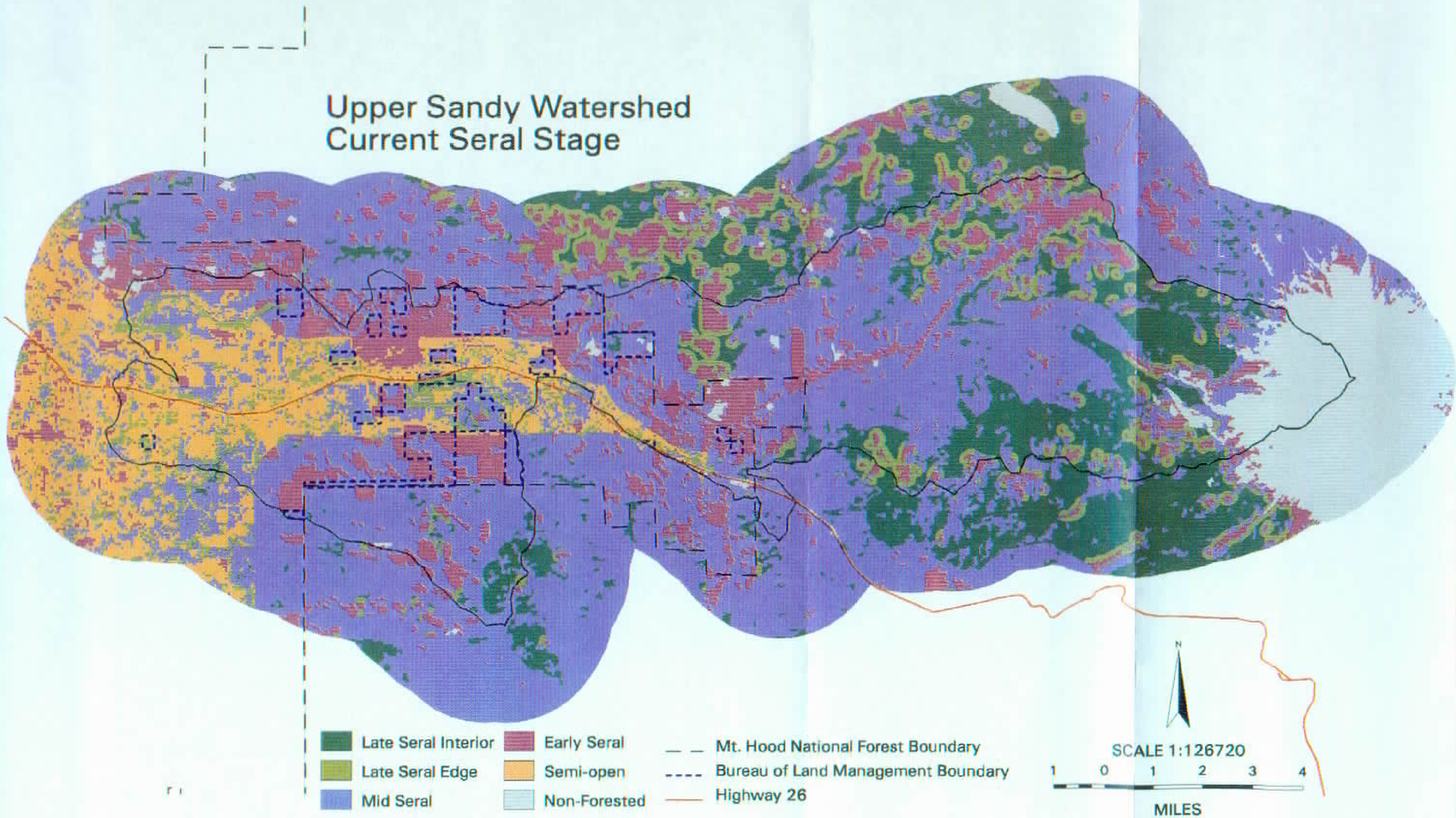
1. **Early:** Essentially all stands classed as Open structure class. Includes areas of potential forest that currently function as openings including grass/forb/shrub through open/sapling/pole classes. As cross referenced with Clackamas County zoning maps, non-forest agriculture lands will be included within this type, and noted as such.

2. **Mid:** Includes closed sapling pole structure class and all stands dominated by trees 9-21" dbh in Western Hemlock Zone (may have some trees over 21"), and stands dominated by trees 9-21" dbh in the Pacific Silver Fir or Mountain Hemlock zones that do not have a component of trees over 21" dbh.

3. **Late:** Late-seral forests are those forest seral stages that include mature and old-growth age classes. Includes all stands classified as Large conifer (over 21" dbh) in all zones. Includes Small conifer stands in the Pacific Silver Fir or Mountain Hemlock Zone with multiple canopies that include at least some trees over 21" dbh.

Currently, late-seral forests occupy 21% of the Upper Sandy Watershed's land area. Mid-seral accounts for 51%, 24% are early-seral, and 5% is non-vegetated (rock/snow/water).

Figure 4-14, displays the current seral stages of forests across the Upper Sandy Watershed. Areas immediately adjacent to the watershed are also included to display current connectivity of forest types across watersheds.


Upper Sandy Watershed
Current Seral Stage
Late Seral Interior
Late Seral Edge
Mid Seral
Early Seral
Semi-open
Non-Forested
Mt. Hood National Forest Boundary
Bureau of Land Management Boundary
Highway 26
N
SCALE 1:126720
1 0 1 2 3 4
MILES

ROD 15% Late-Successional Guideline

With 29% of federal lands in a late-successional (late-seral) condition, the Upper Sandy meets the 15% standard and guideline of the Northwest Forest Plan.

In this watershed analysis document the terms late-successional and late-seral are used with the same meaning. Standards and guidelines from the Northwest Forest Plan state that landscape areas where little late-successional forest persists should be managed to retain late-successional patches. This standard and guideline will be applied in fifth field watersheds with 15% or less late-successional forest on federal lands (ROD p. C-44). The Upper Sandy Watershed as defined in this analysis *(a fifth field watershed)* is currently above this criteria with 29% late-seral on ***federal lands***. Amounts of late-seral forest, however, are often poorly distributed and highly fragmented in the watershed (*see also "Late-Seral Distribution and Pattern" discussion that follows*).

Most of the late-seral forest in the watershed occurs on "reserve lands". Currently 24% of federal lands in the watershed support late-seral forests that are protected by reserve lands. Reserve lands for this purpose include Congressionally Reserved, Administratively Withdrawn, Riparian Reserves and Late Successional Reserves. Table 4-17 displays how the amounts of late-seral forest are distributed on federal lands. Figure 4-15 displays where late-seral forests on federal lands are located.

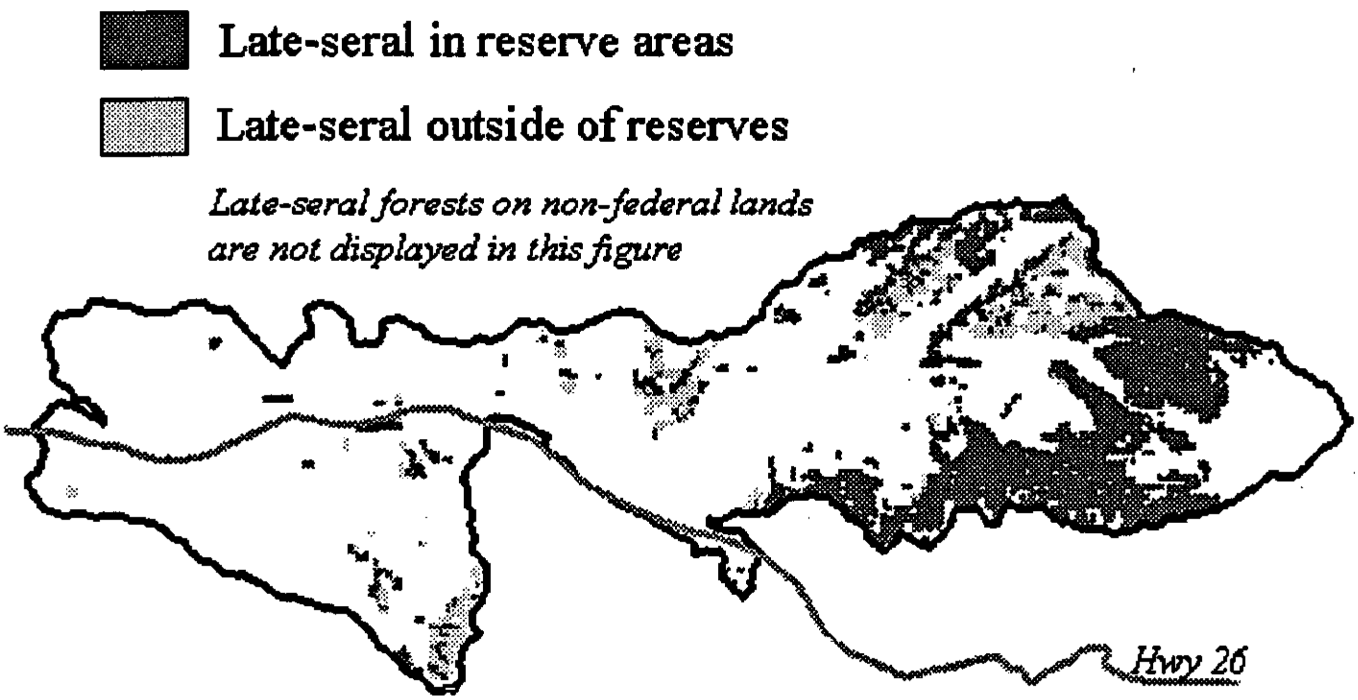
Table 4-17 -- Late-Seral Amounts on Federal Lands

Amounts are grouped by reserve and matrix allocations

Federal Land Area	Total Acres by Area	Acres of Late-Seral	Percent of Late-Seral
Reserve Lands*	30,243	9,994	**24%**
Matrix Lands	11,690	2,346	**5%**
All Federal Lands	**41,933**	**12,340**	**29%**

*Reserve lands as presented in this table include the following "general management" allocations: A2-Wilderness; Riparian Reserves; Late Successional Reserves; A1-Wild and Scenic River; BLM Scenic Viewshed; A9-Key Site Riparian; A4-Special Interest Area. (See Chapter 2, General Management Objectives for detailed allocation information and mapping.)

Figure 4-15 -- Late-Seral Forests on Federal Lands

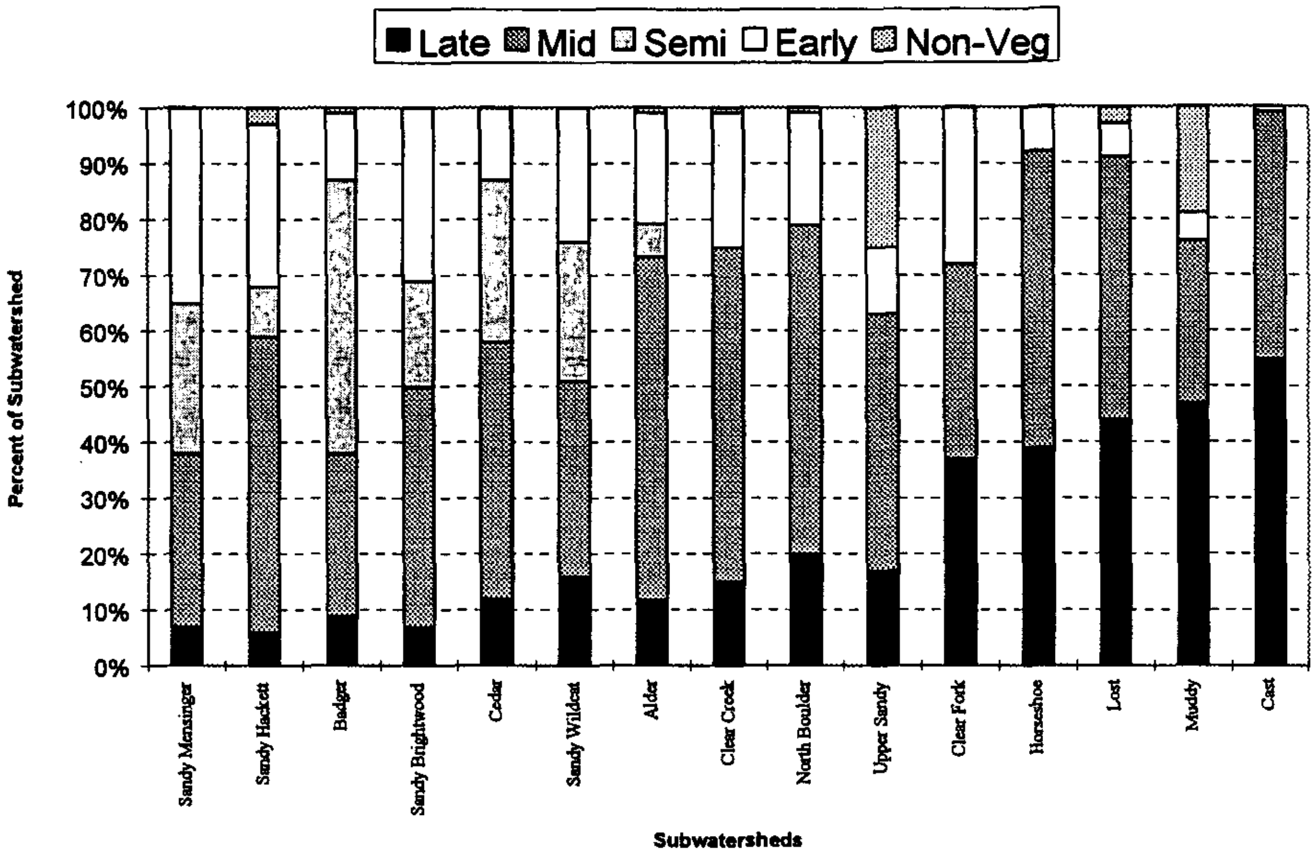


Although late-seral forests occur on 29% of the federal lands in the watershed. many of these stands are only 80-120 years old. Stands of large, old trees are not common and occupy only 6% of the federal lands.

A fair amount of the existing late-seral forests as classed in this analysis are transitional, they are 80 to 120-years-old and just beginning to display characteristics of late-seral forests. Stands of large, old trees (dominated by trees over 21" and over 200 years of age) occur on only 6% of the federal lands (and on only 7% of the entire watershed).

Chart 4-3, displays the proportion of each subwatershed within each seral stage. Five subwatersheds have late-seral amounts between 37%-55% which approximates the natural range of variability as determined at the basin level. These five subwatersheds are entirely within federal ownership. Ten of the Upper Sandy's fifteen subwatersheds have below 20% late-seral forest while four subwatersheds have below 10%. Six of the ten subwatersheds low in late-seral have only isolated patches of late-seral habitat that lack interior habitat. Likewise, these six are also high in early-seral and semi-open conditions. (All six are predominantly in non-federal ownership).

Chart 4-3 Seral Stage Amounts by Subwatershed



Seral Stage – Range of Natural Variability (RNV)

Ecosystems are not static. They vary over both time and space. Successional processes, coupled with a range of disturbance regimes, account for much of this natural variability. Rather than emphasizing any single point in time, the range of natural variability (RNV) concept recognizes the dynamic nature of ecosystems and helps us understand what these parameters may be. These parameters provide an indication on what may or may not be sustainable within an ecosystem, as well as the ecosystem's resiliency. When an ecosystem condition or process is pushed outside this range, that condition/process and those depending upon it might not be sustained naturally. This range can provide "a picture" of what condition a particular species or population may have evolved under or adapted to over time.

Under certain management scenarios, this natural "range of change" may prove too broad. Under other management scenarios, we may wish to exceed it. Thus, exploring what this range of natural variability is, helps ensure we make informed assessments on possible consequences of deviation, and choose appropriate courses of action.

Seral Stage -- Watershed Scale Trends

Applying the range of natural variation (RNV) to Seral Stage in the Upper Sandy Watershed provides an ecosystem reference from which to assess current conditions and future trends. Data from the *1993 Regional Ecological Assessment Project* or "REAP" (USDA, 1993), presents Seral Stage conditions at the basin level. RNV and existing conditions were developed for the Sandy Basin for early and late-seral stage by forest zone.

The amount of late-seral forest is currently well below the Range of Natural Variability, within the Western Hemlock Zone. Late-seral amounts appear to be within the natural range in the Pacific Silver Fir Zone and Mountain Hemlock Zone. Early-seral amounts are within the natural range for all three zones.

Table 4-18 displays the RNV for the three seral stages (previously described) compared to the 1996 existing condition and conditions in 1948 for the Upper Sandy Watershed. *(Note: Future conditions and trends are presented and discussed in Chapter Five.)*

Table 4-18 -- Seral Stage: RNV vs. Past and Present Conditions

Upper Sandy Watershed

By percent of total area (federal lands only)

Zone	Seral Stage	RNV* %	1948 %	Current %
WH	Late	47-59	16	8
PSF	Late	38-55	44	52
MH	Late	n/d	18	66
Total	**Late**	**n/d**	**25**	**29**
WH	Mid	n/d	59	77
PSF	Mid	n/d	20	33
MH	Mid	n/d	37	23
Total	**Mid**	**n/d**	**39**	**50**
WH	Early	8-28	24	15
PSF	Early	9-35	35	14
MH	Early	n/d	43	9
Total	**Early**	**n/d**	**29**	**14**

**RNV based on Basin Level as adapted from REAP, 1993.*

Note: "n/d" = no data or unknown. The 1993 REAP data included natural ranges only for late and early-seral forests and did not include the Mountain Hemlock Zone for the Sandy River Basin.

It is important not to extract too much detail from such comparisons, but rather to focus on obvious trends or amount of deviation and in turn, the implications to ecological function.

At present, the amount of early-seral forest appears to be within the natural range of variability for all forest zones. This was not the case in 1948, however, the trend since has been a reduction in the total amount of early-seral forest. This reduction is primarily due to growth recovery in areas exposed to stand replacement fire earlier this century.

The amount of late-seral is currently outside the natural range only in the Western Hemlock Zone, where at 8% it is well below. It is important to point out that part of this lowered amount is no doubt attributed to the influence of the Old Maid Flats area that is prevalent within the Western Hemlock Zone of this watershed. Although data from Old Maid Flats were also included in the original calculation of

RNV (during REAP, 1993), RNV was calculated at the Basin level, thus the affect of the lower site potential of mudflows is amplified when looking only at the Upper Sandy Watershed. 12% of the Western Hemlock Zone on federal lands in the watershed falls within the mudflow. Additional reasons for this low amount includes the clearing of land for the power line corridor, road building, timber harvest and stand replacing fires early in the century.

At present (1996) late-seral amounts are within the natural range for the Pacific Silver Fir Zone and are similar in the Mountain Hemlock Zone.

Forest stands from the large stand-replacing fires approximately 100 years ago are presently in transition from mid-seral to late-seral within the watershed. In fact, although 29% of federal lands are classed late-seral in this analysis, three fourths of these stands should be viewed as *transitional* to late-seral, that is they are only 80-120 years old and usually do not have well developed old-growth components (found in only one quarter of the late-seral stands). Many of the transitional stands, however, form large contiguous patches, a significant ecological feature.

Seral Stage -- Watershed Context and Basin Scale Trends

The Upper Sandy Watershed along with four other watersheds comprise the Sandy River Basin. According to the Regional Ecological Assessment Project (REAP), the Sandy River Basin is currently below the RNV for late-seral forests in both the Western Hemlock and Pacific Silver Fir Zone. Additionally, the Basin is at the low end of RNV for early-seral. (Refer to Table 4-19)

Table 4-19 -- Seral Stage: RNV vs. Current Condition, Sandy Basin

(by percent of total area within Forest boundary)

Zone	Seral Stage	RNV %	Current %
WH	Late	47-59	**26**
PSF	Late	38-55	**38**
WH	Early	8-28	**12**
PSF	Early	9-35	**13**

REAP information, coupled with information from Watershed Analysis, provides a context to the Upper Sandy Watershed's overall role in reference to the Sandy Basin's other watersheds. Table 4-20 displays the percentage of total late-seral acreage (by forest zone) distributed among the basin's five watersheds on federal lands.

Table 4-20 -- Distribution of Late-Seral Forests in the Sandy Basin

Percent of Basin total by watershed, grouped by zone
(amounts based on federal lands only)

Zone	Bull Run	Zigzag	Salmon	Sandy	Gorge Tribs	Sandy Basin
WH	54	3	18	5	20	30,044 ac
PSF	49	3	25	16	7	47,355 ac
MH	6	4	37	52	2	6,043 ac

By comparing the amounts of late-seral forest in Table 4-20 to the proportion of forest zone present in a particular watershed, Table 4-21, an idea of the contributing role of each watershed at the Basin scale can be visualized. For example, although the Upper Sandy contains 16% of the basin's Western Hemlock Zone (federal lands), it accounts for only 5% of the Basin's late-seral forests in that zone. By contrast, the Bull Run Watershed which contains 40% of the Basin's Western Hemlock Zone, contributes 54% of the Basin's late-seral total in that zone. Thus, it could follow that conditions in the Upper Sandy Watershed are in part, contributing to the below RNV condition at the Basin level.

Table 4-21 -- Distribution of Forest Zones in the Sandy Basin

Percent of basin total by watershed, grouped by zone
(amounts based on federal lands only)

Zone	Bull Run	Zigzag	Salmon	Sandy	Gorge Tribs	Sandy Basin
WH	40	11	18	16	15	115,566 ac
PSF	29	16	33	13	9	123,221 ac
MH	2	31	37	29	1	13,413 ac

Conclusions: Seral Stage

- Seral stage is defined by using both stand structure data (*tree size and forest canopy closure*) and productivity data (*forest zone*).
- Seral stage is synonymous with successional stage throughout this analysis.
- Late-seral forests are above the ROD retention standard of 15%, with 29% currently present on federal lands, most of which is within reserve lands.
- Currently 24% of federal lands in the watershed support late-seral forests that are protected by reserve lands.

- Late-seral amounts will increase in the future as a large portion of the reserve lands are presently in younger forests (Table 4-17).

- Three fourths of the late-seral amount is *transitional*, that is only 80-100 years old.

- Seral stage amounts are within the RNV for the Pacific Silver Fir and Mountain Hemlock Zones.

- Late-seral forests in the Western Hemlock Zone are uncommon and highly fragmented. The amount is far below the RNV (see Table 4-18 -- Seral Stage: RNV vs. Past and Present Conditions).

- Conditions in the Upper Sandy Watershed may be contributing to the low amount of late-seral at the Basin level (see Table 4-20).

Late-Seral Distribution and Pattern

Although the Western Hemlock Zone dominates the land area of the watershed, late-seral forests in these low elevation forests are scarce and highly fragmented.

When quantifying late-seral conditions, not only is the total amount of interest, but also the pattern (patch size and arrangement). The pattern affects ecological function. According to Chen et al. (1990), late-seral forests next to clearcuts may have reduced humidity, increased wind velocity, and increased summer temperatures up to 600 feet into the forest. Soil temperature and moisture content may be affected up to 400 feet from the edge. Any species that relies on microhabitats found in interior forest patches may have problems with edge habitat.(Chen et al. 1990) High amounts of edge may also allow for invasion by edge predators and introduced species (Simberloff et al. 1992).

Interior habitat is defined in this analysis as late-seral stands that are at least 500 feet from created openings whereas that portion within 500 feet functions as edge. Created openings include those created by human activities such as timber harvest or natural disturbance events such as lightning fires. Openings for this purpose generally will be early-seral forest patches or agricultural lands and exclude stable natural openings such as wetlands or rock patches.

The Upper Sandy Watershed has 12% interior late-seral habitat and 9% edge habitat for a total of 21% late-seral habitat (all ownership's). Practically the entire amount of interior habitat is found on federal lands. Refer back to Figure 4-14 -- Current Seral Stage, to view the arrangement of interior and edge habitat in the watershed and adjacent areas. As can be seen in this map, dispersed early-seral openings create high amounts of edge habitat and contribute to forest fragmentation.

Patch size of late-seral forest affects the quality of habitat as pertaining to a variety of species associated with late-seral forests. The Mt. Hood Forest Plan includes Forestwide standards that state fragmentation of old-growth forest stands of substantial size (e.g. 100 acres) should be minimized (USDA 1990, p. 4-67). The standard suggests measures to minimize fragmentation such as placement of harvest units in small fragmented patches or at the edge of large intact blocks. Existing late-seral blocks may serve as important links in the existing "functional and interconnected old-growth ecosystem" (ROD p. 5) and may have a role in assuring this objective of ecosystem management is met in the future. (This concern is evaluated further in Chapter Six, Key Question #2).

Large patches of interior habitat in this watershed are located primarily in upper elevation forests of the Pacific Silver Fir and Mountain Hemlock Zones. Late-seral habitat in low elevation forests (i.e. Western Hemlock Zone) is scarce and tends to be highly fragmented. To help characterize the distribution of late-seral forests across the Upper Sandy Watershed and adjacent lands, the number and size of interior late-seral forest patches are presented in Table 4-22.

Table 4-22 -- Interior Late-Seral Forest: Patch Size and Number

Patch size (acres):	> 1000	301-1000	101-300	41-100	10-40
Number of Patches: (watershed only)	2	2	4	7	30
Number of Patches: (watershed and adjoining lands*)	4	8	13	17	75

** adjoining lands include a two mile area around the watershed*

Landscape Pattern

Landscape pattern is a critical determinant of landscape scale ecological processes. Many forests in the Upper Sandy Watershed have been initiated by stand-replacing fires and to a lesser extent volcanic mudflows. Some young forests have been initiated by human activities such as timber harvest, while other forests have been altered by timber management activities such as thinning. Other areas have been converted from forest to agriculture or developed land. These events influence species composition and stand structure, and, in turn, the landscape pattern.

Pattern characteristics include patch size, shape, amount of edge/interior habitat, and degree of fragmentation or connectivity. Plants and animals may have become adapted to a particular level of patchiness in the distribution of resources across the landscape.

Landscape patterns in previous centuries generally consisted of large unfragmented, irregularly-shaped patches of early, mid or late-seral forests. Forest cover of mid to late-seral stands dominated the landscape in large contiguous areas. These forests were generally well connected across the landscape. Nearby examples of such patterns are evident within portions of the Mt. Hood Wilderness, the Salmon-Huckleberry Wilderness and the Bull Run Watershed.

A large-scale landscape analysis of the Mt. Hood National Forest (PULSE, 1994) included a classification of landscape patterns. The Sandy River Basin as a whole currently includes extensive areas of non-fragmented forest (some late, but most within mid-seral conditions); perforated old forest; and some smaller areas of local fragmentation or aggregated openings. Dominant pattern types and amounts specific to the Upper Sandy Watershed are summarized below.

Aggregated Openings **– (approximately 58% of watershed)**

Closed Canopy forest occupies less than 50% of this landscape. Open patches, created primarily by human activities, dominate the structure and function of the landscape. Openings begin to coalesce into areas larger than 60 acres. Forest connectivity and interior habitat is severely reduced or absent. This condition is prevalent in the western half of the watershed as well as along the Lolo Pass Road and powerline corridor area in the mid to northeast portion of the watershed. This west to east band dissects the connected forest landscape areas of the Bull Run to the north from the extensive unfragmented forests of the Salmon-Huckleberry Wilderness to the south.

Fragmented **– (approximately 7% of watershed)**

Closed canopy forest comprises approximately 60-70% of this landscape, with the remainder occurring in open patches or plantations created through timber harvest. Harvest units tend to be uniform in size, less than 60 acres, with high contrast edges. Harvest units are fairly evenly dispersed within the forest. Forest connectivity may begin to be significantly impaired when the amount of forest reaches 60% or less. Areas in the northeast portion of the watershed fit this description.

Perforated -- **(approximately 5% of watershed)**

Closed canopy forest comprises 70-80% of total landscape within this class and is perforated by uniformly dispersed harvest units of up to 60 acres. Forest connectivity is still high, although the amount of interior habitat is reduced from that of a non-fragmented condition. Small "fingers" of perforated forest extend south from the Bull Run into the Upper Sandy Watershed around North Mountain and upper Clear Creek.

Unfragmented Forest -- **(approximately 22% of watershed)**

Closed canopy forest dominates the landscape, composing 85% or more of the total acreage. Open patches within are primarily natural in origin (such as rocky ridges, meadows or wetlands). There is a high degree of forest connectivity and a large amount of interior habitat area. Unfragmented forest dominates the southeast portion of the watershed in the Mt. Hood Wilderness.

Nonforested Alpine -- **(approximately 5% of watershed)**
Open areas that may include sparse alpine vegetation, meadows, tree islands, or rock/snow/ice dominate this portion of the watershed generally above 6000 feet elevation on the flanks of Mt. Hood.

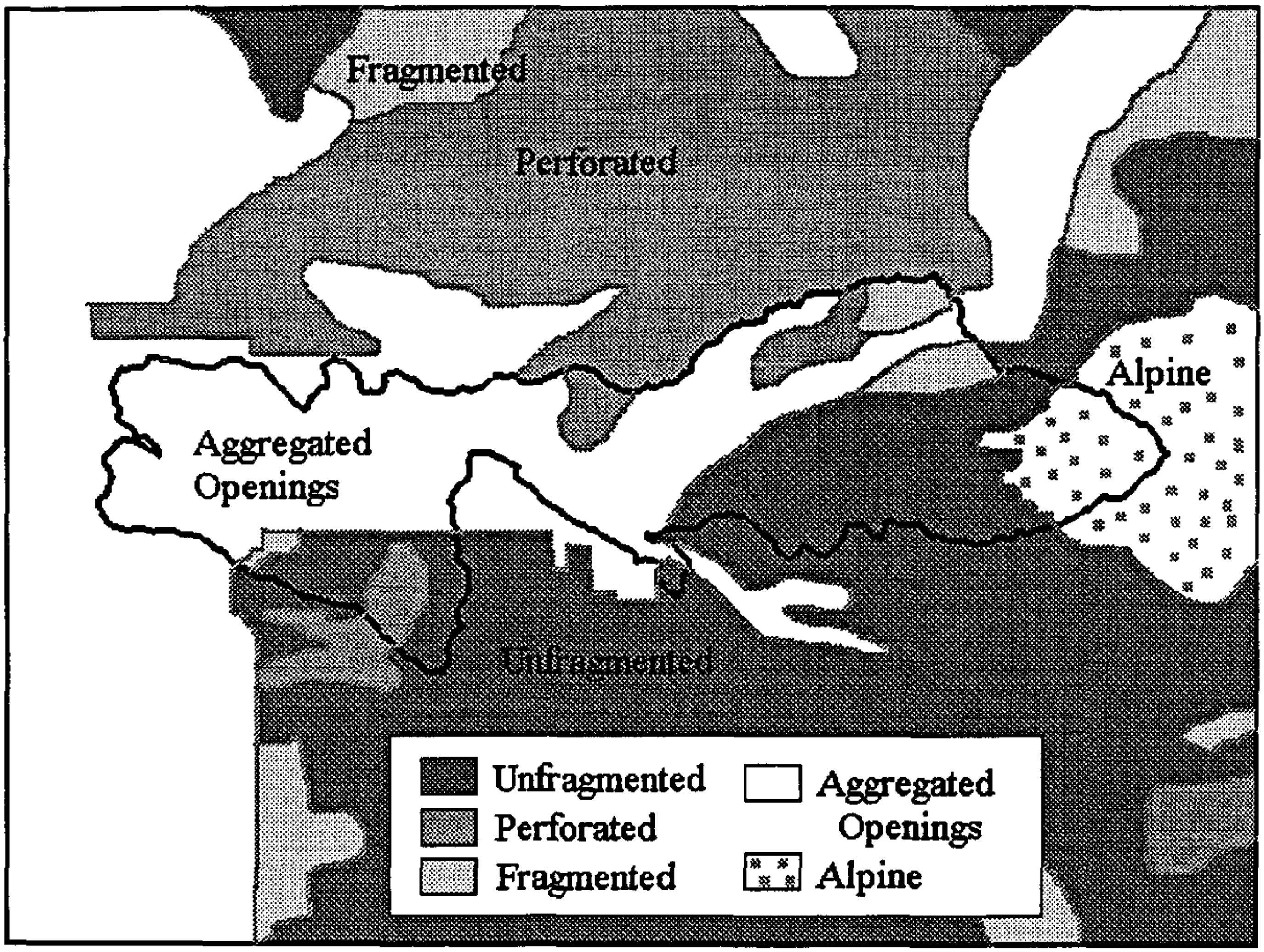
Figure 4-16 (adapted from PULSE 1994) displays a simplification of general landscape patterns within the Upper Sandy Watershed and upon adjacent lands. Lands to the west of the watershed are dominated by aggregated openings on residential/commercial and agriculture lands. This pattern forms a west to east band across the Upper Sandy Watershed that dissects the large continuous forest landscape areas of the Bull Run to the north (perforated forest) from the continuous (unfragmented) forests of the Salmon-Huckleberry Wilderness to the south. Alpine and unfragmented high elevation forests dominate the eastern end of the watershed and form connections with adjacent watersheds to the east as well as to extensive unfragmented areas to the southeast of the watershed.

Conclusions: Landscape Pattern

- A pattern of aggregated openings cover over half of the watersheds land area and form an east/west band between large continuous forest blocks to the north and south (see Figure 4-16 -- Landscape Patterns of the Upper Sandy and Vicinity).
- Landscape patterns are generally altered from the RNV, with patchy high contrast patterns common instead of large irregular patches.
- Nearly one half of the late-seral habitat in the watershed functions as edge (9% edge and 12% interior).

- Dispersed timber harvest units have caused many portions of late-seral forests to function as edge.
- All interior habitat is on federal lands.
- Large patches of late-seral forest are not common and tend to be present only at high elevations in the watershed (see Figure 4-14 and Table 4-22).

Figure 4-16 – Landscape Patterns of the Upper Sandy and Vicinity



Special Habitats

Special habitats constitute a vital part of the Forest's vegetation diversity – both biologically and in terms of human values. While special habitats comprise a relatively small portion of the Upper Sandy Watershed (11%), they nonetheless represent a significant contribution to the watershed's species and ecosystem diversity, as well as the ecological function at the landscape scale.

The Upper Sandy Watershed contains approximately 7,663 acres of these special habitats, including an abundance of unique alpine/subalpine and mudflow communities. Table 4-23 lists the watershed's special habitat types, approximate acres, and their associated species of concern. Additional discussions of individual species are included in this chapter's botany, wildlife, and fisheries subsections. In addition, Figure 4-17 -- Special Habitats, displays the distribution of these habitats throughout the watershed.

Table 4-23 -- Special Habitats and Associated Species of Concern in the Upper Sandy Watershed

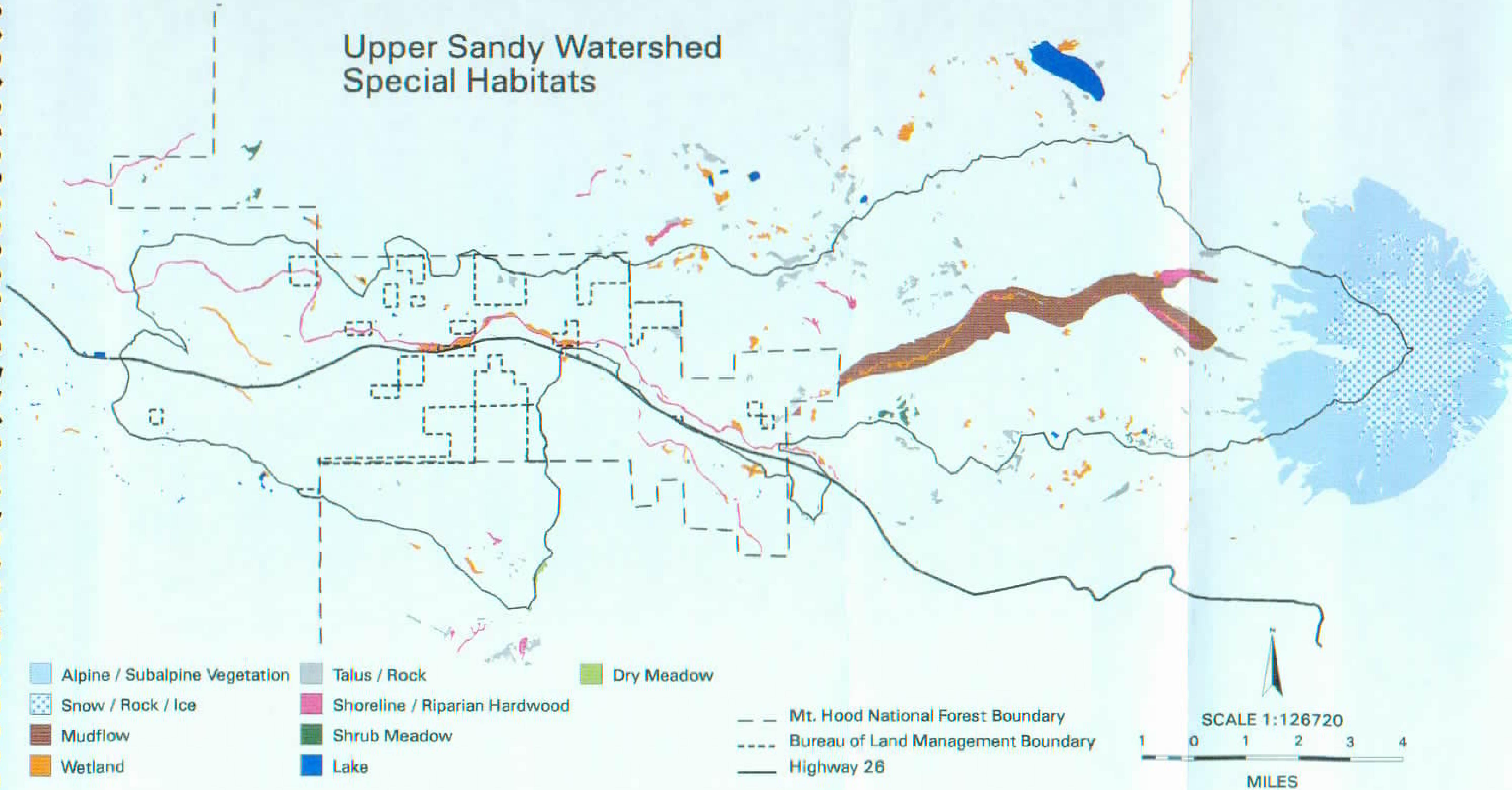
SPECIAL HABITAT	ACRES	ASSOCIATED SPECIES OF CONCERN*
Subalpine/Alpine		
snow-rock	1181	Gray rosy crowned finch
tall shrub	823	
subalpine mosiac	367	*Tholurna dissimilis* (D), survey and manage lichens (S)
pin cushion	340	*Phlox hendersonii* (S)
low shrub	330	
meadow	231	Brewer's reedgrass (D)
open forest – high elevation	8	*Gastroboletus ruber* (D), *Tholurna dissimilis* (S), survey and manage fungi and lichens (S)
Wetlands	555	pale sedge (D), fir clubmoss (D), cottongrass (D), wild cranberry (D), three-leaved goldthread (S), indian rice (S), bog clubmoss (S), adder's tongue (S), scheuchzeria (S), *Strickland's taushia* (S), lesser bladderwort (S)
Mudflow	2606	survey and manage fungi, lichens and bryophytes (S); black-backed woodpecker

SPECIAL HABITAT	ACRES	ASSOCIATED SPECIES OF CONCERN*
Boulders, Talus, Scree	457	survey and manage lichens (S); Larch mountain salamander
Rocky Lands	119	Howell's daisy (S), survey and manage lichens (S)
Shoreline	347	Howell's montia (S)
Riparian Hardwoods	215	survey and manage fungi, lichens and bryophytes (S)
Shrub Meadow	65	ground cedar (S)
Dry Meadow	11	tall agoseris (S), lance-leaved grape fern (S)
Lakes	6	Red-legged frog
Quarry	2	

*** D = documented S = suspected**

Subalpine and Alpine Zone

Mt. Hood's subalpine and alpine zone is composed of seven individual special habitat types: low shrub, tall shrub, open forest, meadow, pincushion (low growing plants), subalpine mosiac, and non-vegetated snow-rock. This zone's 3280 total acres makes it the largest special habitat area in the watershed. And, because subalpine/alpine plant communities account for only one percent of the Mt. Hood National Forest, the Upper Sandy Watershed's contribution (approximately 20 percent) provides an important component to Forest-wide biodiversity.


Upper Sandy Watershed
Special Habitats
Alpine / Subalpine Vegetation
Snow / Rock / Ice
Mudflow
Wetland
Talus / Rock
Shoreline / Riparian Hardwood
Shrub Meadow
Lake
Dry Meadow
Mt. Hood National Forest Boundary
Bureau of Land Management Boundary
Highway 26
SCALE 1:126720
1 0 1 2 3 4
MILES

Forest visitors and recreationists are attracted to Paradise Park and Yocum Ridge for their colorful wildflower meadows. **Brewer's reed grass**, a rare grass, grows in moist meadow sites at Paradise Park. ***Tholurna dissimilis***, a Survey and Manage lichen, is also found at Paradise Park in krummholz trees (trees dwarfed by harsh environmental conditions).

Wetlands

Wetlands, representing 555 acres, include several large wetlands located in the North Mountain area. A complex of five wetlands located on the southwest side of North Mountain is recognized as a Key Site Riparian (KSR) Area (A9) in the Mt. Hood Forest Plan. These wetlands are monitored by a volunteer organization called Wetland Wildlife Watch.

In July 1996, **Pale sedge**, a Forest Service Sensitive plant, was located in a wetland on North Mountain's southeast side. **Cottongrass** and **wild cranberry** also grow within these North Mountain wetlands.

Another KSR wetland is located in the Cedar Creek drainage on Wildcat Mountain. Despite timber harvest impacts, a small population of **fir clubmoss** has survived in this wetland.

Mudflow

Old Maid Flat (2600 acres) is designated as a Geologic Special Interest Area in the Mt. Hood Forest Plan. This 200-year-old mudflow surface which forms a broad, flat valley bottom, is a textbook example of primary successional stages associated with volcanic activity. Lodgepole pine dominates park-like open-canopy forest that supports dense carpets of lichens and mosses. *The Upper Sandy Wild and Scenic River Environmental Assessment and Management Plan* (USDA, 1994), describes the various unique aspects of this area in detail.

More than 100 species of mushrooms -- and an equal number of bryophytes and lichens -- cover the mudflow surface. In fact, Old Maid Flat is among a few rare locations adjacent to the Portland metropolitan area where the highly-prized matzutake mushroom grows in abundance. Heavy recreational use including camping and mushroom-picking threatens this area's unique biodiversity through activities such as littering and off-road vehicle use. Ultimately, through natural succession, the mudflow community will resemble mature forest. *The Upper Sandy Wild and Scenic River Plan* allows for activities that may change or retard the potential natural vegetation.

The lodgepole pine communities of the mudflow may be potential habitat for the black-backed woodpecker.

In 1994, a large-scale analysis of the Mt. Hood National Forest, "Pulse," targeted Old Maid Flat as an area at risk from current uses that is a critical candidate for restoration.

Boulders, Talus, Scree and Rocky Lands

Boulders, talus and scree (457 acres) and rocky lands (119 acres) are scattered throughout the watershed's upper portion. Boulders, talus and scree serve as homes to various plants, including: stonecrop, parsley fern, selaginella, lichens and mosses. Moist talus slopes could provide habitat for Larch Mountain salamander.

Shaded, moist talus is potential habitat for the Survey and Manage lichen, ***Pilophorus nigricaulis***. In addition, seasonally moist rocky areas with thin soils often support productive wildflower meadows. In fact, the south-facing meadow on Bald Mountain hosts one of the watershed's most diverse and visually explosive wildflower displays. Thus, this meadow receives heavy visitation during May and June via the adjacent Timber Line (Pacific Crest) Trail. While some subsequent erosion and trampling is evident, Bald Mountain's steepness convinces most visitors to keep their tracks on the trail.

Shoreline and Riparian Hardwood

All shoreline (347 acres) and the majority of the riparian hardwood (215 acres) special habitat occurs along the Sandy River. This habitat configuration reflects the broader floodplain landform. Vegetation here actively interacts with the river, providing a multitude of functions, including: slowing flood flows, filtering sediment, contributing organic materials, and providing hiding cover for fish. Red alder, a dominant nitrogen-fixing hardwood species, can provide significant nitrogen inputs to riparian ecosystems. In addition, riparian hardwoods serve as important homes to many bryophyte and lichen species that require a humid cool environment. The Sandy River functions as a migration flyway for Harlequin ducks.

Shrub Meadow

Shrub meadows (65 acres) have resulted from past fires provide habitat for **ground cedar**. Existing sites are located at the edges of forest/shrub openings. Plant succession may change shrub-meadow habitat to forest over time.

Lakes

Three small lakes (Burnt, Cast and Dumbell) are located in the upper watershed. All receive recreational use. A wetland area is associated with the south end of Burnt Lake. No unusual plants are known from the lakes area. The watershed's lakes could potentially provide habitat for red-legged frog.

Botany

Plant Biodiversity

The Upper Sandy Watershed's wide elevation range (approximately 600 to11,000 feet), its unique geology, and its varied habitat all contribute to its diversity of plants. Plant communities range: from sparse alpine pincushion to lush forest, from floristically spectacular subalpine meadows to manicured urban yards, from lichen and moss covered volcanic flows to sedge wetlands.

Potentially 913 different vascular plants -- 14 percent of which would not be native to the Pacific Northwest (USDA 1994, SCAA Database) -- may be present within the watershed's Forest Service lands. However, because 38% of the Upper Sandy Watershed is comprised of non-federal lands which experience a wide range of uses, the number and percent of non-native species is expected to be much higher for the entire watershed. Due to the lack of information on fungi, lichens, and bryophytes, there are no species estimates for these plant groups.

Threatened and Endangered Plant Species

No federally listed threatened or endangered plant species are known or expected within the Upper Sandy Watershed.

Regional Forester's Sensitive Species

Twenty sensitive plant species are either documented or suspected to occur in the Upper Sandy Watershed (see Table 4-24). Documented sensitive plant surveys date back to the early 1980's. The majority of these surveys examine areas associated with timber harvest.

Table 4-24 -- Sensitive and Inventory Plants in the Upper Sandy Watershed

SPECIES	FS STATUS	ONHP STATUS*	HABITAT/ LOCATION
Calamagrotis brewerii Brewer's reedgrass	Sensitive, Documented	List 2	moist subalpine meadows/ Paradise Park
Carex livida pale sedge	Sensitive, Documented	List 2	wetlands/North Mtn
Corydalis aquae-gelidae cold-water corydalis	Sensitive, Documented	List 1	cold springs, streams on fine gravels/Wildcat Mtn
Diphasiastrum complanatum ground cedar	Sensitive, Documented	List 2	mid-elevation shrub openings/North Mtn
Huperzia occidentale fir clubmoss	Sensitive, Documented	List 2	riparian areas, damp forest/Clear Fk, Lost Ck, Wildcat Mtn
Streptopus streptopoides krushea	Sensitive, Documented	List 2	mature forest on thick duff/ North Mtn
Agoseris elata tall agoseris	Sensitive, Suspected	List 2	dry-moist meadows
Botrychium lanceolatum lance-leaved grape fern	Sensitive, Suspected	List 2	mesic meadows, open forest
Botrychium minganense moonwort	Sensitive, Suspected	List 2	wet old-growth cedar forest
Botrychium montanum mountain grape fern	Sensitive, Suspected	List 2	wet old-growth cedar forest
Botrychium pinnatum pinnate grape fern	Sensitive, Suspected	List 2	wet cedar/spruce forest
Cimicifuga elata tall bugbane	Sensitive, Suspected	List 1	mesic forest openings
Coptis trifolia three-leaflet goldthread	Sensitive, Suspected	List 2	wetland edges

SPECIES	FS STATUS	ONHP STATUS*	HABITAT/ LOCATION
Erigeron howellii Howell's daisy	Sensitive, Suspected	List 1	basalt outcrops
Fritillaria camschatcensis indian rice	Sensitive, Suspected	List 2	wetlands
Lycopodiella imundata bog clubmoss	Sensitive, Suspected	List 2	wetlands
Ophioglossum pusillum adder's tongue	Sensitive, Suspected	List 2	wetlands
Phlox hendersonii Henderson's phlox	Sensitive, Suspected	List 2	alpine pincushion
Scheuchzeria palustris scheuchzeria	Sensitive, Suspected	List 2	wetlands
Taushia stricklandii Strickland's taushia	Sensitive, Suspected	List 2	wetland edges
Utricularia minor lesser bladderwort	Sensitive, Suspected	List 2	wetland ponds, depressions
Eriophorum polystachion cottongrass	Inventory, Documented	Watch List	wetlands/ North Mtn
Lycopodium annotinum stiff clubmoss	Inventory, Documented	Watch List	wetlands/
Poa laxiflora loose-flowered bluegrass	Inventory, Documented	Watch List	riparian areas/Lost Ck
Vaccinium oxycoccus wild cranberry	Inventory, Documented	Watch List	wetlands

* ONHP = Oregon Natural Heritage Program: List 1 = threatened with extinction throughout range; List 2 = threatened with extirpation or very rare in Oregon; Watch List = conservation concern.

Documented Species:

***Streptopus streptopoides*, krushea**: reaches the southern edge of its North American range in the Upper Sandy Watershed on North Mountain. This little lily is more common from northern Washington to Alaska, and is sparsely distributed in northern Idaho. In Oregon, the majority of sites are located in the Bull Run Watershed. The *Bull Run Watershed Analysis* (in preparation, 1996) highlights important aspects of krushea's local ecology. Further information and management recommendations are described in the Oregon Natural Heritage Program's draft *Species Management Guide for Streptopus streptopoides* (Kagan and Vrilakas, 1993).

Important habitat characteristics include old-growth forest with 50-75% canopy cover, and a well-developed duff layer consisting of rotting wood and bark. Because of its strong relationship with decomposing wood, krushea may also have a fungal associate.

Events that reduce canopy cover, soil moisture, and duff can negatively impact krushea. Natural short-term threats include windthrow and wildfire. Human-related threats include logging and slash-burning. Sites in the North Mountain area are found almost exclusively in fragmented old-growth stands of large stand structure (trees > 21" diameter), including some selectively cut stands. Kagan and Vrilakas' draft species management guide lists five major sites which should be protected to assure the long-term viability of this species in Oregon -- and perhaps help preserve the genetic viability of the entire species. An approximately five hundred-acre area on North Mountain within the Upper Sandy Watershed is one of these five sites. The Northwest Forest Plan also suggests protecting these sites as a mitigation measure (ROD, p 33).

***Calamagrotis breweri "var. breweri"*, Brewer's reedgrass**: is a small blue-green subalpine grass found in moist meadow sites. Two populations grow on Mt. Hood: a northwest group that includes small patches in the Upper Sandy Watershed at Paradise Park; and a southeast group that includes areas within the Mt. Hood Meadows. Ski Area. These two Mt. Hood populations, along with one on Mt. Jefferson, are disjunct from related populations in the Klamath Mountains. In addition, all of these northern populations are genetically distinct from the southern populations of the Sierra Nevadas. Therefore, these northern populations were recently recognized as "var. breweri" (Susan Nugent, pers. com.). Ecological and genetic studies are in progress at Oregon State University. Intensive field surveys were also launched during the 1996 summer season to determine the distribution of Brewer's reedgrass on Mt. Hood (Susan Nugent, pers. com.).

***Carex livida*, pale sedge**: was recently located in a North Mountain wetland where it forms distinctive blue-green patches along the edges of small channels. Though its range is circumboreal, pale sedge is rare in Oregon. Four locations are known within the Mt. Hood National Forest: two Bull Run Watershed wetlands and the Salmon River Meadows in the Salmon River Watershed and North Mountain.

Corydalis aquae-gelidae, **cold-water corydalis**: is an elegant pink-flowered inhabitant of clear, cold springs, seeps and streams in northwest Oregon and southwest Washington. Due to its small local range and dependence on high-quality riparian habitat, cold-water corydalis is also listed as a Survey and Manage species in the Northwest Forest Plan (see next section). The largest concentration of its sites are located in the Clackamas River Basin. Within the Upper Sandy Watershed, several sites are located in the Alder Creek headwaters on Wildcat Mountain in small tributaries and in a spring. Sensitive plant reports note grazing on coldwater corydalis by deer and elk. A historical site located beside U.S. Highway 26 in the Wildcat Creek drainage has not been relocated.

Habitat requirements include: cold water (average substrate temperature of 10 C); >50% gravel with coarse sand; usually perennial flow; shallow water; and a high streamside canopy. The draft Species Management Guide for *Corydalis aquae-gelidae* (Goldenberg, 1990) contains more information about the distribution and ecology of this plant within the Mt. Hood National Forest.

***Diphasiastrum complanatum*, ground cedar**: grows at the shrubby edge of a wet depression at the headwaters of Little Clear Creek. A population discovered in 1976 on the old Burnt Lake trail has not been found again since 1989 despite numerous attempts. While ground cedar is more common from Washington to Alaska, it reaches the southern edge of its range in Oregon. Government Camp's Ski Bowl ski area in the Zigzag Watershed is home to the largest population in Oregon.

Ground cedar favors shrubby areas with northern aspects at upper mid-elevations. Its life history appears to be associated with hot fires (Eames, 1942) or other disturbances that expose mineral soil. Fire history maps from the late 1800s and 1914 indicate that both sites burned about 90-100 years ago. Competition from surrounding vegetation on the abandoned Burnt Lake Trail may have eliminated this population.

***Huperzia occidentale*, fir clubmoss**: is circumboreal in its distribution and nears the southern edge of its range on Mt. Hood National Forest and adjacent Bureau of Land Managment (BLM) lands. It is well distributed on the west side of the Forest, though not common. At least 28 sites have been identified within the Upper Sandy Watershed within riparian areas in the following drainages: Lost Creek, Clear Fork, North Boulder Creek, Clear Creek, Wildcat Creek,Cedar Creek and Alder Creek.

Fir clubmoss favors mature riparian forest and prefers an undisturbed forest floor/streamside with well-developed humus layer and woody debris. Occasionally, as in the Cedar Creek Key Site Riparian (KSR) area, it grows on mossy hummocks in wetlands. Historically, fir clubmoss may have been more abundant. Past timber harvest pratices, however, have altered riparian forests that provided its necessary quality habitat. Current Riparian Reserve guidelines should help improve this habitat.

Mt. Hood National Forest Inventory Species

Unlike Regional Forester's Sensitive Species, Mt. Hood Inventory Species do not require any special protection or management. These plants are on the Oregon Natural Heritage Program Review or Watch Lists, and are recorded when found.

Table 4-24 lists the Inventory Species located in the Upper Sandy Watershed. **Loose-flowered bluegrass**, formerly on the Sensitive list, is found in patches along Lost Creek. Because loose-flowered bluegrass is commonly associated with disturbed ground in riparian areas (Grenier, 1993), the potential construction of new hiking trails in this area should not harm it.

BLM Special Status Species

Habitat for the Bureau of Land Management (BLM) Special Status Species (listed in Table 4-25) is present in the Upper Sandy Watershed. Bureau Sensitive Species are those that may be threatened or rare in Oregon. Assessment Species are plants of concern in Oregon that are not eligible for Federal or State listing.

Two species are documented in the watershed: noble polypore and fir clubmoss. *For information on noble polypore, see the Survey and Manage section of this chapter. Fir clubmoss is discussed under the Regional Forester's Sensitive Species section of this chapter.*

Table 4-25 -- BLM Special Status Species in Upper Sandy Watershed

SPECIES	BLM STATUS	ONHP STATUS	HABITAT/ LOCATION
Bridgeoporus nobilissmus noble polypore	Bureau Sensitive, Documented	List 1	old-growth true fir snags and stumps/North Mtn (extirpated)
Cimicifuga elata tall bugbane	Bureau Sensitive, Suspected	List 1	mesic forest openings
Corydalis aquae-gelidae cold-water corydalis	Bureau Sensitive, Suspected	List 1	cold springs, streams on fine gravels
Montia howellii Howell's montia	Bureau Sensitive, Suspected	List 1	rocky river banks, especially in disturbed sites
Botrychium minganense moonwort	Assessment Species, Suspected	List 2	wet old growth cedar forest
Botrychium montanum mountain grape fern	Assessment Species, Suspected	List 2	wet old growth cedar forest
Huperzia occidentale fir clubmoss	Assessment Species, Documented	List 2	riparian areas, damp forest/North Boulder Ck, Wildcat Ck
Hypogymnia oceanica	Assessment Species, Suspected	List 2	old-growth forest canopy
Nephroma occultum	Assessment Species, Suspected	List 2	old-growth forest canopy
Pannaria rubiginosa	Assessment Species, Suspected	List 2	old-growth forest canopy
Streptopus streptopoides krushea	Assessment Species, Suspected	List 2	mature forest on thick duff

Northwest Forest Plan Survey and Manage Species

The Northwest Forest Plan lists fungi, lichens, bryophytes, and vascular plants to be given consideration through survey and management standards and guidelines (ROD pp C4-C6, Table C-3 pp C49-C61).

Four strategy ratings apply to survey and manage species:

1. Manage known sites (beginning in 1995).
2. Survey prior to ground disturbing activities and manage newly discovered sites (for 1999 project implementation and beyond).
3. Conduct extensive surveys for the species to find high priority sites for species management.
4. Conduct general regional surveys to acquire additional information and to determine necessary levels of protection.

Species with strategy ratings 1 or 2 demand the most immediate attention. Guidelines for survey and manage species with a strategy 1 rating are in draft form and should be available from the Forest Service's Region Six Regional Ecosystem Office by the fall of 1996. Protocol for strategy 2 surveys should be available for 1997.

All survey and manage species from Table C-3 in the Northwest Forest Plan were analyzed for distribution and habitat in the Upper Sandy Watershed. A table summarizing this information is on file with the Zigzag Ranger District Botanist. Strategy 1 or 2 species documented from the watershed are summarized in Table 4-26.

Table 4-26 -- Documented Survey and Manage Species

Upper Sandy Watershed

SPECIES	SURVEY AND MANAGE STRATEGY	HABITAT/LOCATION
FUNGI		
Bridgeoporus nobilissmus	1,2,3	large diameter true fir snags and stumps/Wildcat Mtn, North Mtn
LICHENS		
Hydrothyria venosa	1,3	cold, clear streams
Hypogymnia duplicata	1,2,3	cool, damp late successional forest/Clear Fork, Wildcat Mtn
Loxosporopsis coraliferra	1,3	cool, damp late-successional forest/Lost Creek
Pseudocyphellaria rainierensis	1,3	late-successional forest canopy/Burnt Lake Trail
Tholurna dissimilis	1,3	krummholz trees/Paradise Park
VASCULAR PLANTS		
Corydalis aquae-gelidae cold-water corydalis	1,2	cold springs, streams on fine gravel/sand substrate/Wildcat Mtn

Strategy 1 & 2 Species

Fungi

Out of 234 fungi species listed in the Northwest Forest Plan, one strategy 1 fungi is documented from the Upper Sandy Watershed. Two have been observed but not documented.

***Bridgeoporus nobilissmus (Oxyporus nobilissmus)*, noble polypore:** is nicknamed "fuzzy green pizza" due to its shape, texture and variety of small plant "toppings" on its upper surface. It is truly a rare, endemic fungus with only nine sites known in the Washington and Oregon Cascades. A single conk was found in BLM forest on North Mountain in the late 1980's just prior to a clearcutting a unit. The conk was destroyed during logging. In 1995 a site was also discovered approximately 1000 feet south of the watershed on Wildcat Mountain.

Habitat for this conk includes large diameter noble fir or silver fir stumps or snags within the Pacific Silver Fir Zone. Adjacent stand age can be variable. The fungus is a brown rot type and produces conks close to the ground. Little is known of this species' ecology. Research is currently underway at the University of Washington.

Tylopilus pseudoscaber and ***Tricholomopsis fulvescens***: have been observed -- but not recorded -- in the Upper Sandy Watershed (T.Sroufe pers. com.). *T. pseudoscaber* is a mycorrhizal bolete that grows in old-growth forests on decay class III, IV, and V logs (ROD Appendix J2, pp 104-106). *T. fulvescens* also grows in moist old-growth forest on large decomposing logs (ROD, Appendix J2, pp 183-184). Within this watershed it is found in areas with well-drained soils in wet years (T.Sroufe pers com.). Sites need to be documented for these species to subsequently determine if any habitat needs protection.

Lichens

Eighty-one lichens are listed in the Northwest Forest Plan. Five with strategy 1 ratings are documented in the Upper Sandy Watershed, while seven others may potentially occur here (Boyll, 1996). The Old Maid Flat landform provides a unique area of high lichen diversity. Many of the strategy 3 and 4 species can be found here. Other good lichen habitats within the watershed include old-growth tree canopies and boles, foggy ridgetops, and riparian corridors. Very old forest (500 years +) support a high diversity of lichen species, many which do not live in younger stands. All old-growth fragments in the watershed are important as a source of lichen propagules for younger stands.

Hydrothyria venosa: is an aquatic lichen that inhabits streams with cold (average 15 C), clear water. A site was discovered in 1996 on a tributary to Clear Fork, north of the BPA powerline corridor. *H. venosa* is endemic to the Appalachian Mountains and the Pacific Northwest. Most of the populations in the Appalachian Mountains, however, are gone -- perhaps due to acid rain effects (ROD, Appendix J2, pp 241-243). Riparian Reserves should provide protection for this lichens' habitat.

Hypogymnia duplicata: is an endemic rare leafy lichen typically found in low elevation foggy maritime forests within the Pacific Northwest and Alaska (ROD Appendix J2, pp 226-228). Its four sites within the Mt. Hood National Forest occur in cool, moist forest types. Two sites are located in this watershed -- both in Riparian Reserves--one on McIntyre Ridge on Wildcat Mountain, and one along Clear Fork. Maintenance of the canopy microclimate is important to the survival of this lichen. Cool, moist stands including old-growth silver fir or mountain hemlock and stands on foggy ridges, provide potential habitat for this rare lichen.

Loxosporopsis coraliferra: is an overlooked white crustose lichen, formerly associated solely with coastal forests, but now also identified in montane conifer stands within the Cascades. Ten sites, all in Oregon, are known inside Region 6 lands. Inside the Upper Sandy Watershed, this lichen grows at the Lost Creek picnic area. Another site exists within the Zigzag Watershed. In addition, the trunks and branches of conifers in cool, moist areas below 4,000 feet serve as potential habitat.

Pseudocyphellaria rainierensis: is endemic to the Pacific Northwest, ranging from southeast Alaska to west of the Cascade Mountains in Oregon. Its habitat includes the canopy of very old, cool, moist forests between 1,200 and 3,200 feet. About 640 acres of interior closed large canopy forest are available in the watershed. The only known site within the Upper Sandy Watershed is located near Burnt Lake Trail, just inside the wilderness boundary. To maintain canopy microsite conditions, this lichen requires 10-40 acre patches with 200+ year trees. For sites located in Matrix lands, a protection buffer is recommended (ROD Appenidix J2, pp 228-232).

Tholurna dissimilis: grows on krummholz trees in the subalpine fog zone, and in the upper canopy of old-growth Douglas-fir trees. It is rare in Oregon and Washington but more common in Canada and Alaska. One site is located in this watershed from Paradise Park. The retention of old-growth Douglas-fir on foggy ridgetops and krummholz subalpine fir and Englemann's spruce is recommended (ROD Appendix J2, pp 226-228, Boyll 1996).

Bryophytes

Of the 25 species of mosses and liverworts listed in the Northwest Forest Plan, none are documented in the Upper Sandy Watershed. While potential habitat (old-growth and riparian forest) for 16 species is unquestionably present, expert surveys are lacking. Of all plant groups listed in the Northwest Forest Plan, the bryophytes have the least amount of known information.

Vascular Plants

Only one of the 15 listed vascular plant species is documented in the Upper Sandy Watershed. Potential habitat is present for four other species: ***Allotropa virgata*** **(sugar stick),** ***Botrychium minganense*** **(mingan's moonwort),** ***Botrychium montanum*** **(mountain moonwort), and** ***Coptis trifolia*** **(three-leaved goldthread).**

***Corydalis aquae-gelidae*, coldwater corydalis**: was previously discussed in this chapter's Regional Forester's Sensitive Species section. Although it is a riparian-dependent plant, Riparian Reserves may not offer adequate protection for populations in headwaters and intermittent streams and seeps. Concerns about road construction, salvage logging and other habitat disturbing activities prompted Northwest Forest Plan scientists to recommend a 300-foot buffer around all populations (ROD Appendix J2 pp 272-273).

Draft management recommendations have been completed (M.Stein, pers com.). Final recommendations released by the Regional Ecosystems Office will take priority over Appendix J2. The cold-water corydalis sites on Forest Service land on Wildcat Mountain appear undisturbed. Logging that has occurred elsewhere along Alder Creek may have impacted potential habitat by altering substrate and shade requirements.

Noxious Weeds and Other Non-Native Species

Invasive, non-native plants pose one of the greatest threats to natural biodiversity. Table 4-27 lists species from the Mt. Hood National Forest and BLM Noxious Weed Lists that have been indentified within the watershed.

Due to the greater diversity of land-uses and ownerships within the Upper Sandy Watershed, weeds most likely occupy more habitat than in other Sandy River Basin watersheds. Their distribution extends beyond road systems into logged areas, pastures, agricultural fields, and urban yards.

Table 4-27 -- Noxious Weeds and Invasive Non-Native Plants Found in the Upper Sandy Watershed

STATUS	COMMON NAME	SPECIES
POTENTIAL INVADERS	gorse (FS)	*Ulex europarus*
NEW INVADERS	diffuse knapweed	*Centaurea diffusa*
	spotted knapweed	*Centaurea maculosa*
	meadow knapweed	*Centaurea pratensis*
	gorse (BLM)	*Ulex europarus*
ESTABLISHED INFESTATIONS	Canada thistle	*Cirsium arvense*
	Scotch broom	*Cytisus scoparius*
	St. Johnswort	*Hypericum perforatum*
	tansy ragwort	*Senecio jacobaea*
INVASIVE NON-NATIVES	English ivy	*Hedera helix*
	Japanese knotweed	*Polygonum cuspidatum*
	Himalayan blackberry	*Rubus discolor*
	evergreen blackberry	*Rubus lacinatus*

On National Forest lands within the watershed, the largest concentration of noxious weeds occurs in the Lolo Pass area. Road density, timber sales, and the BPA powerline corridor all contribute to their abundance. Below is a brief discussion of important noxious weeds and several invasive non-native plants.

Gorse, a thorny relative of Scotch broom, has the potential to become a serious pest in this watershed. Besides displacing native plant communities, large gorse stands are a fire hazard. Within the Upper Sandy Watershed, one site was located and eradicated in the Wildcat Creek drainage on BLM lands. This area should be monitored in the future to assure no other sites appear.

On the east side of the Cascades, knapweeds cause economic losses to rangelands and threaten natural biodiversity. While habitat is not as optimal west of the Cascades, small patches on roadsides can serve as propagule sources for infestations. Occasional **diffuse knapweed, spotted knapweed and meadow knapweed** plants have been hand-pulled on Lolo Pass Road and along Highway 26. The distribution of knapweeds on non-federal lands is not known.

Canada thistle is common in disturbed sites such as pastures, timber harvest areas, and roadsides. Because it readily re-sprouts from root fragments, it is difficult to manually control. Livestock owners commonly control thistles in their pastures with herbicides. Canada thistle usually disappears as shade and native plant cover increases. Biocontrol agents are available for release on dense populations.

A springtime aerial tour of the watershed would no doubt reveal large bright yellow patches of **Scotch broom** extending west from the BPA powerline corridor. Some of the heaviest infestations occur on non-federal lands, such as Marmot-area pasture lands. The attractive flowers and hedgerow/erosion control capablilities of this European native hastened its widespread historic planting. Without its control by its natural predators, "broom" has increased to the point of damaging native biodiversity and decreasing land values.

Releases of a seed weevil biocontrol insect have occurred inside the powerline corridor. Recent studies on control methods have indicated that cutting during drought stress and selective herbicide applications are effective (Broom Symposium, 1996).

St. Johnswort is a widespread invader of disturbed areas in the watershed, particularily along sandy, gravely roadsides. St. Johnswort is classified as a noxious weed due to its toxicity to livestock. It is not an aggressive competitor with native plants. Ancient medicinal values include relief from depression, aches and burns. Harvest as a special forest product occurs on a limited basis.

All livestock owners can identify **tansy ragwort.** This weed is toxic to livestock and will actively invade pastures and disturbed areas -- with the potential to form large stands. In the Upper Sandy Watershed it grows along roadsides, in clearcuts and pastures. Two biocontrol agents are active in the watershed, the cinnabar moth and the flea beetle. Both are highly effective at controlling tansy. The cinnabar larvae will also occasionally eat other native species of senecios.

Other non-native invasive plants that are significant in the watershed include **Himalayan** and **evergreen blackberries**, **Japanese knotweed**, and **English ivy**. All are very competitive with native plants and can easily form monocultures. Blackberries do provide some habitat and food for birds and small mammals. Large amounts can decrease property values. Knotweed, once solely an ornamental for yards, has started to rapidly increase in riparian areas with negative impacts similar to blackberries. English ivy, also an escapee from yards, smothers understory vegetation and damages trees. None of these plants are a problem on Forest Service lands -- *yet*. Continual monitoring and immediate action on infestations is recommended.

Riparian Species

Eight fungi, 14 lichens, 4 bryophytes and 4 vascular plants listed as Survey and Manage species in the Northwest Forest Plan are dependent upon riparian habitats. Because very little is known about the ecology of most bryophytes, lichens and fungi, recommended riparian reserve widths should be maintained. For one vascular plant, **cold-water corydalis**, 300 foot buffers around all known sites are recommended (ROD, Appendix J2, p 272-273). For two survey and manage lichens in this watershed that occur within riparian areas, the Northwest Forest Plan states that Riparian Reserves do not provide suitable habitat (ROD, Appendix J2, p 226-227). These are: ***Hypogymnia duplicata*** and ***Loxosporopsis coraliferra***. Riparian Reserves may need to be linked to blocks of old-growth forest to provide suitable interior canopy habitat for these lichens.. Riparian Reserves should allow for the improvement of habitat for **fir clubmoss** , a Forest Service Sensitive species.

Wildlife

Late-Successional Reserves and Riparian Reserves were designated by the Northwest Forest Plan to provide for both aquatic habitat conditions and the terrestrial species that inhabit riparian habitats. Despite this extensive reserve system, future outcomes were considered uncertain for more than 300 terrestrial plant and animal species. As a result, as mandated by the Northwest Forest Plan, agencies are to survey for these species and manage sites where they are located. Additional standards and guidelines were also prescribed for Matrix lands to provide for terrestrial species' needs. This assembly of reserves and standards and guidelines creates a terrestrial ecosystem management strategy analogous to the objectives of the Aquatic Conservation Strategy (Mellen, Huff, and Hagestedt, 1995).

Within this watershed analysis, the approach for wildlife discussions include examining Northwest Forest Plan species of concern where finer scale attention was deemed necessary. These include C-3 survey and manage species, threatened or endangered species, and protection buffer species in the Matrix. In addition, species outside the scope of the Northwest Forest Plan deemed to be at risk or sensitive (Regional's Forester List of Sensitive Species) were also considered. Species are discussed individually or by guilds.

Based on habitat requirements, 237 terrestrial and aquatic amphibian species could potentially occur within the Upper Sandy Watershed. (A full listing of these species with potential habitat is available in the Analysis File.)

Threatened and Endangered Species Known to Occur Within the Upper Sandy Watershed

Bald Eagle (*Halieatus luecocephalus*)

The bald eagle, a permanent resident in Oregon, is listed as threatened in this state by the U.S. Fish and Wildlife Service, and is protected at the federal level by the Endangered Species Act of 1973, the Bald and Golden Eagle Protection Act, and the Migratory Bird Treaty. While bald eagles still occupy most of their historic range in the northwest, populations have been steadily declining for many years (Brown, 1985). Recently, however, this decline seems to have slowed, or even stopped. Eagles have fared better in Oregon and Washington than in most areas. Substantial populations still exist in these two states. In fact, recent surveys indicate that more than 100 breeding pairs and approximately 600 wintering birds occur in Oregon, with the largest concentration in the Klamath Basin.

Bald eagle nesting habitat is found in all forest types bordering coastal, lake, or river areas. Nests, which usually consist of bulky stick platforms, are often located in the super-canopy of large trees. Nest sites are usually within 1/2 mile of water (National Geographic Society, 1983; Peterson, 1961). Bald eagles prey on a wide variety of species, live and dead, but feed primarily on fish and waterfowl (Stalmaster 1987).

Bald eagles inhabit forested lakeside or riparian associated habitats of Oregon during both the wintering and nesting seasons. In the winter, they are more abundant on the Columbia River and lower elevations. During their spring and summer breeding seasons, they migrate through the Upper Sandy Watershed and can be seen occasionally perching or soaring in the area. No nest sites have been identified. The Bull Run watershed to the north supports higher quality nesting habitat than the Upper Sandy Watershed, therefore bald eagles are more likely to nest there.

Peregrine Falcon (*Falco peregrinus anatum*)

The peregrine falcon, rare to uncommon in Oregon, is listed by the U.S. Fish and Wildlife Service as an Endangered species. Revised (1991) recovery objectives and recommendations for the Pacific States and Nevada Region are to change status from endangered to threatened. Currently, there are about 141 known pairs in the region, 180 or more known pairs would be needed for full delisting. In this Region the trend is strongly upward (from less than five known pairs to 141 in 20 years). The number of pairs in Oregon (approximately 18) is also increasing. The Mt. Hood Forest Plan does not identify the Upper Sandy Watershed as a peregrine falcon recovery area, although there is potential habitat.

The species is particularly dependent on cliff habitat, especially for nesting and roosting. The height of cliffs aids hunting by providing predictable updrafts and thermal currents for soaring, as well as a greater field of view. Peregrines feed almost exclusively on birds, many of which are associated with riparian zones and wetlands.

Recent surveys in the Upper Sandy Watershed located no nest sites. There have been no known historical eyries either. Peregrines have been sighted regularly around Paradise Park but nest sites are not suspected. There are no high priority peregrine cliffs in the watershed.

Although no nest sites have been located with the Upper Sandy Watershed, it is used for foraging. The Columbia River Gorge Scenic Area, located north of the watershed, currently supports high quality habitat, with three wild pairs documented nesting in the cliffs on the Gorge's Oregon side. These peregrines are suspected to also utilize the Upper Sandy area as a foraging site.

A peregrine hack site, (reintroduction of young raptors by humans), was introduced on the Zigzag Ranger District's Tom, Dick, and Harry Ridge from 1990-94. The site is located just south of the Upper Sandy Watershed. More than 25 birds were released from this site over the five-year period. Several hacking programs have also been introduced in the Columbia River Gorge. The tagged, released birds have been seen in the Upper Sandy Watershed on numerous occasions.

Northern Spotted Owl (***Strix occidentalis caurina***)

Northern spotted owls are listed as a threatened species by the U.S. Fish and Wildlife Service (USFWS), and are protected under the Endangered Species Act (ESA) of 1973. When listed as a threatened species in 1990, the USFWS identified Critical Habitat as required by the ESA. 3,489 acres of Critical Habitat Unit (CHU) are located in the Wildcat Mountain area and the northeast portion of the watershed (now designated LSR). Any proposed action within the CHU may require consultation with the USFWS to determine effects on spotted owls.

2,460 acres of the watershed are designated as Late-Successional Reserve (LSR) by the Northwest Forest Plan. These acres are located at the headwaters of the Clear Fork and Clear Creek subwatersheds and are included within the Bull Run Watershed Management Unit. This is the southern end of LSR Oregon 201 which is 110,400 acres in size and encompasses a large percentage of the Bull Run Watershed and Columbia River Gorge Scenic Area located to the north of the Upper Sandy Watershed.

The objective of an LSR is to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth related species including the northern spotted owl (ROD C-9). A management assessment should be prepared for each Late-Successional Reserve (or group of smaller LSRs) before habitat manipulation activities are designed and implemented. Information from this watershed analysis should be used in preparation of the overall LSR assessment.

The LSR is one of the few places within the watershed that has not burned within the last century which has allowed forests to mature in the area. Currently, however, only one third of the LSR contains late-seral habitat. This is mainly due to past timber harvest activity before LSR designation. Approximately one third is mid-seral and one third is early-seral

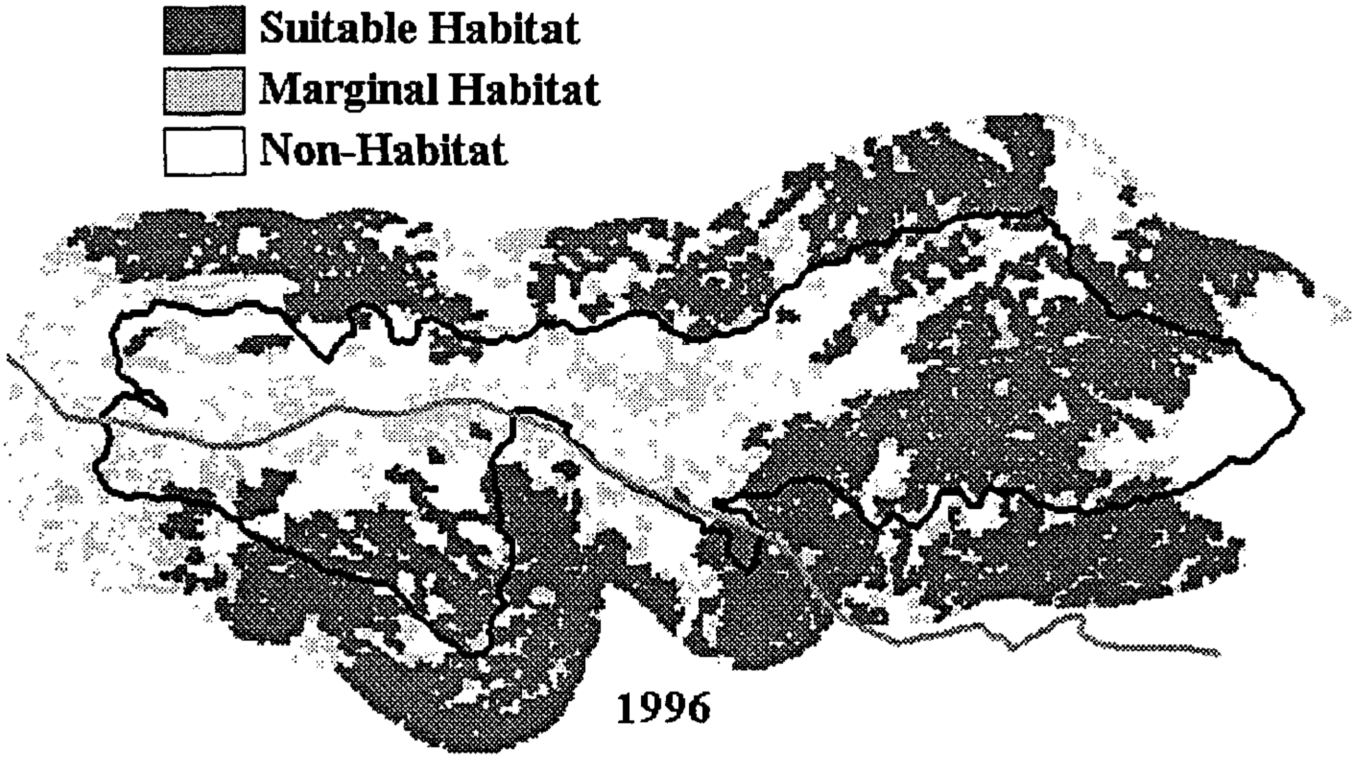
Spotted owls are closely associated with old-growth stand conditions in the temperate and high temperate conifer forest plant communities (Forsman, 1976, USDI, FWS, 1982). Multi-layered old-growth forests are the preferred nesting habitat of spotted owls in Oregon and appear to be the most consistent feature of forests occupied by spotted owls. Mature and second-growth stands with scattered old-growth and broken-topped trees provide suitable nesting sites for owls. Forest canopy closure averages 70% at most nest sites. In addition to suitable nest sites, roosting, foraging and dispersal habitat are all crucial elements to spotted owl viability (Brown, 1985). Roosting habitat includes the area within several hundred yards of the nest and includes trees low in the forest understory during warm or hot weather, and high up in old-growth or mature trees during cold, wet weather. Foraging habitat includes areas with large amounts of large woody debris and snags, providing adequate amounts of prey species (flying squirrel, red tree voles, and other small mammals).

The HABSCAPES program was run by Mt. Hood Wildlife Ecologist Kim Mellen to model spotted owl habitat for the Upper Sandy Watershed. The program inputs were specific for the spotted owl and habitat was queried from the vegetation database as developed for this watershed (see analysis file for specific requirements). The HABSCAPES program takes into account spatial relationships of habitat as well as patch size.

For the Upper Sandy Watershed, 20,005 acres were identified as suitable habitat, 4,836 as marginal habitat, and 42,963 acres as non habitat. Traditionally, for consultation, suitable habitat equates to nesting, roosting, and foraging habitat. In this model both suitable and marginal habitat are nesting, roosting, and foraging habitat. The difference is that suitable habitat has more than 40% nesting, roosting, and foraging habitat within the home range, whereas marginal habitat has less than 40% and a smaller patch size.

As displayed in Figure 4-18, most of the existing suitable habitat occurs within the Mt. Hood Wilderness, the upper end of the Old Maid Flats area, and the Wildcat Mountain area. Scattered patches of habitat occur throughout the rest of the watershed, but are marginal due to the small size of the patches.

Figure 4-18 -- Suitable Owl Habitat: Current Condition



Dispersal habitat is used for both foraging and as a crucial link for owls to travel between blocks of suitable habitat. It is defined as a stand of trees with an average diameter at breast height (DBH) of eleven inches, and average canopy closure of 40%. Dispersal habitat within the Upper Sandy Watershed was calculated at approximately 39,224 acres, or 58% of the watershed..

There are five active owl pairs within the watershed and one additional pair on the border with the Bull Run Watershed. Of the five pairs, one is within the LSR, one within the Mt. Hood Wilderness, and three are within matrix lands.

In addition to the larger, mapped LSRs, 100-acre LSRs are to be designated around each known spotted owl activity center not already protected by another reserve (ROD C-10). Here, this standard and guideline is applicable to the three pairs within the matrix. One pair was located on the edge of the wilderness. A 100-acre LSR was also drawn around this pair to ensure habitat that extended beyond the wilderness boundary

In designating these areas, one hundred acres of the best spotted owl habitat will be retained as close to the nest site or owl activity center as possible. This is intended to preserve an intensively used portion of the breeding season home range. Because these areas are considered important to meeting objectives for species other than spotted owls, they are to be maintained even if vacated by spotted owls.

Regional Forester Sensitive Species Known to Occur Within the Upper Sandy Watershed

Harlequin Duck (*Histrionicus histrionicus*)

Harlequin ducks inhabit turbulent mountain streams in coniferous forests with dense shrubby streamside vegetation. In-stream structures (logs, boulders) are important for providing loafing sites for this species. Slower side channels and slower moving waters are important for brood-rearing. Harlequins use areas away from human activity with a dense shrub component (Cassirer, 1989). Generally, males and females arrive in the streams of the Mt. Hood National Forest in March and leave to winter at the coast in September. Nests are found on the ground near streams, in tree cavities, and cliffs (National Geographic Society, 1983 Peterson, 1961; USDA FS PNW Region 1985).

The species range is the Pacific and Atlantic sides of North America, Greenland, Iceland, eastern Siberia, and the Kurile Islands. The species range in Oregon is along the coast in the winter, especially along rocky shores. During the spring and summer, Harlequin ducks nest along streams of the Cascade Range and Wallowa Mountains.

Habitat exists in the entire upper Sandy River system for Harlequins. Harlequin ducks have been observed using the Sandy River and its tributaries. The species has been sighted regularly throughout the summer along the Sandy River, on Still Creek, Camp Creek, and the Zigzag River. The Sandy River functions as a migration flyway for the harlequin duck between its nesting habitat on generally higher elevation rivers and streams and its coastal wintering habitat (USDI, 1992).

A nest site was recorded on the Salmon River near Wemme in 1931, and on Clear Creek near its confluence with the Sandy River in 1991. Both young and adult birds have been observed in Lost Creek and Clear Creek. These areas provide foraging, loafing, nesting and brood rearing habitat for the ducks.

The species has been and is declining. It is identified as a sensitive species due to impacts on breeding habitat from: timber harvest, recreation increases, and degraded riparian habitats.

Regional Forester Sensitive Species That Could Potentially Occur in the Upper Sandy Watershed

Cope's giant salamander (*Dicamptodon copei*)

Cope's giant salamander inhabit fast flowing first to third order streams with clear cold water, and streamside forest (Nussbaum, 1983). Water temperatures usually range from 8 to 14 degrees Centigrade (46.4 to 57.2 degrees Fahrenheit) and are seldom higher than 18 degrees Centigrade (64.4 degrees Fahrenheit). Recent data identifies that Cope's occurrences have been found in water temperatures not exceeding 10 degrees Centigrade (50 degrees Fahrenheit) (Corkran, pers. comm., 8/28/95). Stream substrate consists of cobble and small boulders, some large logs and no silt. They occasionally occur in clear, cold mountain lakes and ponds. The elevational range is from sea level up to approximately 1,350 m (4,400 ft.) (Nussbaum, 1983 & Corkran, Thoms, 1994). More recent data collected by Corkran, 1994, identifies their elevation limit to be 1000 m (3,500 ft.).

Current distribution of the species is from western Washington to northwestern Oregon. It occurs in the Olympic Mountains and Willapa Hills of western Washington, the Cascade Mountains in southern Washington and northern Oregon, and in the northern Oregon Coast Range.

Cope's giant salamander are believed to be declining. The sensitive status was applied due to the species' restricted distribution, combined with potential for habitat destruction from increases in water temperatures.

Red-legged Frog (*Rana aurora*)

The geographic distribution of the red-legged frog extends from southwest British Columbia through western Washington and Oregon into northern California. They are found throughout western Washington and Oregon at elevations ranging from sea level to 860 meters (2,830 ft.) on Mt. Rainier, and to 1427 meters (4,680 ft.) in the Umpqua National Forest. They also occur in the Columbia River Gorge as far east as White Salmon, Washington.

Breeding habitat includes marshes, bogs, swamps, ponds, lakes and slow-moving streams. In general, breeding sites seem to have one certain requirement: little or no flow. Outside the breeding season, red-legged frogs are highly terrestrial and are frequently encountered in woodlands adjacent to streams.

The species is currently declining. Possible causes for this decline include: displacement by the introduced bullfrog, pesticide and herbicide runoff, and introduction of non-native fish.

Townsend's big-eared bat *(Plecotus townsendii)*

Townsend's big-eared bats occur in numerous plant community types, using caves, buildings, mines, and bridge undersides for nursery and hibernation purposes. These sites must meet exacting temperature, humidity, and physical requirements. In dictating the presence of this species, suitable undisturbed roost, nursery, and hibernaculum sites appear more important than other habitat factors. Food consists of insect -- primarily moths -- and other arthropods. Besides aerial feeding, this bat also gleans insects from foliage. They are a protected species on the Oregon Sensitive Species List (Critical sub category) and a species of concern (USFWS).

The species range is Western North America from southern British Columbia south to southern Mexico, and east as far as South Dakota, Oklahoma, and Texas. A narrow range extends into the central Atlantic states. In Oregon, they are a statewide resident, but are scattered due to the fragmented nature of their habitat.

The species is rapidly declining in Oregon and other states. Populations have declined 58% west of the Cascade range during the 1975-85 time period. East of the Cascades, the decline has been 16%.

Disturbance at hibernaculum and nursery sites appears to be the main reason for their decline. Townsend's big eared bats are known to be extremely sensitive to disturbance, including grazing and timber harvest around cave entrances and human activity inside caves used by this species (WA Dept. of Wildlife). The number of suitable caves or other structures that can support the species is limited. The species also has a low reproductive rate (one young per year). A female produces only five to eight young in a lifetime (Marshall 1992).

A 1995 survey of bridges and other potential habitat on the Zigzag Ranger District did not identify any presence of Townsend's big eared bat.

California Wolverine *(Gulo gulo luteus)*

While the wolverine occupies a variety of habitats, their habitat is usually remote and devoid of humans and human developments. Preference for some forest cover types, aspects, slopes, or elevations are attributed to a greater abundance of food, but also to avoidance of high temperatures and of humans (USDA, RM-254, 1994).

The species distribution is circumpolar; occupying tundra, taiga, and forest zones of North America and Eurasia (Wilson 1982). Wolverines (low densities) extend as far south as California and Colorado and as far east as the coast of Labrador.

The wolverine is a scavenger, largely dependent on large mammal carrion. While they have been described as opportunistic omnivores in summer and primarily scavengers in winter, they can also prey on ungulates or larger mammals under various conditions (such as deep snow). Mule deer and elk were the primary ungulates in the diet of wolverines in Montana. Small mammals are primary prey only when carrion of larger mammals is unavailable, however wolverines are too large to survive on only small prey. Studies have shown the paramount importance of large mammal carrion, and the availability of large mammals underlies the distribution, survival, and reproductive success of wolverines (USDA, RM-254, 1994).

Reasons for this species' decline could be due to: low reproductive rates, delayed sexual maturity, high mortality from trapping (trapping currently legal in Alaska and Montana), and fragmentation of large areas of habitat from land use impacts and trapping.

Wolverines have not been officially documented within the watershed but a wolverine sighting was reported in 1988 at the foot of Crutcher's Bench. In addition tracks were confirmed southeast of the watershed in the West Fork of the Salmon River (1990). A two year old wolverine was hit on Highway 84 in the Columbia Gorge in 1990 near the north end of the forest. In 1996 a wolverine was sighted in the adjacent Bull Run Watershed at the Bear Creek house.

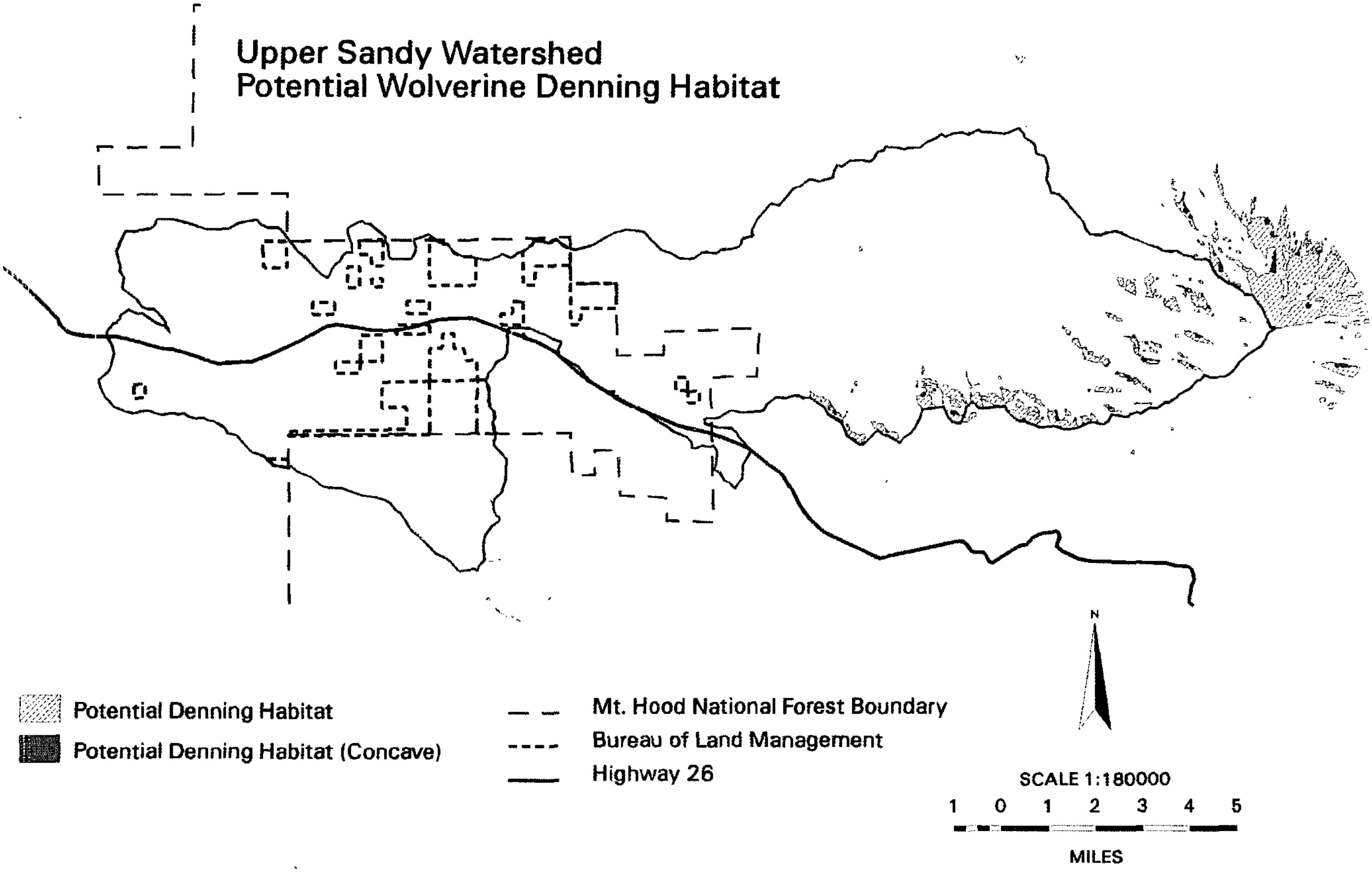
Wolverine denning habitat characteristics for the Mt. Hood are currently being assessed using a study in central Idaho as a starting point. The criteria are based on seven natal/maternal den sites studied by Jeff Copeland, a Wildlife Biologist with the Idaho Fish and Game Department, in the Sawtooth Mountains. The key characteristics of these den sites are as follows:

- high elevation (above 8,000 feet) subalpine cirque areas
- bare/exposed big granite boulder/talus rock/scree areas
- north to northeast facing aspects (holds the snow longer)
- glacial cirque basins (concave feature for snow persistence)
- seclusion from human disturbance (especially February 1 through May)

Adapting these characteristics for the Cascades, Sarah Hall, Mt. Hood Wildlife Biologist, created a map of potential wolverine denning habitat on the forest (Figure 4-19 Potential Wolverine Denning Habitat). The above characteristics were used except a lower, 4,000 foot, elevation band was used (Hall, 10/96, unpublished). This newly created map has had some field verification, but not in the Upper Sandy Watershed. Furthermore, it has not been compared to any winter recreation information which could indicate potential areas of human disturbance.

For the Upper Sandy Watershed, potential denning habitat exists in higher elevation portions of the Mt. Hood Wilderness including the flanks of Mt. Hood.

Upper Sandy Watershed
Potential Wolverine Denning Habitat



Survey And Manage Species (C-3 Species)

Table C-3 of the Northwest Forest Plan lists four arthropods, five amphibians, one mammal, and forty three mollusk species with special survey and management needs.

The Mt. Hood National Forest is outside the range for the listed arthropod species. Of the five amphibians, only one species, Larch Mountain salamander, may potentially occur within the Forest. The Larch Mountain salamander is also a Regional Forester's sensitive species. The red tree vole has been documented on the Forest in the Bull Run Watershed located adjacent to the Upper Sandy Watershed.

The list of 43 species of mollusks was assessed by Mt. Hood National Forest Wildlife Biologist Robert Huff. His June 1994 document identifies which species occur or may potentially occur within the Forest. The terrestrial species are: *Hemphillia malonei, deroceras hesperium, Hemphillis pantherina, Prophysaon coerulem*, and *Prophysaon dubium*. These species inhabit moist forest within riparian areas and upland forests. They are often found in forest litter.

As of 1995, species in the Northwest Forest Plan table with a survey strategy 1 (manage known sites) must be considered in project implementation. The Larch Mountain salamander, red tree vole, and lynx (tentatively survey strategy 3 species) require surveys to precede design of all ground-disturbing activities that will be implemented in 1997 or later. The Larch Mountain salamander and lynx also fall under the category of Protection Buffer Species (ROD C-28 and C-47). Extensive and general regional surveys (strategies 3 and 4) are required for many other species (ROD C-4 - C-6). All amphibians, mammals and mollusks are survey strategy 1 or 2, while all arthropods are survey strategy 4. (For the full listing of species, refer to ROD Table C-3, page C-59 and C-61.)

Red Tree Vole (*Phenacomys longicaudus)*

The red tree vole spends most of its life in the canopy of coniferous trees and feeds on the needles. The voles main source of water is derived from fog drip and raindrops on Douglas-fir needles. It has been well documented that red tree voles are strongly associated with Douglas-fir trees (Carey 1991; Huff, Holthausen and Aubrey 1992), and to a lesser extent with western hemlock, grand fir, and Sitka spruce. The voles are considered to be closely associated with old-growth Douglas-fir forests (Carey et al. 1991).

Most tree vole nests are in the lower one third of the canopy, from 10 to 150 feet up. At night the vole gathers fir needles for nests. Some of the larger tree vole nests may be as much as 100 years old. Because the red tree vole is almost entirely arboreal and stays within the forest canopy, the northern spotted owl, a subcanopy forager, is believed to be its main predator (Forsman 1976). Red tree voles in Oregon are distributed along the entire length of the coast, and in the northern Cascades on the western slope (Maser, Mate, Franklin, and Dryness, 1981).

Red tree voles were surveyed for on the Mt. Hood National Forest in 1995. Several nests were found in the Bull Run Watershed. All of the nests were in Douglas-fir trees ranging from two feet DBH to five and a half feet DBH. In addition, it is believed that red tree voles prefer to build their nests on upslopes, away from riparian areas (Huff et al. 1992).

A habitat model developed by the Mt. Hood National Forest's wildlife and ecology departments was used to create a map of red tree vole habitat on the Forest, based on Huff, et al., 1992. Primary habitat includes stands classified as large conifer (>21" DBH) greater than 300 acres which occur at less than 3,000 feet in the Western Hemlock or Pacific Silver Fir vegetation zones. Secondary habitat requirements are the same, except size of habitat is 75 to 300 acres. Marginal habitat includes closed small conifer stands, less than 3,000 ft. in elevation, greater than 75 acres within the same two vegetation zones.

Based on the habitat model, the Upper Sandy Watershed contains very little habitat for the red tree vole. There are .33 acres of primary habitat, 607 acres of secondary habitat, and 2,985 acres of marginal habitat.

The 1995 survey of red tree vole habitat included the Wildcat Mountain Planning Area. 1920 acres were surveyed. Several clearcuts and thins throughout the site resulted in patchy habitat. In the area surveyed, Douglas-fir and western red cedar were the dominant trees. No nests were found. Additional vole surveys will be conducted in the area of Last Chance Mountain, Enola Hill, and Wildcat Mountain.

Larch Mountain Salamander *(Plethodon larselli)*

The Columbia River Gorge in Washington and Oregon comprises the range for the Larch Mountain salamander. The range in Oregon is the Columbia River Gorge in Multnomah and Hood River counties between Bridal Veil on the west and Mitchell Point on the east. While the range's southern edge has not been identified, the salamander has been reported from near the summit of Larch Mountain -- a record which has been questioned (Marshall, 1992). Similarly, the northern range has not been identified, but four populations have been found north of the Gorge near Mt.

St. Helens, and also south of Mt. Rainier. They have been found to 3400 ft. (Leonard et.al 1993).

Habitat for Larch Mountain salamander may exist in the watershed although this area is on the southern most periphery of the species range. Habitat for the species is small-sized angular talus slopes where the talus is kept moist by a covering of mosses and dense overstory of coniferous trees. The species is terrestrial and is almost never found associated with water.

All survey work for this species has been conducted in the Columbia River Gorge Scenic Area, where documented sightings have been reported. No documented sightings have occurred within the Upper Sandy Watershed.

Protection Buffer Species

Protection Buffer Species in Matrix (ROD C-45)

Protection buffer species are defined as rare and local endemic species identified in the Scientific Analysis Team Report that are likely to be assured viability if they occur within designated areas. Where these species occur in the matrix, however, specific standards and guidelines will be applied. These species are: the white-headed woodpecker, black-backed woodpecker, pygmy nuthatch, flammulated owl, and lynx.

Because the white-headed woodpecker, pygmy nuthatch, and flammulated owl occur in ponderosa pine forests, they are highly unlikely to occur within the watershed.

It is also unlikely that lynx would occur within the watershed because it is rare within the range of the northern spotted owl, occurring primarily in the Okanogan National Forest of Washington. Winter track surveys have been conducted on the Zigzag and Columbia Gorge ranger districts since 1990. No lynx tracks have been identified.

The black-backed woodpecker, *Picoides arcticus*, could potentially occur within the watershed, however no sightings have been documented. Primary habitat for the black-backed woodpecker is lodgepole pine forest, usually within the Pacific Silver Fir or Mountain Hemlock vegetative zones. There is lodgepole pine within the watershed which is growing on the mudflow at Old Maid Flats. Matrix lands in this area would need to consider the protection buffer if this species was found.

The black-backed woodpecker is also known to follow pest infestations, or burned-over areas where prey is found in dead or dying conifers. It is known to flake away large patches of bark rather than drilling in for larva and insects. A recent study by Hutto, 1995, suggests that standing dead forests created by stand replacing fires may be an important habitat for black-backed woodpeckers.

The great grey owl is another protection buffer species that may occur in the Upper Sandy Watershed.

Within Oregon, great gray owls have been found in the central western Cascades, the south central Cascades, and in the northeast portion of the state in lodgepole pine and mixed conifer forests (Hayward 1994). Large meadows have often been a component of their habitat. Great gray owls have been found breeding on the Willamette National Forest (south of the watershed), and have been reported on the Warm Springs Indian Reservation to the southeast and Gifford Pinchot National Forest to the north (Hayward 1994; Garehardt 1995).

There have been few documented occurrences of great gray owls on the Mt. Hood Forest and none of these were in the Upper Sandy Watershed.

Species Afforded Additional Protection Within Matrix

In addition to protection buffer species, several bat species are protected by additional standards and guidelines within Matrix lands (ROD C-43). Surveys are to be conducted of crevices in caves, mines, and bridges and buildings for presence of roosting bats. Species potentially occurring within the watershed include the silver-haired bat, long-eared myotis, and long-legged myotis.

Silver-haired bats, *Lasionycteris noctivagans*, are closely associated with old growth/mature forests. They roost in the fissures and grooves of the bark of large trees and snags. Long-eared myotis, *Myotis volans*, and Long-legged myotis, *Myotis evotis*, use a variety of habitats. They are associated with coniferous forests and are known to use mines, bridges, and abandoned buildings. Long-legged myotis are also known to use shrub wetlands and wet meadows.

A survey of bridges and other potential bat habitat occurred on the Zigzag Ranger District in 1995. Several Myotis were located although identification could not be narrowed beyond the genus level. Myotis were found in the Muddy Fork and Clear Fork subwatersheds. Several bats of unkwown species were found in the Wildcat Mountain area.

Pileated Woodpecker/Pine Marten Areas (B5 Areas)

Page C-3 of the ROD states that: *Administratively Withdrawn Areas that are specified in current Forest Plans to benefit American martens, pileated woodpeckers, and other late-successional species are returned to the Matrix unless local knowledge indicates that other allocations and these standard and guidelines will not meet the objectives for these species* .

A forest-wide analysis was drafted (July, 1995) that assessed the relative importance of individual B-5 land allocation areas based on their contribution to late-seral forest conditions at the watershed level. The analysis procedure started by screening out any B-5 area that was in reserved land allocations. The remaining areas were further reviewed for their relation to the Northwest Forest Plan land allocations.

Four B-5 Management Areas are located within the Upper Sandy Watershed. These were reviewed for adjacency to late successional reserves, congressionally reserved areas, or administratively withdrawn areas. They were also reviewed for proximity to riparian reserves and connectivity to other B-5 areas and other land allocations.

The forest-wide analysis recommended that one of the B-5 areas within Matrix lands in the watershed be retained. This Management Requirement Area is located in the North Mountain area of the watershed and was designated to benefit pileated woodpecker habitat. The entire Management Area is 625 acres. Of this, 383 are currently providing late-seral habitat, 175 mid-seral, and 67 early-seral.

Late-seral habitat is low within the watershed and the North Mountain area provides a large block of contiguous, late-seral habitat including well developed old-growth stands. This habitat is also important to the connectivity of LSR habitat to the north and south of the drainage. It contains the southern most range of the sensitive plant, Krushea. Work with the winter tracking in the watershed found cougar and intensive bobcat presence in the North Boulder area as well. District biologists have concurred with the recommendation to retain this area.

Within pileated woodpecker habitat areas, at least 300 contiguous acres of mature and/or old growth forest habitat shall be maintained within each 600 acre Management Area (LRMP B5-008).

Snags and Coarse Woody Debris

Forty seven wildlife species that potentially occur within the watershed are dependent on snags. Most of the primary cavity nesters are generalists and can make use of available snags in any seral condition. Three species, however, (black-backed woodpecker, pileated woodpecker, and three-toed woodpecker) require snag habitat in late-seral forest condition. While the majority of secondary cavity nesters are also generalists, two species (mountain bluebird and western bluebird) require snags in early-seral conditions, and four species (barred owl, marten, northern flying squirrel, and northern spotted owl) use snags in late-seral conditions.

No quantitative assessment of snag habitat has been conducted for the watershed. However, due to the watershed's low volume of late-seral forest, its overall high levels of harvest, and its past fire history, it most likely has a low snag population and distribution for the total acreage it encompasses. Significant numbers of snags were cut by the Civilian Conservation Corps in the 1930s in at least Clear Creek. Large snags are most abundant within unmanaged large conifer stands which are very uncommon in this watershed. The most abundant snag habitat of this type would be found in the riparian stringers along Clear Fork.

The watershed also contains trees infected with laminated root disease (*P. weirii)*. These trees continually add to snag levels, however these snags are less stable and are inevitably windthrown. The biology of *P. weirii* does not contribute to rot higher up in trees, and therefore may not create good habitat for cavity nesters.

Sixty-one wildlife species that potentially occur within the watershed are dependent on downed logs. Coarse woody debris is important in mineral cycling, nutrient mobilization, natural forest regeneration, and also creates a structure and diversity of habitats valuable to many terrestrial and aquatic wildlife species. Coarse woody debris serves as sites for feeding, reproducing, and resting. It is also important for denning areas, invertebrate and vertebrate prey sources for birds and salamanders, and habitat for small mammals.

Coarse woody debris levels likely follow a similar pattern as snag levels and may be low in the watershed. Unmanaged, large conifer stands have higher levels of coarse woody debris than managed plantations. Most harvest areas with subsequent fuels treatment programs reduced coarse woody debris levels.

Life History Guilds

Wildlife species have been grouped into life history guilds based on how they are expected to respond to different amounts and distributions of habitat across the landscape (Mellen, Huff, Hagestedt, 1995). Home range size, patch configuration use, and structural stage use were used to group terrestrial species. Species that require special habitats such as caves or cliffs were not grouped into guilds. The objective of the guilding approach is to predict terrestrial and amphibian occurrence relative to landscape patterns.

The following tables (Table 4-28 -- Criteria Used to Group Species by Life History into Guilds and Table 4-29 – Historic and Current Habitat Available for Terrestrial Guild Groups) display the criteria used to group species by life history into guilds, and the amount of habitat for each guild located within the Upper Sandy Watershed. These acre figures are for National Forest lands only. The adjacent watersheds were taken into account when determining spatial arrangements, but private lands were not included. Amount of habitat is displayed by acres and percent of watershed.

Table 4-28 -- Criteria Used to Group Species by Life History into Guilds

TERRESTRIAL: Terrestrial habitat users (may use riparian or special habitats as well, but do not require them).

HOME RANGE:

SMALL: Home ranges less than 60 acres
MEDIUM: Home ranges 60 - 1000 acres
LARGE: Home ranges more than 1000 acres

PATCH CONFIGURATION:

PATCH: Species requiring one homogeneous patch (one structural stage) during life cycle (or breeding period for migrants).
MOSAIC: Species capable of aggregating patches of like structural stages that are dispersed in a mosaic pattern across the landscape.
CONTRAST: Species using two different major structural stages in close proximity, usually large tree and open.
GENERALIST: Species whose primary habitat is not restricted to one major structural stage.

STRUCTURAL STAGE:

OPEN: Includes grass/forb, shrub, leave tree/shelterwood, and open sapling/pole.
SMALL TREE: Includes closed sapling/pole, open small conifer (less than 21")
LARGE TREE: Includes large conifer (more than 21") and old growth.

For example, TSPO means: Terrestrial, Small home range, Patch configuration, Open structural stage.

Table 4-29 – Historic and Current Habitat Available for Terrestrial Guild Groups

GUILD CODE	HOME RANGE	PATCH TYPE	STRUCTURE STAGE	CURRENT ACRES (F.S. ONLY)	CURRENT % OF F.S. LANDS
TSPO	Small	Patch	Open	8,529	22%
TPSPT	Small	Patch	Small Tree	0	0
TSPLT	Small	Patch	Large Tree	6,763	18%
TSMO	Small	Mosaic	Open	6,002	16%
TSMST	Small	Mosaic	Small Tree	0	0
TSGOS	Small	Generalist	Open/Small Tree	28,726	75%
TSGSL	Small	Generalist	Small/Large Tree	28,696	75%
TSGG	Small	Generalist	All	38,485	approx 100%
TMPO	Medium	Patch	Open	2,729	7%
TMMO	Medium	Mosaic	Open	4,537	12%
TMMLT	Medium	Mosaic	Large Tree	4,125	11%
TMGG	Medium	Generalist	All	38,485	approx 100%
TLMO	Large	Mosaic	Open	3,604	9%
TLMLT	Large	Mosaic	Large Tree	4,940	13%
TLGG	Large	Generalist	All	38,485	approx 100%
TSC	Small	Contrast	Contrast	3,040	8%
TMC	Mosaic	Contrast	Contrast	3,616	9%
TLC	Large	Contrast	Contrast	6,039	16%

Note: Current habitat is based on the SCCA vegetation database developed for the Mt. Hood National Forest. It was not based on the vegetation database developed specifically for the Upper Sandy Watershed. Therefore, some differences in amount of habitat may occur when comparing the two databases.

Elk

Elk, although not a "species of concern," are an important recreational and economic resource both to hunters and those wishing to view the animals. There are two main herds in the watershed with isolated, smaller herds throughout the drainage. The higher concentrations are in the Marmot and Wildcat Mountain areas. The herds are distinct but individual animals will wander and join neighboring herds. The private lands and fringe areas also have healthy herds.

Elk are classified as a contrast species and therefore need both openings/early seral stands for forage and forested areas for cover. Elk need both forage and cover within their home range if they are to acquire and conserve the energy they require daily. Areas with high quality forage and cover with reasonable freedom from human disturbance provide the most productive habitat for deer and elk.

Historically, deer and elk used naturally occurring forest openings. Today, in a managed forest, deer and elk use forage created by clearcut logging adjacent to forest stands (Brown 1985). Agricultural lands are frequently used as well. Elk population numbers appear to be declining within the Zigzag Ranger District. Many factors may affect this, including: high human presence, low amounts of available forage, and high road densities.

Northeast of Marmot, a small 27 acre area is designated winter range. This area is adjacent to 857 acres of designated winter range to the north in the Little Sandy drainage (for a description see Bull Run Watershed Analysis). Elk also use the Wildcat Mountain area and private forest and agricultural lands in the lower watershed for winter range.

Highlights: Wildlife

- During their spring and summer breeding seasons, Bald eagles migrate through the watershed. Peregrine falcons use the watershed for foraging..
- Approximately 37% of the watershed is suitable habitat for northern spotted owls and there are five active owl pairs within the watershed.
- The Sandy River serves as a migration flyway for Harlequin ducks. Tributaries of the Sandy River are used for nesting.
- Habitat exists for Cope's giant salamander, red-legged frogs, and Townsend's big-eared bat, although these species have not been documented in the watershed.
- A wolverine sighting was reported at the foot of Crutcher's Bench and potential denning habitat for the wolverine exists on the flanks of Mt. Hood.
- Very little habitat currently exists for the red tree vole.
- The North Mountain Pileated Woodpecker Area (B5) is recommended for retention due to the contiguous, well developed old-growth stands within the area.
- There are two main herds of elk that use the lower watershed.

Hydrology

Characterization

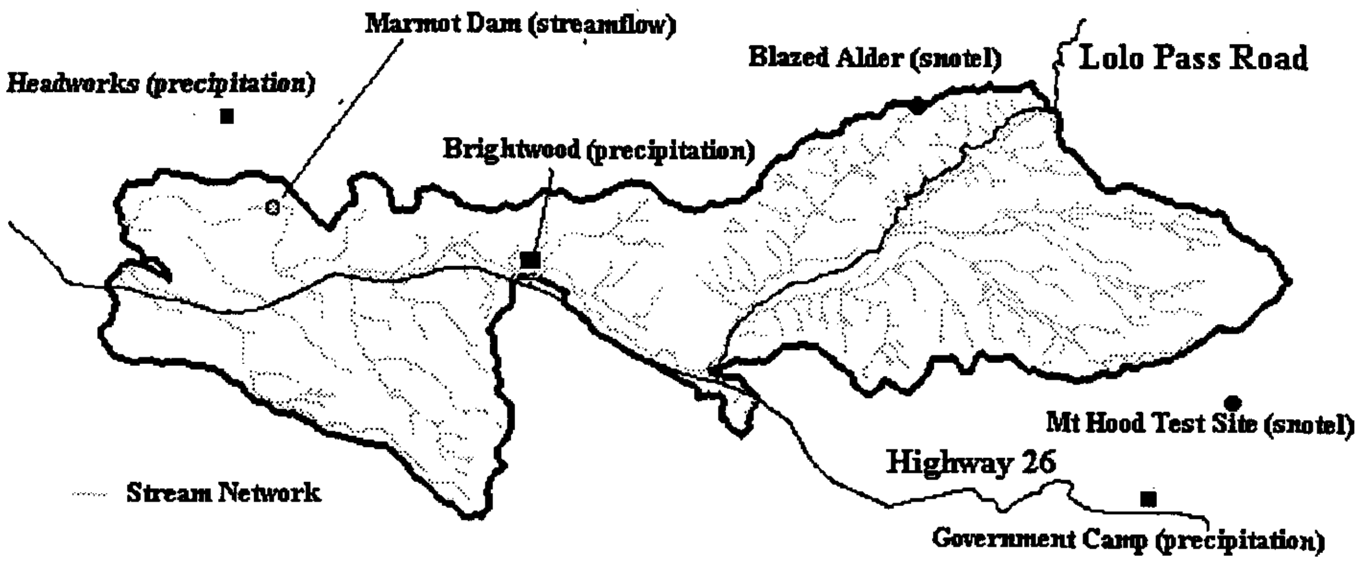
The Upper Sandy watershed encompasses 67,810 acres extending from the summit of Mt. Hood to the area below Marmot Dam. Elevations range from 554 to 11,047 feet with an average elevation of 2,700 feet. Annual precipitation within the watershed varies from greater than 100 inches near the summit of Mt. Hood to 70 inches at the western extent of the watershed. 94 percent of the watershed is at elevations less than 4800 feet and considered in the transient snow zone.

The eastern portion of the watershed is marked by steep slopes with gradients frequently in excess of 70 percent. In contrast, the western portion of the watershed is much flatter, with slope gradients typically less than 20 percent and rarely greater than 50 percent. The glacially carved Upper Sandy River valley has been partially filled in by pyroclastic and debris flows to form a broad flat plain know as Old Maid Flat.

This watershed is not identified as a key watershed in the NW Forest Plan. Key land management designations with respect to hydrology include Wild and Scenic River designation for the Upper Sandy River and Special Emphasis Watershed designation for Alder Creek (the source of water for the City of Sandy).

Monitoring Network

Figure 4-20 -- Streamflow Gages ,Snotel Sites and Precipitation Gages



Various stream gaging stations, National Resource Conservation Service snotel sites and NCDC precipitation sites are located within the Upper Sandy Watershed. The USGS streamflow gage at Marmot Dam has the longest period of record (1912 to the present) of any gage in the Sandy Basin. It is of note that the gage at Marmot Dam includes the areas drained by the Salmon River and Zigzag watersheds.

Climate

Climate is significant in determining: patterns of river and stream flow, moisture content of the soil, and plants that inhabit an area. Climatic conditions within the Upper Sandy Watershed vary from alpine to those that are typical of the Western Cascade foothills.

Chart 4-4 – Daily Average Air Temperatures SNOTEL Sites

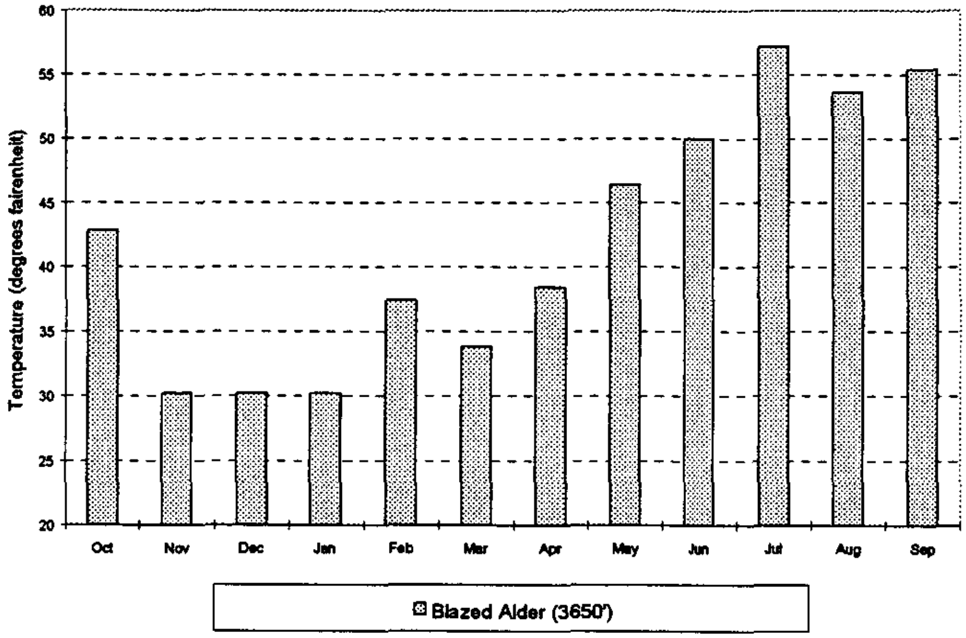
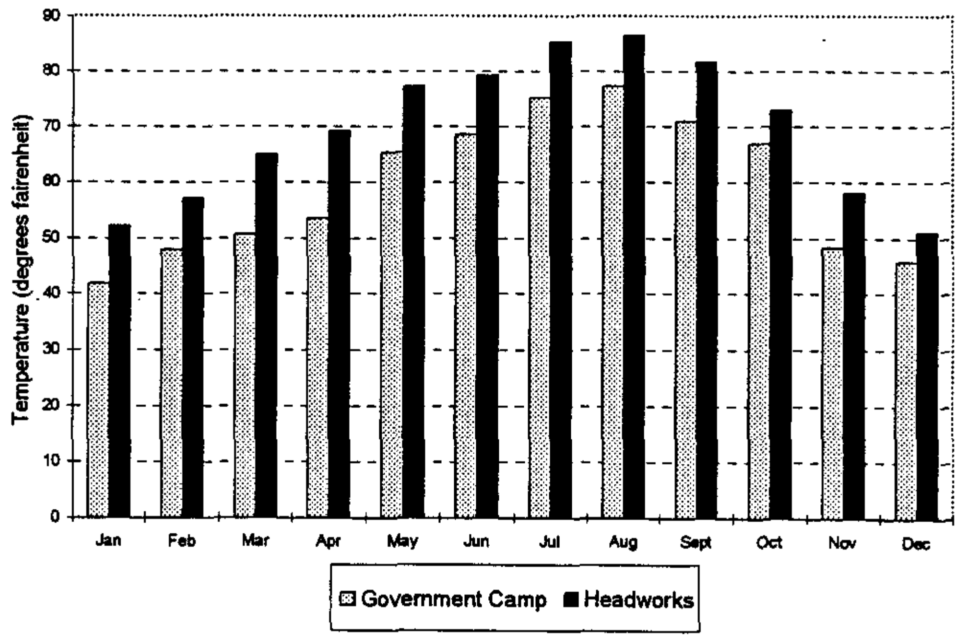


Chart 4-5 Maximum Monthly Temperatures



Average temperatures at the Blazed Alder SNOTEL site (elevation 3750 feet) in the Clear Creek drainage varies from freezing in November, December and January to the upper fifties in July. Maximum monthly temperatures vary from the low forties in January and December in the upper elevations of the watershed to the mid eighties in July and August at the western extent of the watershed.

Precipitation ranges from 70 to 175 inches (Chart 4-6). There is some concern that the map of the annual precipitation for this area (Figure 4-21) is not correctly registered. This coverage was cut from a coverage detailing precipitation across the entire state and it appears that is needs to be adjusted so that the peak (or highest) precipitation amounts line up with the top of Mt. Hood.

July and August are the driest months; November, December, and January are the wettest. Precipitation at the lower elevations is primarily in the form of rain. Snowpack depth and period of accumulation vary with elevation. Chart 4-7 illustrates that the 1650 foot difference between the Blazed Alder and the Mt Hood Test Site make a large difference in snow pack. In the adjacent Bull Run Watershed snow is rare below 2,000 feet, while it often reaches a depth of 6 to 10 feet above 4000 feet. (Blowdown FEIS). Chart 4-8 illustrates this point by comparing snow depth at Brightwood to Government Camp.

Figure 4-21 -- Annual Precipitation in Upper Sandy Watershed

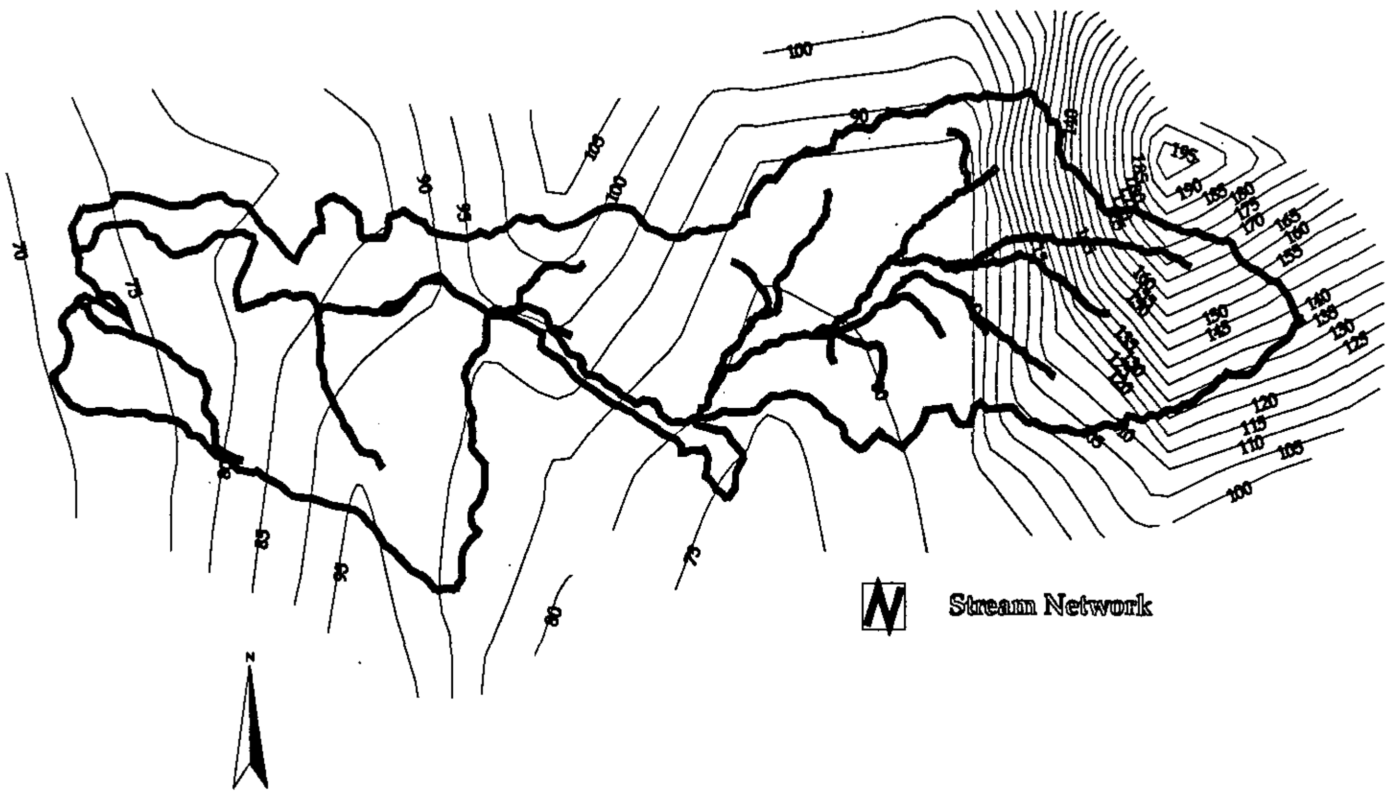


Chart 4-6 -- Average Monthly Precipitation

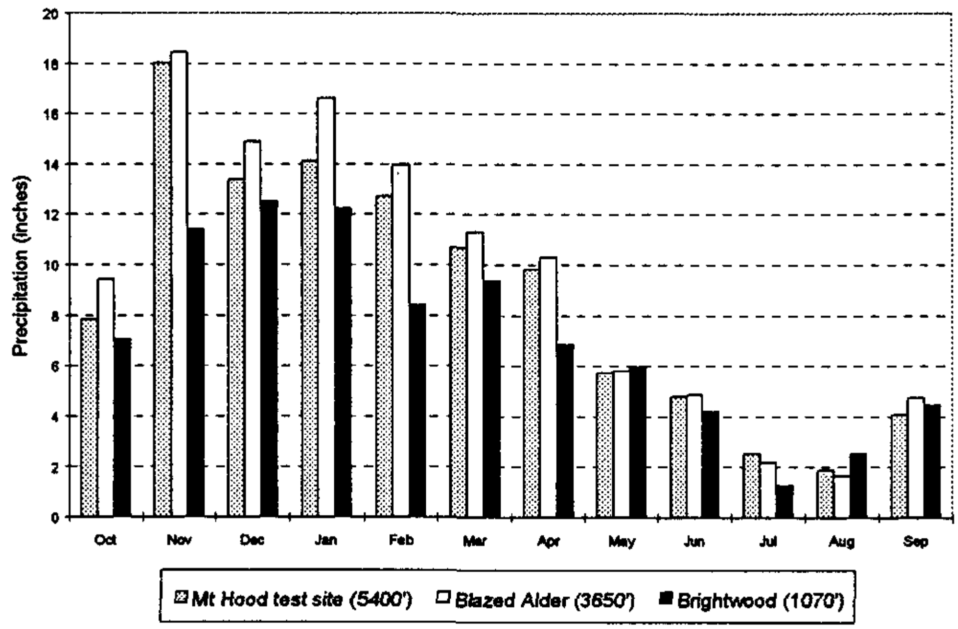


Chart 4-7 – Snowpack (Snow Water Equivalent) at SNOTEL Sites, 1996

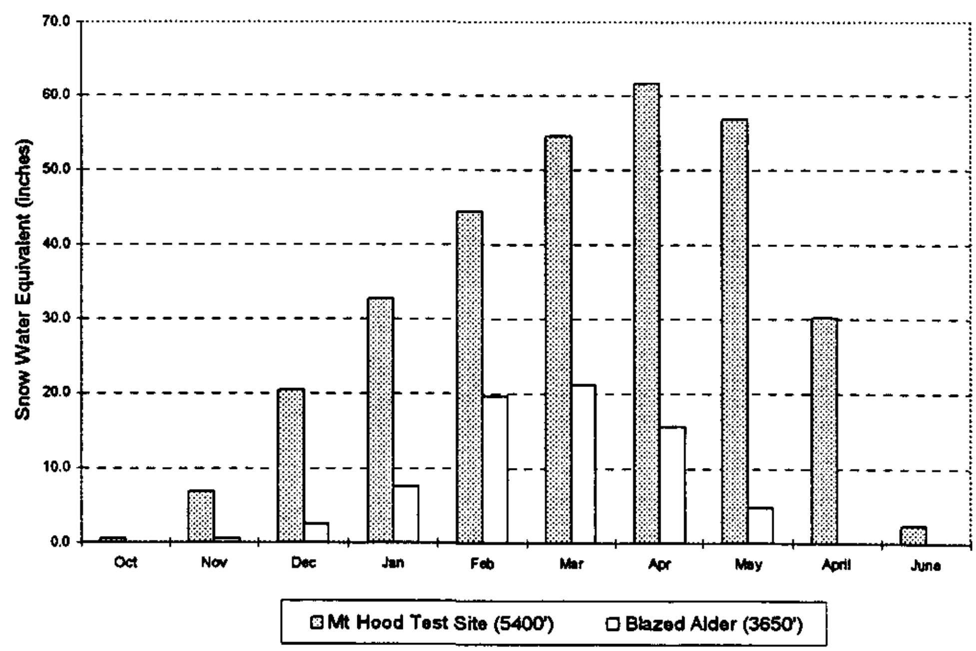
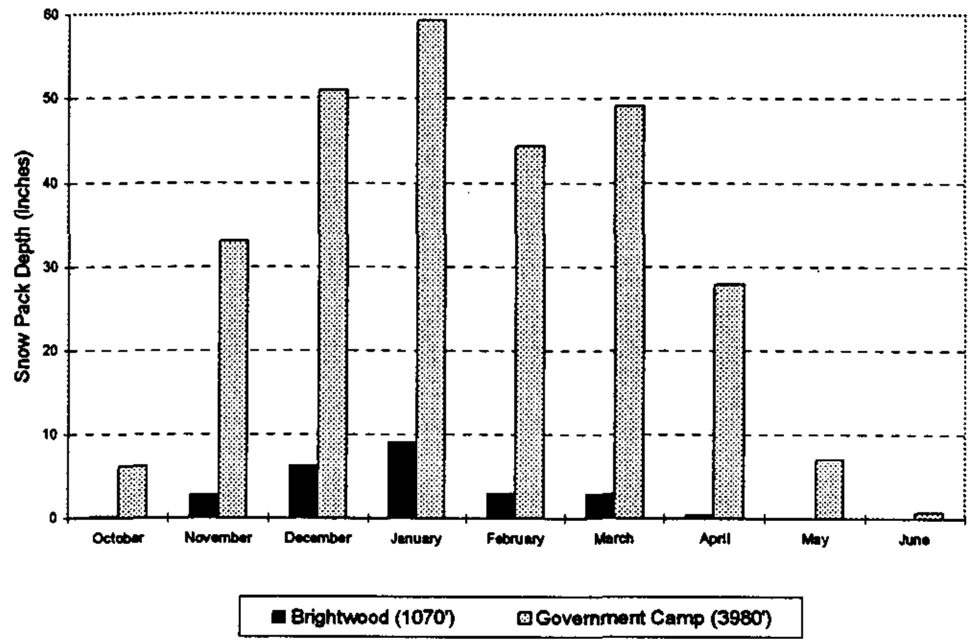


Chart 4-8 Snow Pack Depth

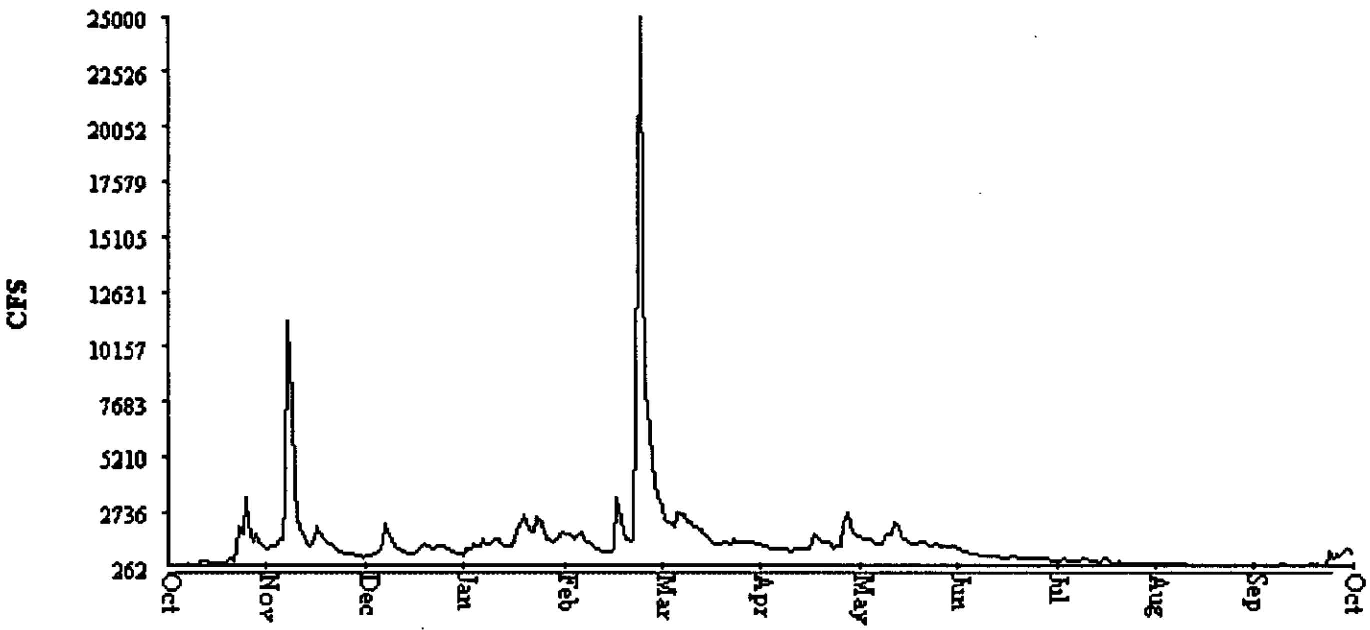


Streamflow

Streamflows within the Upper Sandy Watershed are characterized by lowflows in the late summer (August and September) and high flows generated by, typically, a dozen distinct storm events during October through April. Flows from the Sandy River at Marmot Dam, plotted in Chart 4-9, demonstrate August and September's lowflow period, and the high flows associated with October through April's storm events. (The peakflow event in February and was generated by a rain-on-snow event.) The gaging station on the Sandy River at Marmot Dam includes the drainage area in the Salmon River and Zigzag watersheds and is influenced by these watersheds.

Hydrographs from 1986 are displayed as a representative year because of the typical summer lowflows and the high flows associated with a rain-on-snow event in late February.

Chart 4-9 – Mean Daily Stream Flows Sandy River at Marmot Dam Water Year 1986



The Sandy River originates from Reid Glacier and the Muddy Fork of the Sandy originates from Sandy Glacier so some glacial influence on the hydrograph would be expected. Chart 4-10 and Chart 4-11 are hydrographs from the Zigzag River and the Little Sandy River. The Zigzag River originates and is influenced by the Zigzag Glacier and is adjacent to the Sandy River. The Little Sandy River has no glacial influence and borders the Upper Sandy watershed. The peakflows events in these two hydrographs appear similar as would be expected from rain-on-snow events. The moderate and lowflows in the Zigzag River are moderated by the glacier and are not as "flashy" or quick to respond to runoff as those in the Little Sandy River. Based on these influences a hydrograph with a similar shape to Zigzag River would be expected for the Upper Sandy and Muddy Fork subwatersheds. For the other subwatersheds a hydrograph with a similar shape to the Little Sandy would be expected.

Chart 4-10 Mean Daily Stream Flow Zigzag River Water Year 1986

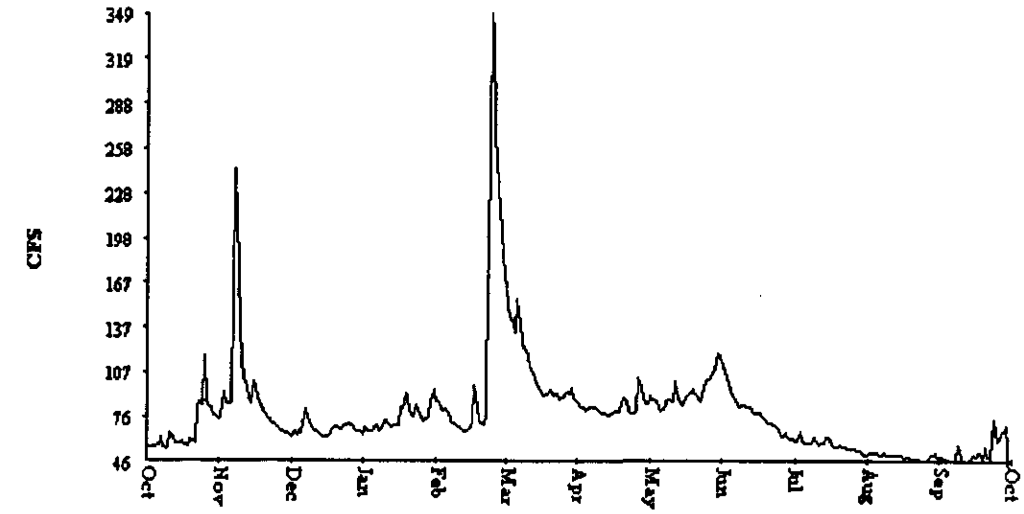
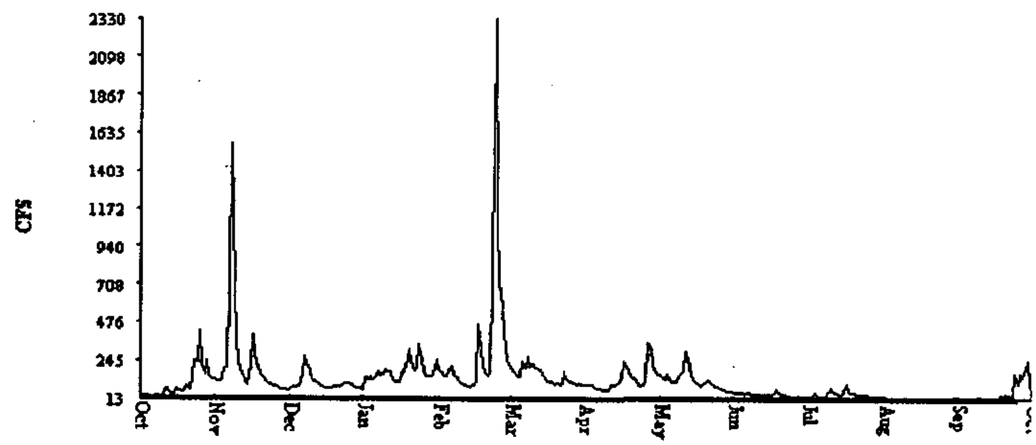


Chart 4-11 Mean Daily Stream Flow Little Sandy River Water Year 1986



Analysis

Aquatic Conservation Strategy

The Aquatic Conservation Strategy from the NW Forest Plan was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands.

The Aquatic Conservation Strategy strives to maintain and restore ecosystem health at watershed and landscape scales to protect habitat for fish and other riparian dependent species and resources and to restore currently degraded habitats. This approach seeks to prevent further degradation and restore habitat over broad landscapes as opposed to individual projects or small watersheds.

The standards and guidelines are designed to focus the review of proposed and certain existing projects to determine compatibility with the Aquatic Conservation Strategy objectives. The standards and guidelines focus on "meeting" and "not preventing attainment" of Aquatic Conservation Strategy objectives. In order to make the finding that a project or management action "meets" or "does not prevent attainment" of the Aquatic Conservation Strategy objectives, watershed analysis must include a description of the existing condition, a description of the range of natural variability of the important physical and biological components of a given watershed.

Hydrologic processes and conditions analyzed include:

- Peakflows
- Lowflows
- Stream Channel Stability
- Water Quality

Statistical Methods

Statistical analysis was used to analyze a number of processes so the statistical methods are introduced in this section to prevent redundancy in the document.

Trends Analysis

The Seasonal Kendall Trend Test used in this analysis is a component of the WQhydro software package, developed by Eric R. Aroner.

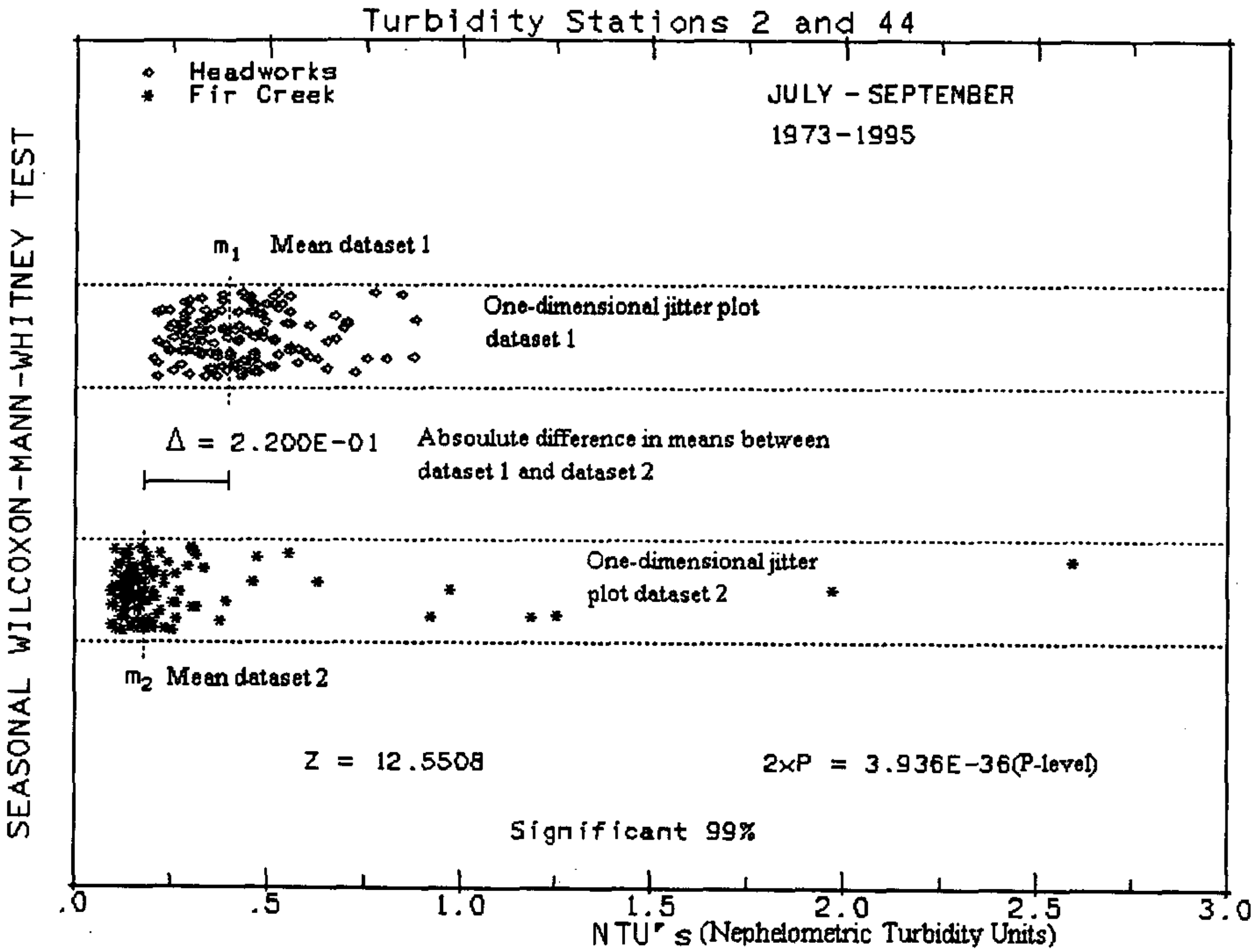
The trends analysis used was developed to detect trends in water quality data. This technique is suitable for detecting time trends in water quality datasets that have: non-normal distributions; seasonally, flow relatedness; missing values; and values below the limit of detection (Rinella, 1987).

Seasonal Wilcoxen-Mann-Whitney Test

The Seasonal Wilcoxen-Mann-Whitney test is a non-parametric test used to determine the differences between two means. This test was used to compare data between two sites. For this analysis this was used to compare data from the Upper

Sandy Watershed to the unmanaged control subwatershed (Fir Creek) in the Bull Run Watershed. Fir Creek was selected because of the close proximity (it is in the adjacent Bull Run Watershed) and it is similar with respect to climate and vegetation.

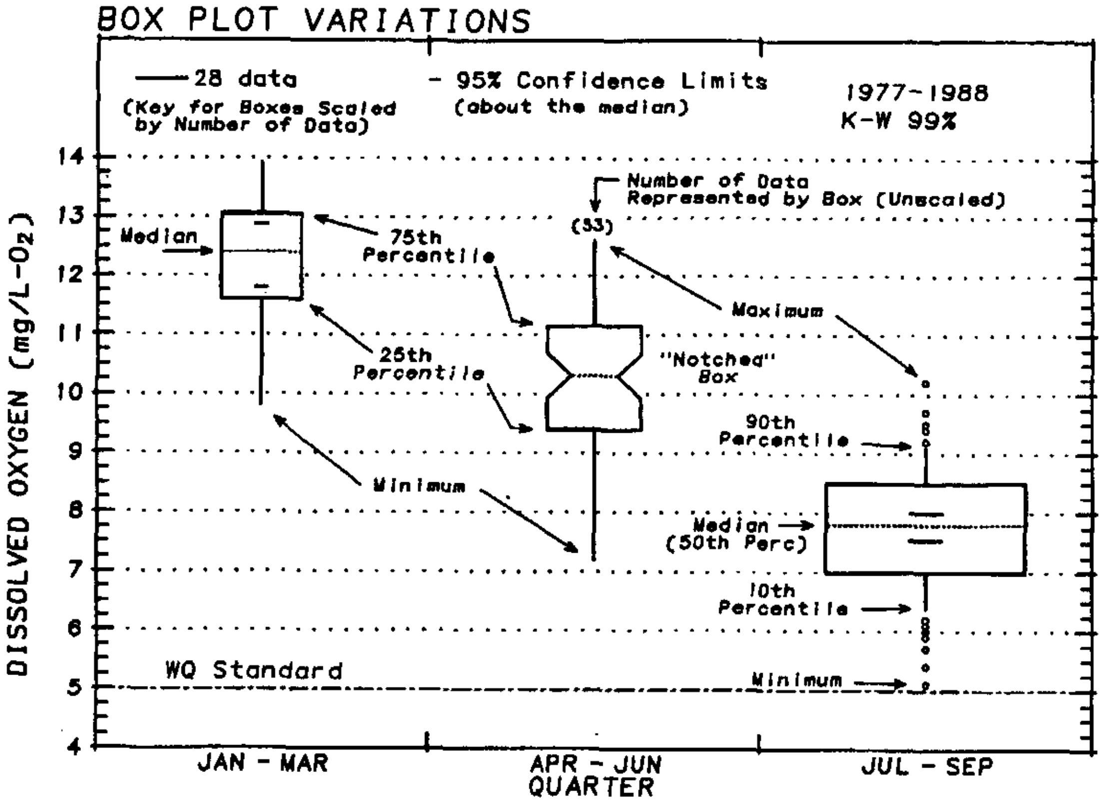
Chart 4-12 -- Example Seasonal Wilcoxen-Mann-Whitney Test Plot



Seasonal Box and Whisker Plots by Station and Variable

Seasonal box and whisker plots and charts of medians were used to graphically display differences between the sites that were analyzed using the Wilcoxen-Mann-Whitney test.

Chart 4-13 -- Sample Box Plot from WQhydro Software



Box and whisker plots used in this analysis were created using WQhydro software (Aroner, 1995). Chart 4-13 is an example of the output. The type of plot used in the analysis is detailed in the box on the far right. Median, 95% confidence limits, 25th and 75th percentile, 10th and 90th percentile, and maximum and minimums are portrayed with this type of box plot.

Flow Regime

Aquatic organisms require adequate flows to be maintained at critical times to satisfy requirements of various life stages. For example, fish are adapted to natural variations in flow regimes but may be adversely affected by disturbances that alter natural flow cycles (Statzner et al. 1988). Timing, magnitude, duration, and spatial distribution of peak and lowflows must be sufficient to create and sustain riparian and aquatic system habitat and to retain patterns of sediment, nutrient, and wood routing. The timing, variability, and duration of floodplain inundation and water table elevation in meadows, floodplains and wetlands affect maintenance of main channel connectivity within these areas.

Timber harvest and associated activities can alter the amount and timing of streamflow by changing onsite hydrologic processes (Keppeler and Ziemer 1990; Wright et al. 1990). These activities (which include harvest, thinning, yarding, road building, and slash disposal) can produce changes that are either short-lived or long-lived -- depending on which hydrologic processes they alter and the intensity of the alteration (Harr 1983). Thus, changes in the hydrologic system caused by road building are most pronounced where road densities are the greatest (Harr et al. 1979; Wright et al. 1990; Ziemer 1981). Similarly, the effects of clearcut logging on hydrologic processes are greater than those resulting from thinning (Harr 1983; Harr et al. 1979).

Changes in hydrologic processes can be grouped into two classes according to causal mechanisms. One class consists of changes resulting from removing forest vegetation through harvest. These changes, which can be very large when located close to the harvest areas immediately following harvest, gradually diminish over time as vegetation re-growth occurs (Harr 1983; Harr et al. 1979; Harris 1977; Hicks et al. 1991b).

Processes that depend on the amount and size of forest vegetation include rain or snow interception, fog drip (Azevedo and Morgan 1974; Byers 1953; Harr 1982; Ingwerson 1985; Isaac 1946), transpiration (Harr 1983; Harr et al. 1979, 1982), and snow accumulation and melt (Berris and Harr 1987; Coffin and Harr 1992; Harr 1981; Troendle 1983; Swanson and Golding 1982). These processes (most of which are at least partially energy-dependent) all increase the amount or timing of water arriving at the soil surface, as well as the resultant amount of water flowing from a logged watershed.

Generally, the longevity of changes in these processes brought about by timber harvest is approximately three to four decades. It is related to vegetation characteristics such as tree height, leaf area, canopy density, and canopy closure (Coffin and Harr 1992; Harr and Coffin 1992; Troendle 1983; Hicks et al. 1991b).

A second class of changes in hydrologic processes consists of those that control infiltration and the flow of surface and subsurface water. This class is dominated by the effects of forest roads. The relatively impermeable surfaces of roads cause surface runoff that bypasses longer, slower subsurface flow routes (Harr et al. 1975, 1979; Ziemer 1981). Where roads are in-sloped to a ditch, the ditch extends the drainage network, collects surface water from the road surface and subsurface water intercepted by roadcuts, and transports this water quickly to streams (Wemple draft; Megahan et al. 1992).

The longevity of changes in hydrologic processes resulting from forest roads is as permanent as the road. Until a road is removed and natural drainage patterns are restored, the road will likely continue to affect the routing of water through watersheds.

In 20-200 square mile watersheds, increased peakflows have been detected after roading and clearcutting occurred (Christner and Harr 1982; Jones and Grant in review). Higher flows result from: a combination of wetter, more efficient water-transporting soils following reduced evapotranspiration (Harr et al. 1982; Harris 1977); increased snow accumulation and subsequent melt during rainfall (Berris and Harr 1987; Harr 1986; Harr and Coffin 1992); surface runoff from roads (Harr et al. 1975, 1979); extension of drainage networks by roadside ditches (Wemple draft); and possibly reduced roughness of stream channels following debris removal and salvage logging in riparian zones (Jones and Grant in review).

The alteration in stream flow regime resulting from timber harvest and associated activities can have both positive and negative effects on the aquatic system (Hicks, B.J 1991a). For example, decreased evapotranspiration following logging and prior to vegetation regrowth can increase summer stream flows which may bring about short-term increases in juvenile salmonid survival. Conversely, increased peakflows may increase bed-load movement and reduce survival of salmonid eggs and alevins.

Effects of streamflow changes on aquatic organisms have not been documented independently from other logging effects. The extent to which the positive effects of short-term increase in summer flows is offset by the detrimental effect of increased peakflows and resultant scour is unknown.

Peakflows

This section examines flows in areas above Marmot Dam. This approach enables natural and management effects to be distinguished from the dams effects on the flow regime. Because the flow regime below the dams within the Upper Sandy Watershed is in an altered state associated with the structures, flows in this area are discussed separately.

Introduction

Peak streamflows have important effects on stream channel morphology, sediment transport, and bed material size. Peak streamflows can affect channel morphology through bank erosion, channel migration, riparian vegetation alteration, bank building, and deposition of material on floodplains. The vast majority of sediment transport occurs during peakflows as sediment transport capacity increases logarithmically with discharge (Ritter 1978; Garde and Rangu Raju, 1985).

The ability of the stream to transport incoming sediment will determine whether deposition or erosion occurs within the active stream channel. The relationship between sediment load and sediment transport capacity will affect the distribution of habitat types, channel morphology, and bed material size (MacDonald, 1991). Increased size of peakflows due to urbanization have been shown to cause rapid channel incision and severe decline in fish habitat quality (Booth, 1990).

Another important consideration is the impact of bankfull flow, often described as the high flow during two out of three years, or as a stream discharge having a recurrence interval of 1.5 years (Dunne and Leopold, 1978). The shape of the channel more closely reflects the bankfull width and height than it does the less frequent floods. If the bankfull flow is raised above the range of natural conditions, excess scouring can occur. If lower, the stream may not have the power to move its natural sediment load, causing sediment deposition within the watershed.

The Aquatic Conservation Strategy (ACS) gives clear direction that "the distribution of land use activities, such as timber harvest or roads, must minimize increases in peak streamflows" (ROD B-9) to create and sustain riparian, aquatic, and wetland habitats, and to retain patterns of sediment, nutrient, and wood routing.

Peak streamflows of large magnitude in the Upper Sandy Watershed are generated by rain-on-snow events. The transient rain-on-snow zone is normally considered to be from 2400 to 4800 feet. 94 percent of the watershed is below 4800 feet. Additionally, based on current flood history, although a large portion of the watershed is below 2400 feet, the entire watershed is considered to be in the transient rain-on-snow zone.

Record floods occur predominantly during November through January, caused by: accumulated snow at lower elevations followed by a rapid rise in temperature, unusually high-elevation freezing levels, and heavy rainfall. In some instances, the ground is frozen prior to snow accumulation, producing more favorable conditions for high runoff (SCS 1976).

February 1996 Flood

In early February 1996, a rain-on-snow event subjected northwest Oregon to some of the most severe regional flooding in nearly 30 years.

Beginning in mid-January, unusually high amounts of snow accumulated in the mid to high elevations of the Cascades. By Jan. 31, average snowpack for the Willamette drainage was 112% of the long-term average. A Feb. 3 storm dropped rain on top of frozen soils and roads, and delivering freezing rain at lower elevations. These conditions set the stage for a rain-on-snow event.

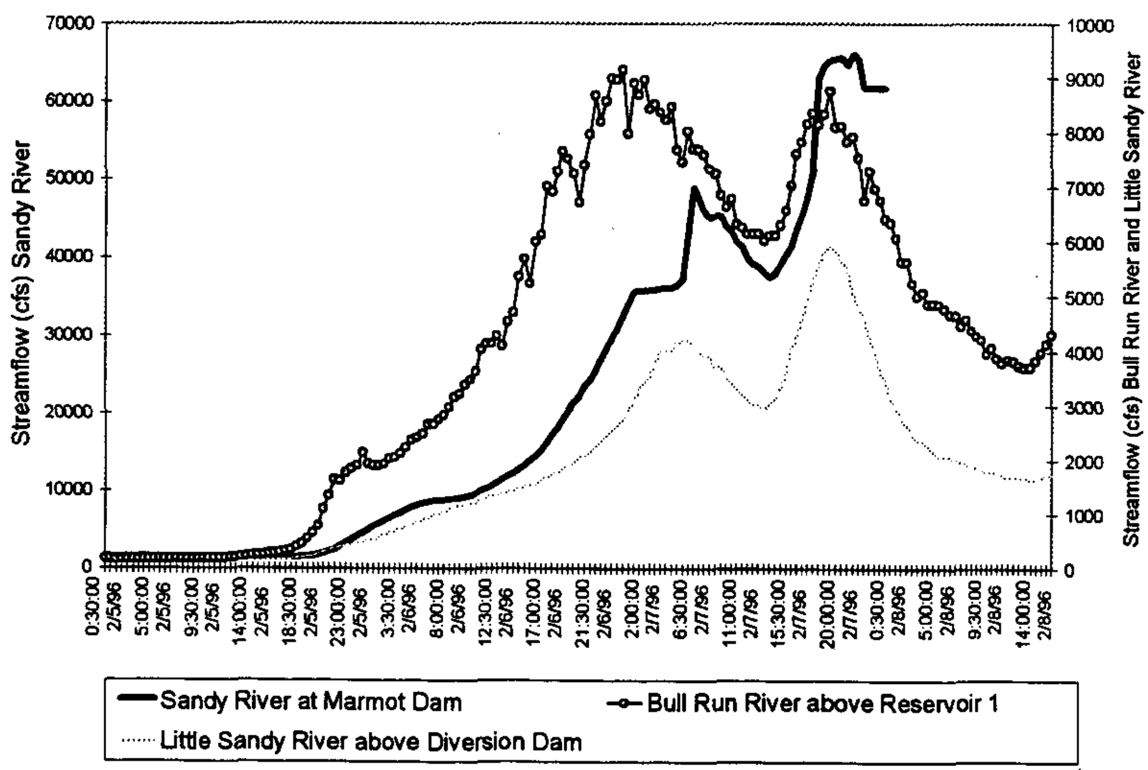
During the period of February 6-8, 16.4 inches of runoff (rainfall and snowmelt) was measured at the Blazed Alder Snotel Site.

The preliminary determination of the flood recurrence interval for the U.S. Geological Survey (USGS) stream gaging station on the Sandy River at Marmot Dam gives a greater than 200 year recurrence interval for this storm using a Log Pearson Type II distribution for annual peaks (this determination was based on preliminary USGS streamflow data). This is a higher recurrence interval than any of the other streamflow gages in the Sandy Basin which varied from 25 years to greater than 100 years. The flow recurrence interval within the adjacent Bull Run Watershed appears to be correlated with the amount of watershed area under 2500 feet.

Table 4-30 -- February 1996 Peakflows, Recurrence Intervals, and Percentage of Watershed Below 2,500 ft.

Stream Gage	USGS #	Peakflow	Recurrence Interval	% of Watershed below 2500 feet
Blazed Alder Creek	14138800	1910 cfs	25 years	0
Bull R. above Res.#1	14138850	9140 cfs	50 years	22
Fir Creek	14138870	1100 cfs	25 years	30
S.F. Bull Run River	14139800	4360 cfs	> 100 year	46
Little Sandy River	14141500	5900 cfs	> 100 year	60
Sandy River at Marmot Dam	14137000	66,100 cfs	>200 year	29

Chart 4-14 Hydrograph Storm Event February 5-8, 1996



The shape of the hydrograph for the February 1996 storm shows that the Sandy River was slower to respond than the stations in the Bull Run (demonstrated by the peak values later in the day on February 7th). This is attributed in part to snowmelt in the Sandy River watershed with a slower response time than rainfall and in part to local patterns of precipitation (note the similar shape of the hydrographs from the Little Sandy and Sandy Rivers).

Peakflow Regime Assessment for Upper Sandy Watershed

Peakflows will be assessed for the Upper Sandy Watershed above dams and diversions by:

- Examination of trends based on the historical record from the USGS gaging station on the Sandy River at Marmot Dam.

- Examination of differences between the Upper Sandy Watershed and the unmanaged control subwatershed (Fir Creek) in the Bull Run.

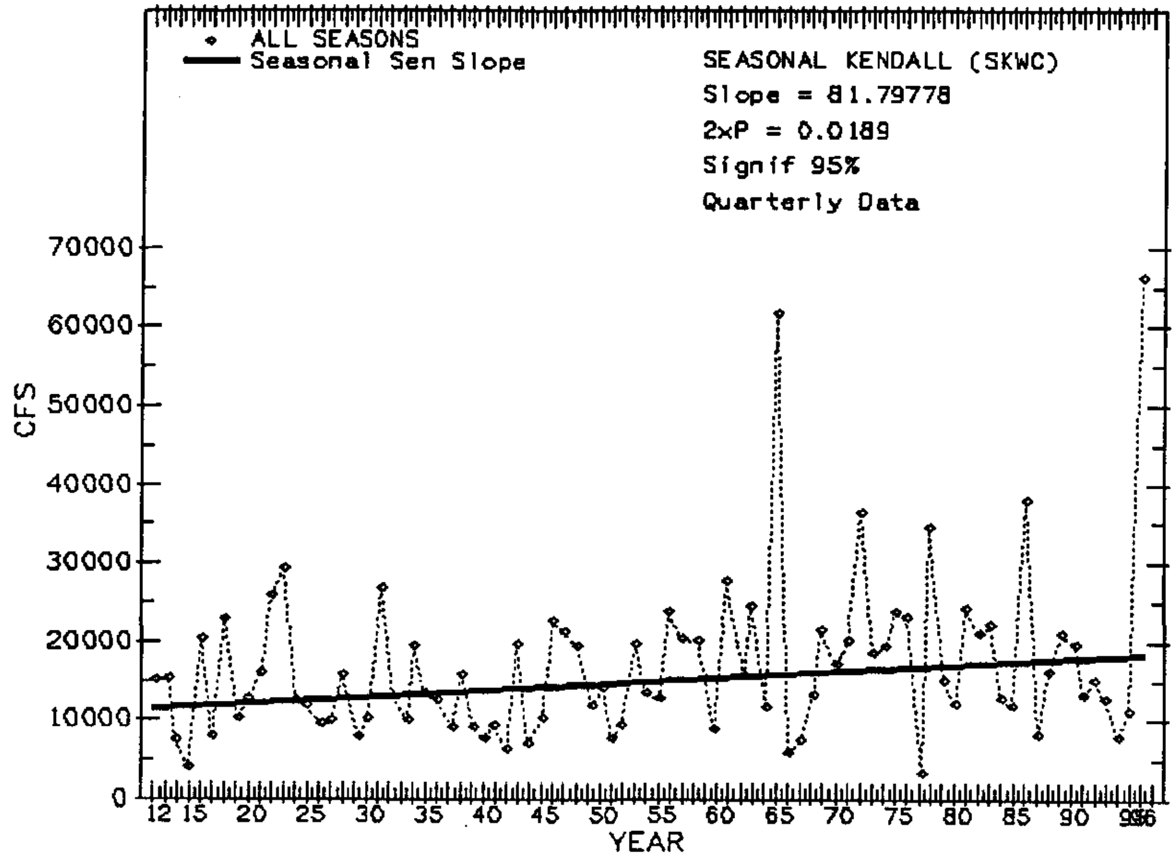
- Assessing changes in peakflows associated with rain-on-snow events.

- Assessing changes in peakflows associated with increases in stream drainage networks.

Trends

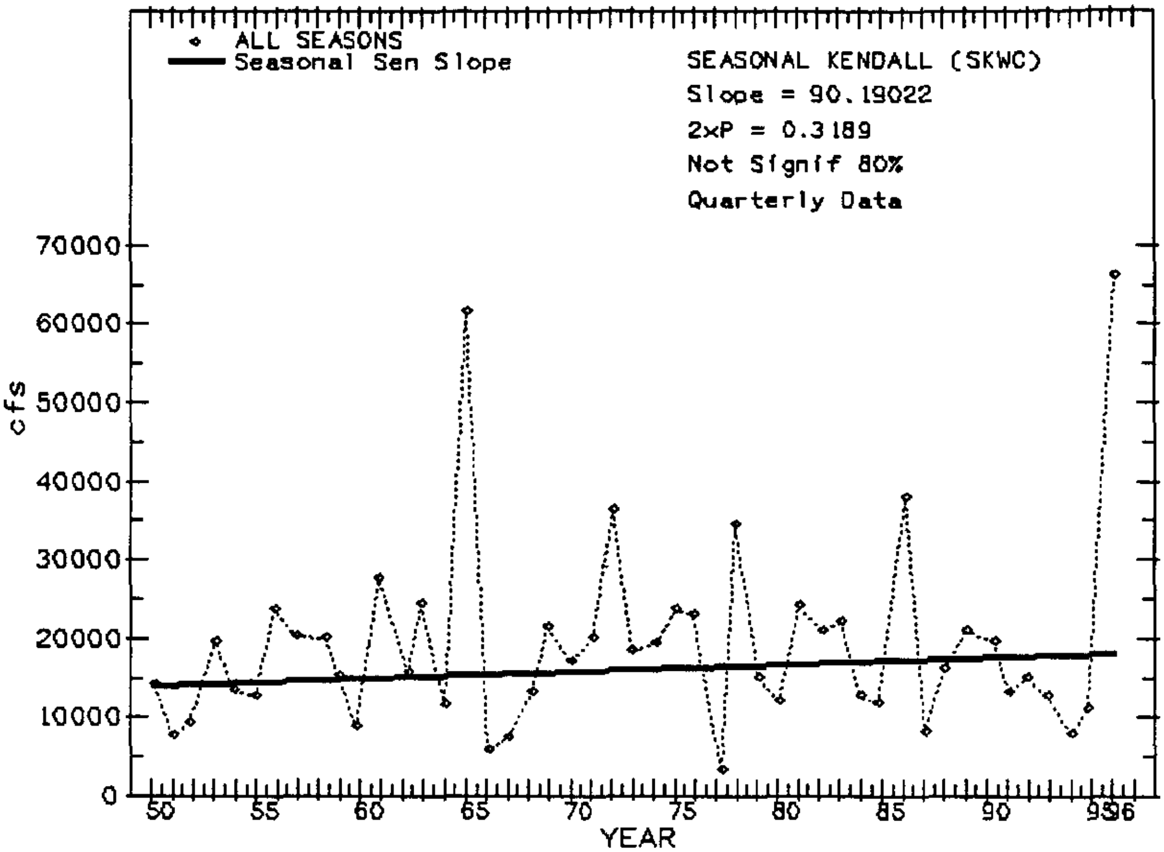
Trends analysis using the Season Kendall Trend Test was completed for the measured instantaneous peakflow from the Sandy River at Marmot Dam. The annual instantaneous peakflow, which focuses on the magnitude of the peakflow event -- not the timing or the duration, was used for this analysis.

Chart 4-15 Peakflow Trends 1912-1996 Sandy River at Marmot Dam



Seasonal Kendall Trends analysis indicates an increasing trend at the rate of 82 cfs per year that is statistically significant (P level less than 0.10). To put the magnitude of the trend in perspective the 1996 peakflow was 66,100 cfs. In order to quantify the effects of recent management activities within the Upper Sandy Watershed trends analysis was completed for the period 1950-1996. This time period was selected because it was felt that large scale timber harvest and associated road building began in the 1950's.

Chart 4-16 Peakflow Trends 1950-1996 Sandy River at Marmot Dam



The trendline for the period 1950-1996 has a similar slope (an increasing trend at 90 cfs per year) to the trendline for the entire period of record, however, the trend is not statistically significant (P less than 0.10).

The lack of a significant trend for the period 1950-1996 would indicate that recent forest management activities (timber harvest and roading) in the Upper Sandy, Salmon River, and Zigzag watersheds are not increasing the peakflow magnitude in the Sandy River at Marmot Dam. However, a large majority of the Upper Sandy, Salmon River, and Zigzag watersheds were impacted by forest fires in the period from 1912 to 1950. A created opening from a forest fire functions the same as a created opening from timber harvest with respect to snow accumulation and melt, so the lack of a significant trend for the period from 1950-1996 may be in part due to the influence of forest fires in this area. The period 1960 through 1996 was analyzed to factor out the influence of forest fires in this area (areas impacted by forest fires would have moved from early seral to mid seral stand conditions and would be hydrologically recovered with respect to snow accumulation and melt).

Chart 4-17 Peakflow Trends 1960-1996 Sandy River at Marmot Dam

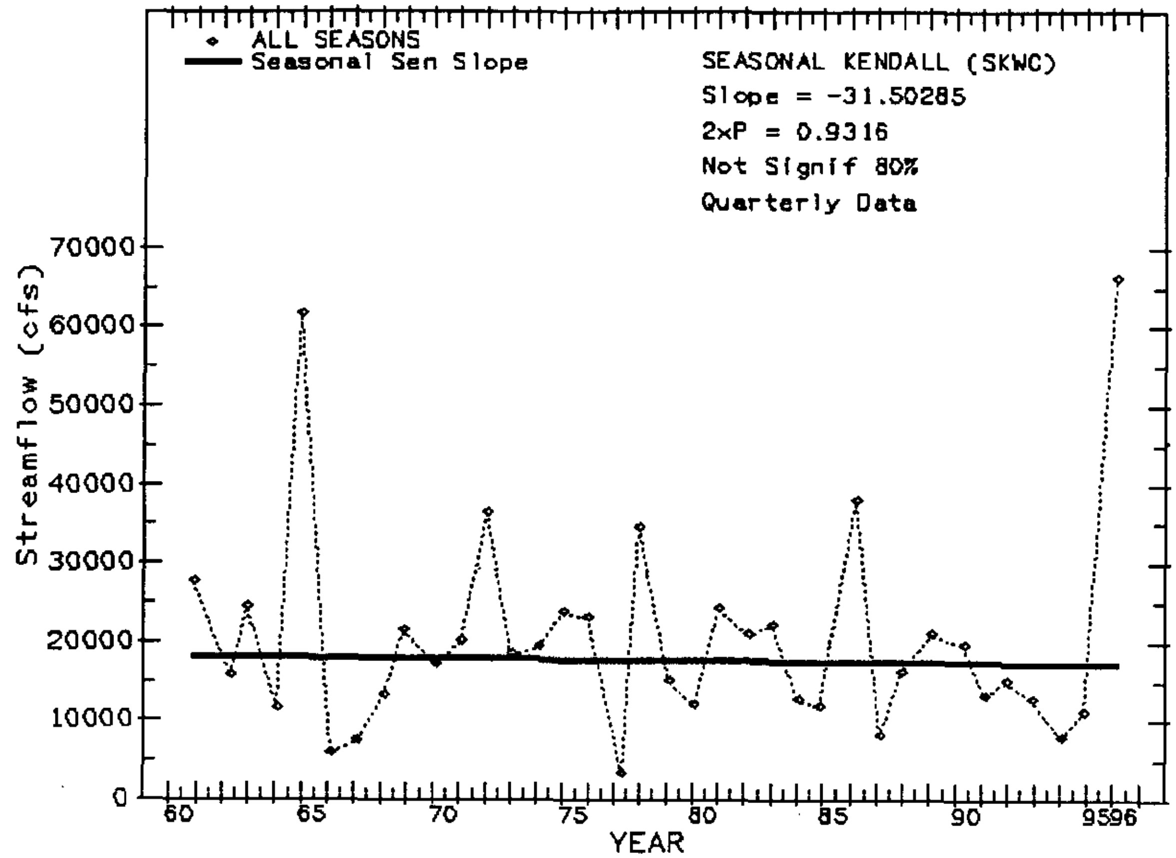


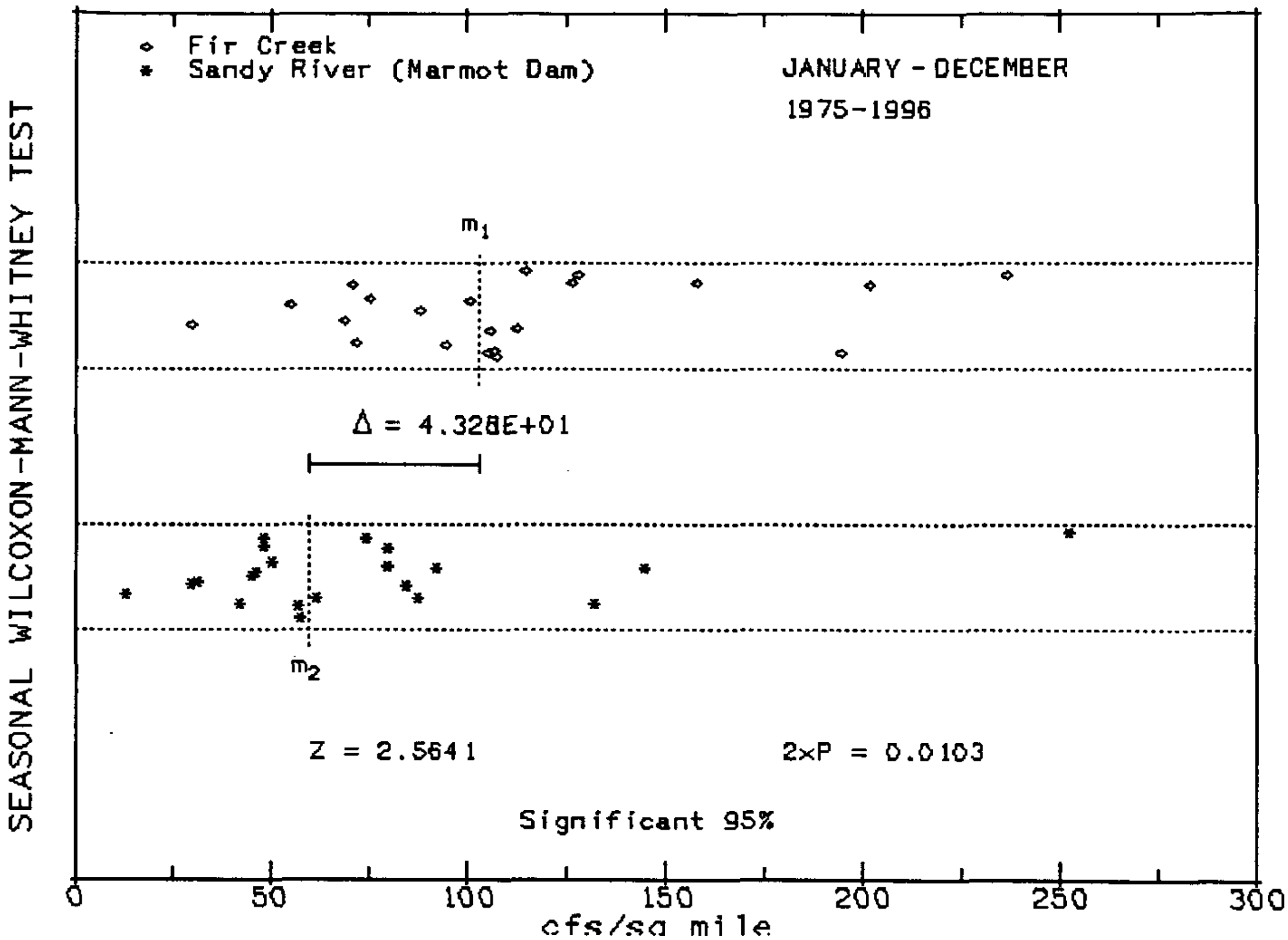
Chart 4-17 indicates that there is a slight decreasing trend for the period 1960-1996, however, this trend is not statistically significant. It would appear that for the last 35 years that there is not a trend associated with forest management activities in this area.

Recommendation (analysis gap): use Aggregate Recovery Percent (ARP) methodology to assess hydrologic recovery with respect to created openings to develop recovery curves for the same period as the streamflow data. Recovery curves would assess created openings from fires and management activities.

Peakflow Differences Between Marmot Dam and Fir Creek

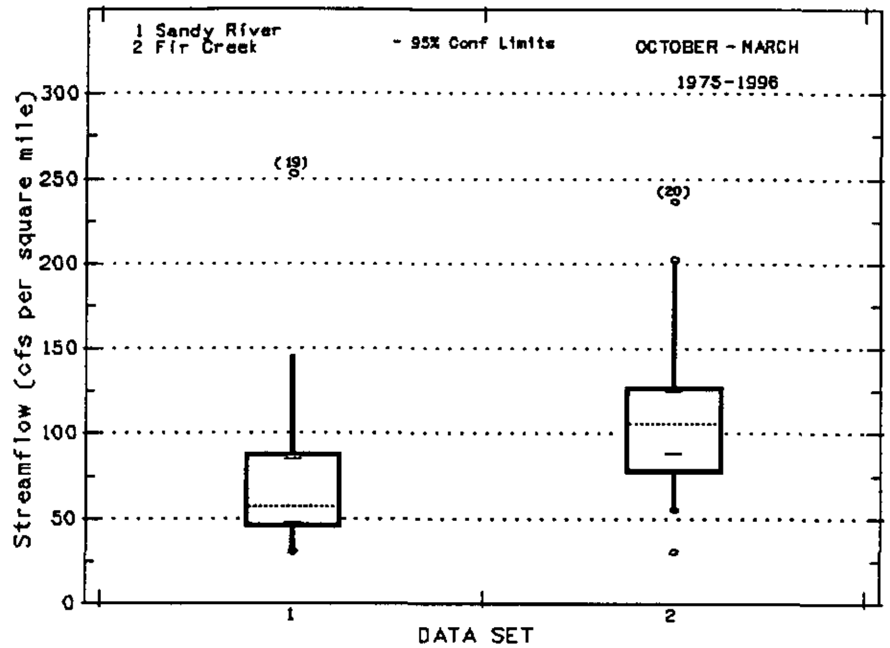
Peakflows were compared between areas by dividing the instantaneous peakflow per year by the gaged area -- to ascertain peakflows (in cfs) per square mile. This enabled a per unit contribution with respect to peakflows, allowing different sized gaged areas to be compared. The Sandy River at Marmot Dam was compared to Fir Creek in attempt to assess the effects of management activities. By comparing the same time period climatic influences such as major storm events are factored out.

Chart 4-18 Peakflow Comparison Sandy River and Fir Creek



A statistically significant (P-level less than 0.10) differences of 43.23 cfs per square mile exists between the two watersheds. The peakflow values per square mile are higher in the Fir Creek subwatershed. The distribution of the peakflows values from 1975-1996 is plotted in Chart 4-19 to determine the range of variability for the two stations.

Chart 4-19 Distribution of Peakflows - Sandy River and Fir Creek



The range or variability is greater for the Fir Creek gage which would indicates a flow regime that is more response to runoff (rainfall and snowmelt). The difference in watershed sized exerts different influences in this type of comparison. The area gaged by the Sandy River at Marmot is considerably larger than that of Fir Creek (262 mile^2 vs 5.5 mile^2). Larger basins have more precipitation variations elevationally and spatially. Peaks in larger basins are broader in time because they attenuate or oppositely increase in the downstream direction, and tributaries are of differing drainage density and enter at many points along the mainstem. It is notable that for the rain-on-snow event in February 1996 the peakflow per square mile was 252 cfs/mile^2 at the Sandy River gage and 201 cfs/mile^2 at the Fir Creek gage, so for that event the Sandy River was more responsive to runoff.

Assessment Of Changes Due To Increased Peakflows From Rain On Snow

This assessment was completed using methodology from the Washington Department of Natural Resources (DNR) *Standard Methodology For Completing Watershed Analysis* (DNR, 1993). This method assumes that the greatest likelihood for significant, long-term cumulative effects on forest hydrologic processes is caused by the influence of created openings from timber harvest and roads on snow accumulation and snowmelt. The effect of vegetation change on peakflows during rain-on-snow events serves as the focus of this assessment.

The primary mechanism by which forest practices affect peak streamflows is alteration of snow accumulation and snowmelt in response to forest canopy density.

Peakflows are calculated for:

- 2, 5, 10, 25, 50, and 100-year recurrence interval peak streamflow events;
- two storm intensities (average and unusual);
- and three vegetative cover conditions (existing, 1944, and hydrologically recovered).

The vegetative cover conditions from 1944 (Clackamas County) were used as a "snapshot" of historical condition.

The "average" storm represents a typical rain-on-snow event using average values for precipitation, storm temperature, wind speed, and snow accumulation. The "unusual" storm uses the average values plus one standard deviation for precipitation, storm temperature, wind speed, and snow accumulation. Hydrologically recovered conditions for vegetative cover were assumed to be 70% canopy closure of trees more than 8 inches diameter at breast height (DBH) in coniferous stands.

Chart 4-20 and Chart 4-21 detail changes in peakflows from a hydrologically mature condition.

Chart 4-20 -- DNR Methodology Predicted Peak Streamflows (Current Condition)

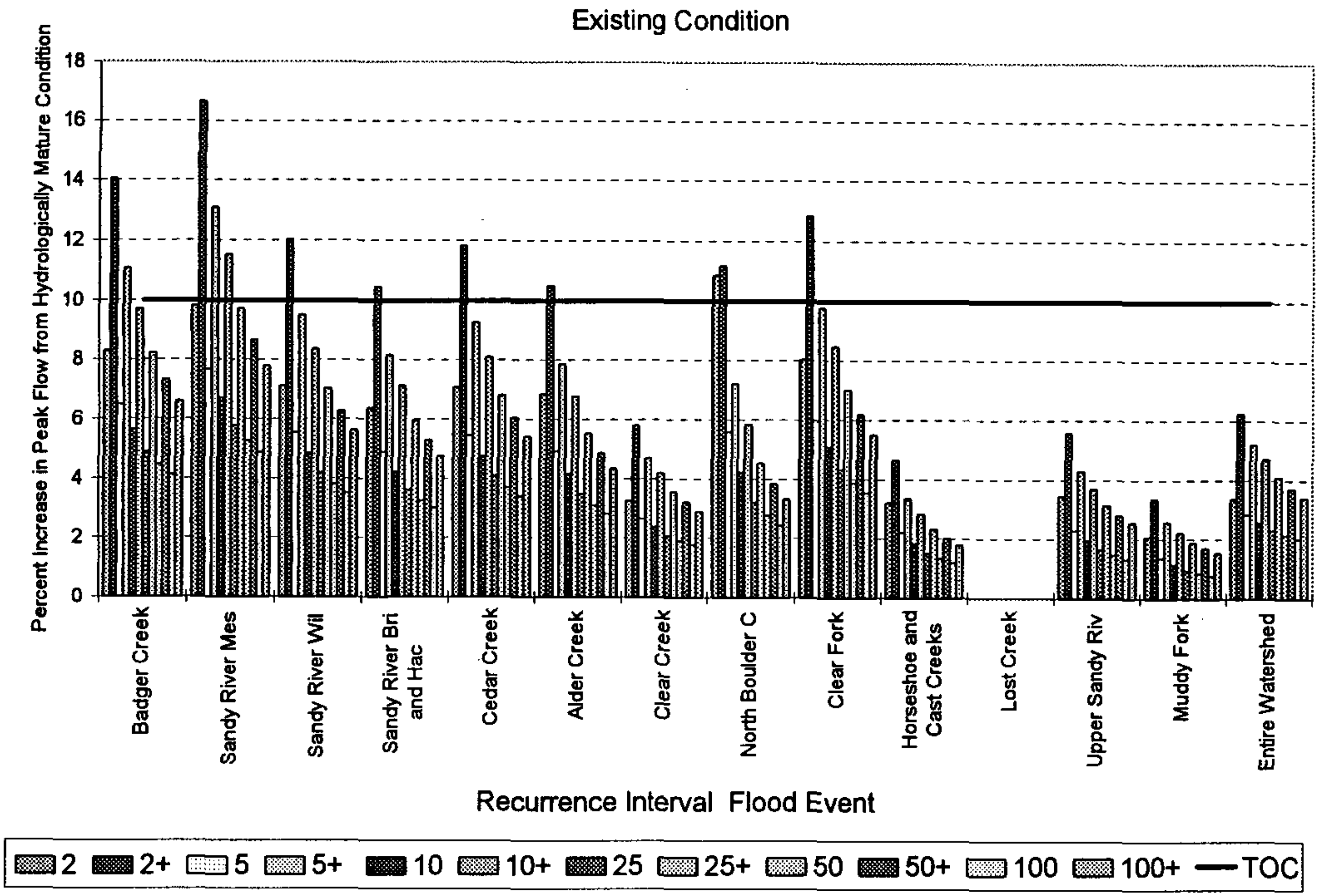
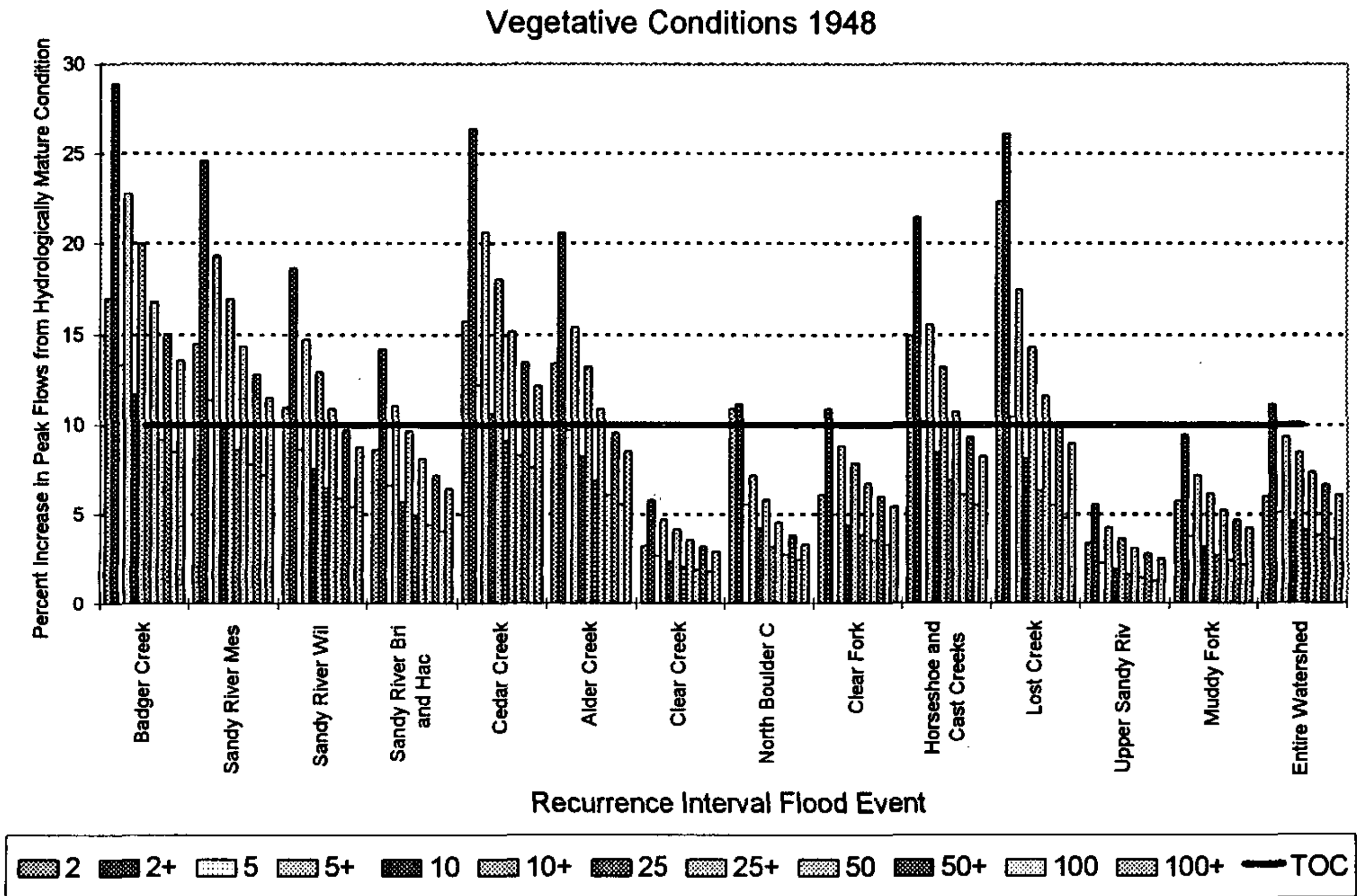


Chart 4-21 -- DNR Methodology Predicted Peak Streamflows (Historical Condition-1948)



Results

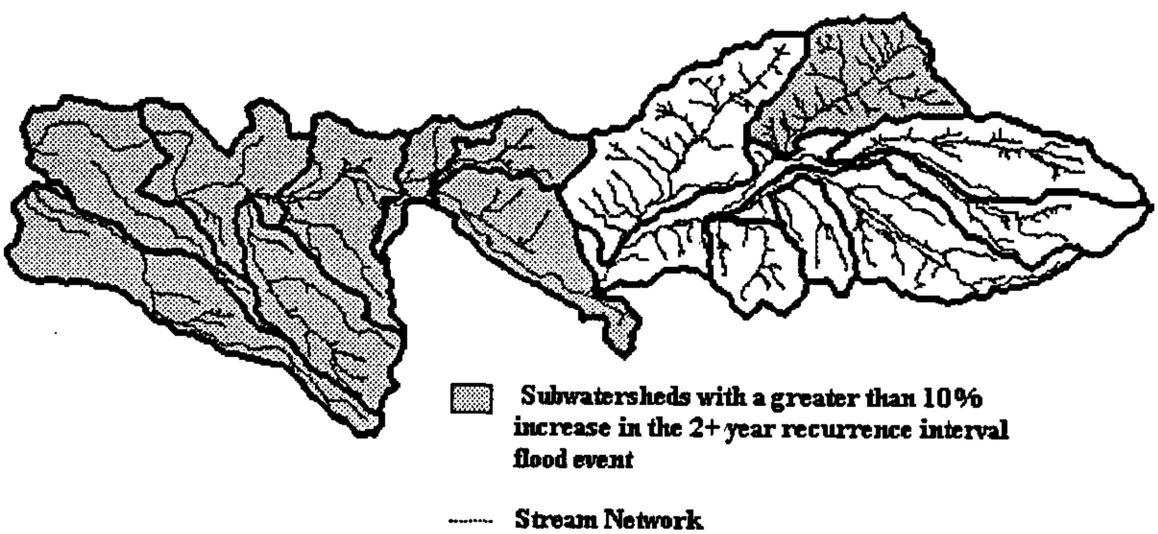
Chart 4-20 and Chart 4-21 detail increases for different recurrence interval peak streamflows for current vegetative conditions, and for vegetative conditions in 1944. The largest increases are predicted for the 2+ storm (a storm with a two-year recurrence interval and "unusual" weather conditions).

Given the inherent error in peakflow prediction methods, the threshold of concern for increases in peakflows based on this methodology is 10%. (Using standard stream gaging methods, changes in peakflows of up to 10% are usually below detection limits.)

The threshold of concern used in this analysis is not intended as a standard, but as an indicator of a need for further analysis.

Peakflow increases greater than 10% offer the possibility for adverse effects and are assessed for impacts on beneficial uses. As Figure 4-22 indicates based on current vegetative conditions the 2+ year recurrence interval storm increases peakflows more than 10% in most of the subwatersheds.

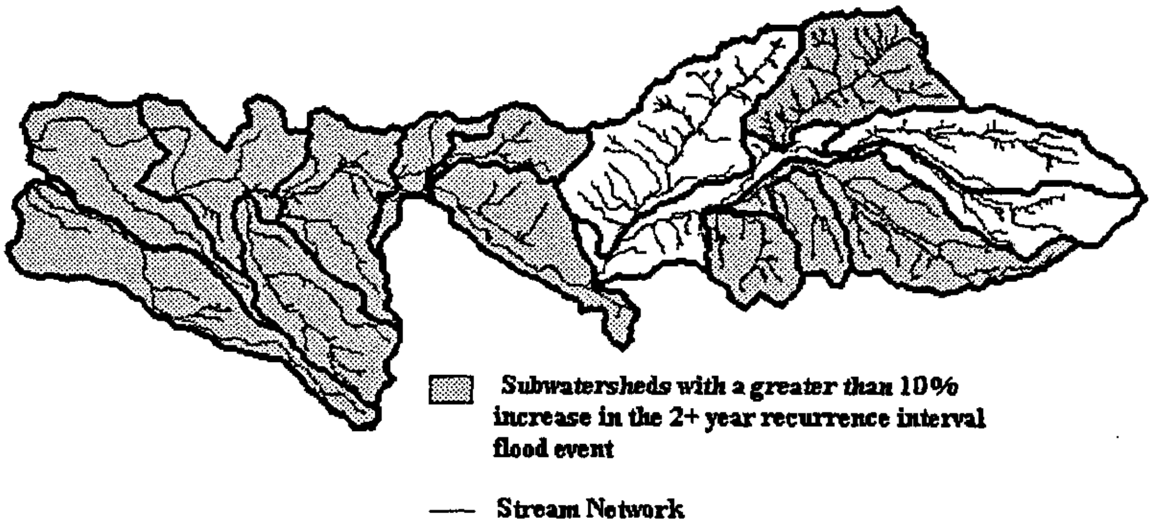
Figure 4-22 Predicted Potential For Increased Peakflows, Current Vegetative Condition (based on DNR Hydrologic Change Module)



Increases in peakflow magnitude greater than 10% have the potential to increase suspended sediment and turbidity levels due to in-channel processes such as streambank and inner gorge failures. Based on the stream channel stability analysis this would be a concern across the watershed due to the high percentage of streams in the watershed with high streambank and inner gorge failure potential. Proposed projects with the potential to create openings need to be further analyzed to determine the effects of the project on the peakflow magnitude.

The two year recurrence interval associated with the increases in peakflow has the potential to effect the stream channels on nearly an annual basis. There is also the potential to effect anadromous fisheries within this watershed due to the disruption of the egg incubation environment (redds). Salmonids generally bury most of their eggs at depths exceeding the mobile stream bed layer for the two year recurrence interval flood event. Evolutionary strategy would suggest an advantage to burying eggs at depths below the two year recurrence interval mobile stream bed layer, since scour frequency at shallower depths could affect populations on a nearly annual basis (DNR, 1993).

Figure 4-23 Predicted Potential For Increased Peakflows 1944 Vegetative Conditions (based on DNR Hydrologic Change Module)



Due to created openings associated with development in the western extend of the watershed and forest fires in the early part of the century a large part of the watershed in 1944 had the potential for increased peakflows from the 2+ year recurrence interval flow event. This indicates that the peakflow magnitude for the 2+ year recurrence interval storm has been altered for the past 50 years with the potential to cause long term alterations and stream channel disruption on nearly an annual basis.

Stream Drainage Network Expansion

Current research suggests that roads function hydrologically to modify streamflow generation in forested watersheds by altering the spatial distribution of surface and subsurface flowpaths. Observations suggest roadside ditches and gullies function as effective surface flowpaths which substantially increase drainage density during storm events (Wemple, draft).

This increase in drainage density may affect the timing, duration, and frequency of peak streamflows. Road ditches that route flow to stream-crossing culverts extend the drainage network by the length of the ditch carrying water under storm conditions (FEMAT). An assessment of the increase in the channel network due to inboard ditches along roads has been completed using methodology that was developed on the Siskiyou National Forest (Elk River WA, 1994).

Channel network expansion is calculated by counting the number of stream crossings within a watershed, multiplying that number by the distance from the stream crossing to the first culvert, and adding that distance to the stream network. This procedure adds the ditchlines from the stream crossing up to the first ditch relief culvert to the stream system.

For this analysis, it was assumed ditchlines on both sides of the stream crossing contributed to the increase in the stream network. Culvert spacing was estimated for each subwatershed by examining the actual culvert spacing, from the FES database for representative roads within that subwatershed. Culvert spacing varied from 400 to 500 feet between culverts. Stream length for each watershed was calculated from the ARCINFO streams coverage.

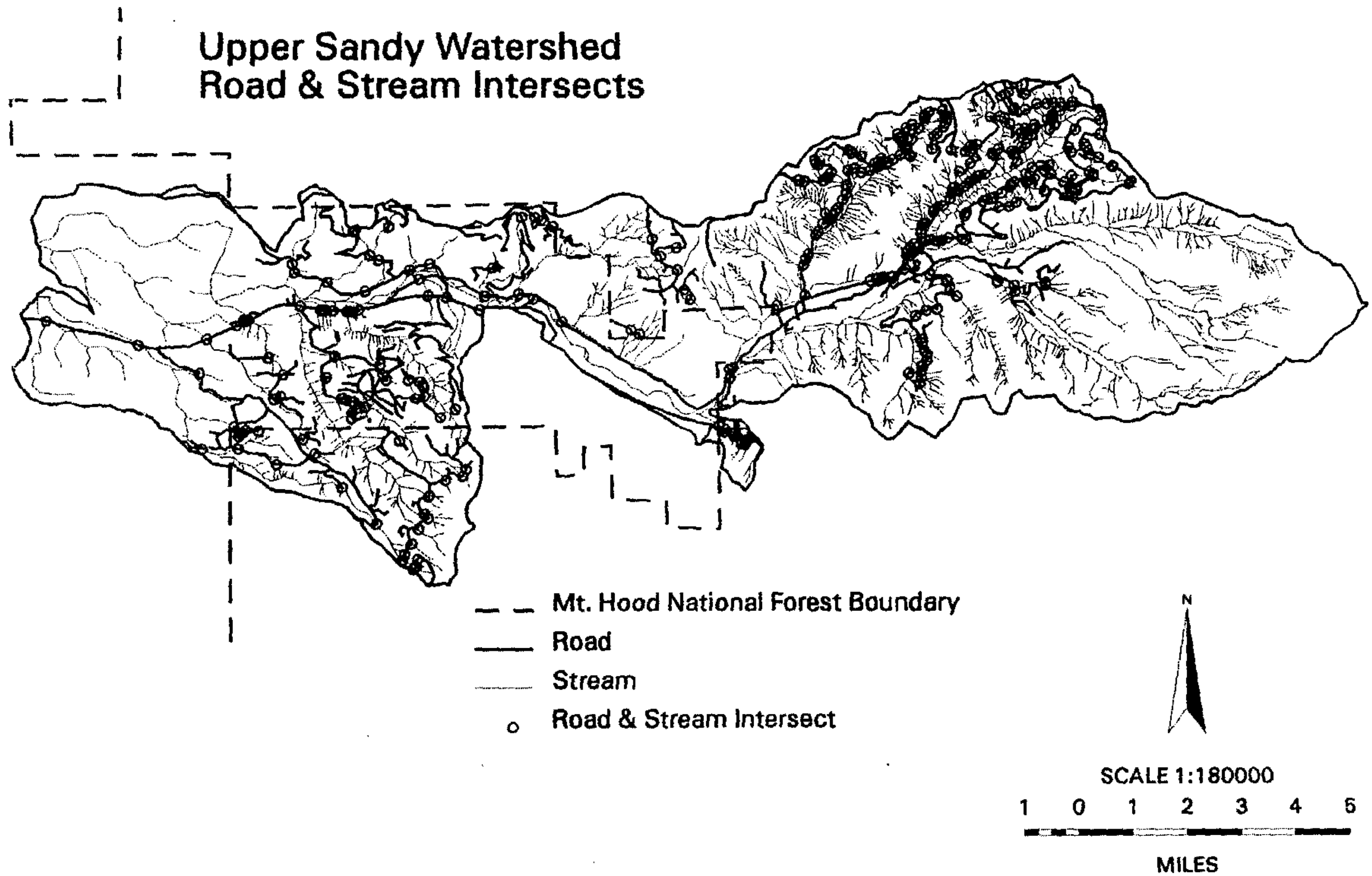

Upper Sandy Watershed
Road & Stream Intersects
Mt. Hood National Forest Boundary
Road
Stream
Road & Stream Intersect
N
SCALE 1:180000
1 0 1 2 3 4 5
MILES

Chart 4-22 -- Stream Drainage Network Expansion

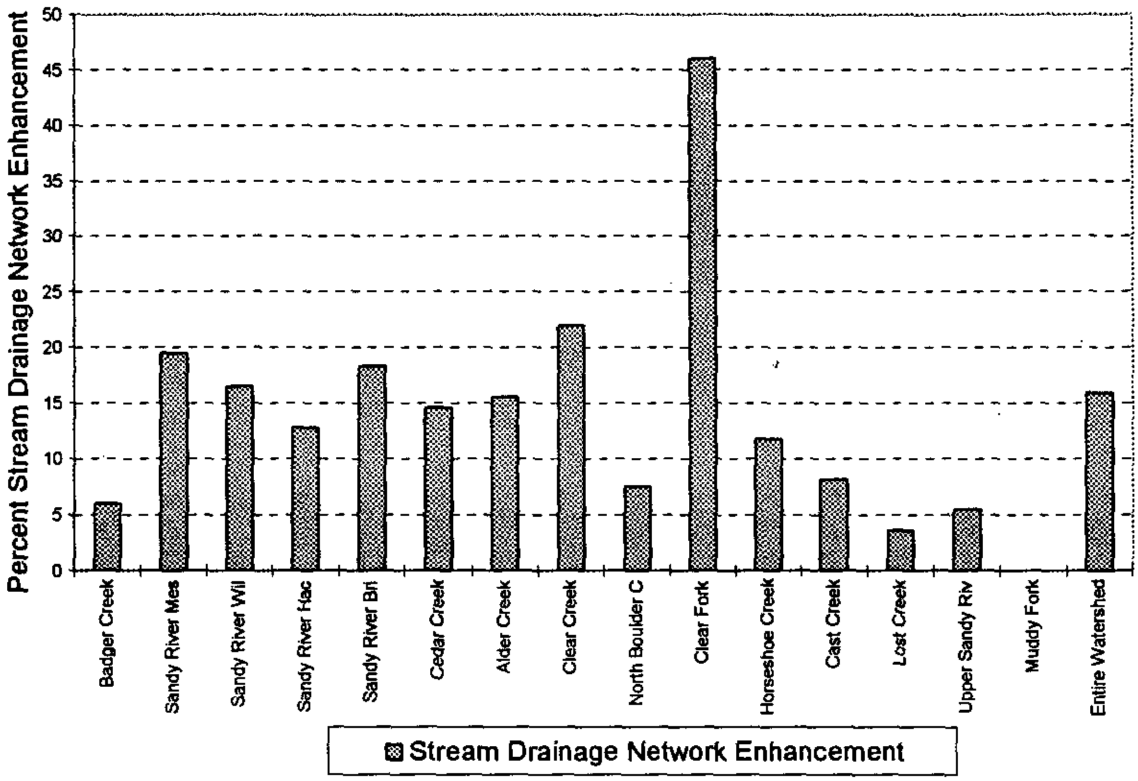
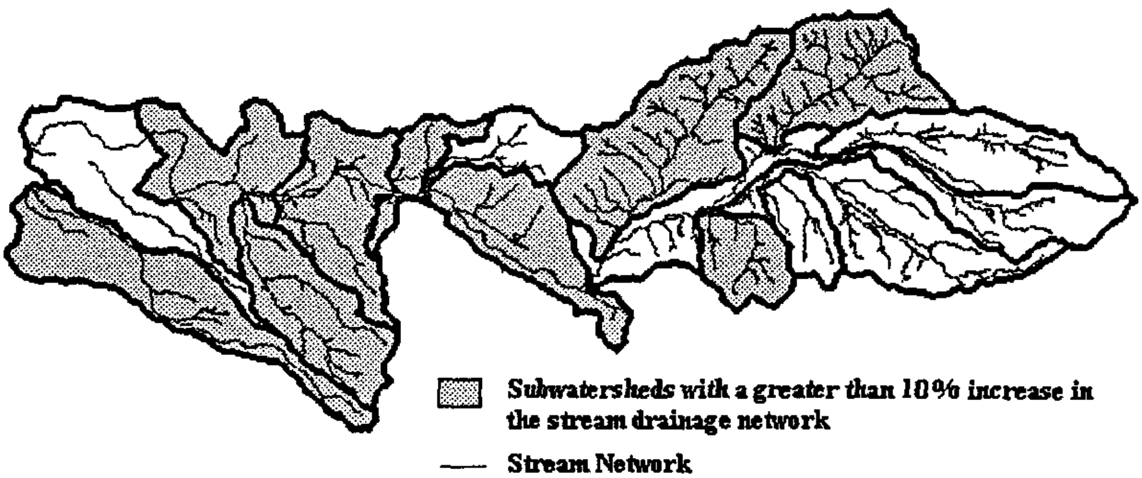


Figure 4-25 Stream Drainage Network Enhancement



As Figure 4-25 illustrates, many of the subwatersheds exceed a 10% increase in the stream drainage network. Clear Fork subwatershed has by far the greatest extent of stream drainage network expansion.

The Aquatic Conservation Strategy (ACS) gives clear direction that: *"The distribution of land use activities, such as timber harvest or roads, must minimize increases in peak streamflows"* (ROD, B-9) to create and sustain riparian, aquatic, and wetland habitats, and to retain patterns of sediment, nutrient, and wood routing. Based on the ACS, this process should be addressed in management of the watershed.

The Zigzag Ranger District has initiated plans to reduce the road system mileage within the Upper Sandy Watershed.

It is believed that the longevity of changes in hydrologic processes resulting from forest roads is as permanent as the road itself. To properly address this process, active road decommissioning is needed. Until a road is removed and natural drainage patterns are restored, the road will likely continue to affect the routing of water through watersheds (FEMAT).

Conclusions Regarding Peakflows

- The recurrence interval of the February 1996 peakflow event was higher in the Sandy River (as measured at Marmot Dam) than any other gaged location within the Sandy Basin.
- There is a slight increasing trend in peakflow magnitude for the period 1912-1996 that does not appear to be tied to forest management activities.
- The magnitude of peakflows per square mile are lower in the Sandy River (as measured at Marmot Dam) than Fir Creek.
- Based on current stand conditions, the majority of subwatersheds are above the threshold associated with the possibility for adverse effects from increased peakflows associated with rain-on-snow events.
- Stream channel network expansion by roads is a concern in the majority of the subwatersheds. The effect of this process on the timing, magnitude, and duration of peakflows is unknown.

Baseflows

Baseflows are a critical component in maintaining aquatic habitat and water quality. Baseflow is the streamflow that originates essentially as groundwater from seeps and springs after rainfall and snowmelt have ceased.

Within the adjacent Bull Run Watershed the following water quality parameters demonstrate increased values with lower stream discharges:, pH, alkalinity, conductivity, and silica (Eilers, 1994). Baseflows are also a critical component in buffering streams with respect to increased stream temperatures associated with the interception of solar radiation when the forest canopy is removed.

ACS objectives state: *"The timing, magnitude, duration, and spatial distribution of peak, high, and lowflows must be protected."*

For this analysis, baseflows were assessed by:

- Seasonal Kendall Trends Analysis on the 30-day duration baseflow for the Sandy River at Marmot Dam.
- Comparison of water yield from the Sandy River at Marmot Dam to Fir Creek
- Assessment of the effects of water withdrawals
- Examination of the effect of forest management effects including fog drip and hardwoods within the riparian area.

Seasonal Kendall Trends Analysis on the 30-day Duration Baseflow

Trends analysis using the Season Kendall Test was completed based on daily averages for the 30-day duration low-flow. The 30-day duration was selected due to its effect on the primary beneficial use of fish habitat.

This trends analysis recognizes the magnitude of the low-flow event -- *not* its timing. The 30-day duration lowflow was calculated using Durfreq software from Earthinfo.

Daily average flow was obtained from USGS records from Hydrosphere CD-ROMs and Hydrodata for Windows software through 1994.

Chart 4-23 Baseflow Trends 1920-1994 Sandy River at Marmot Dam

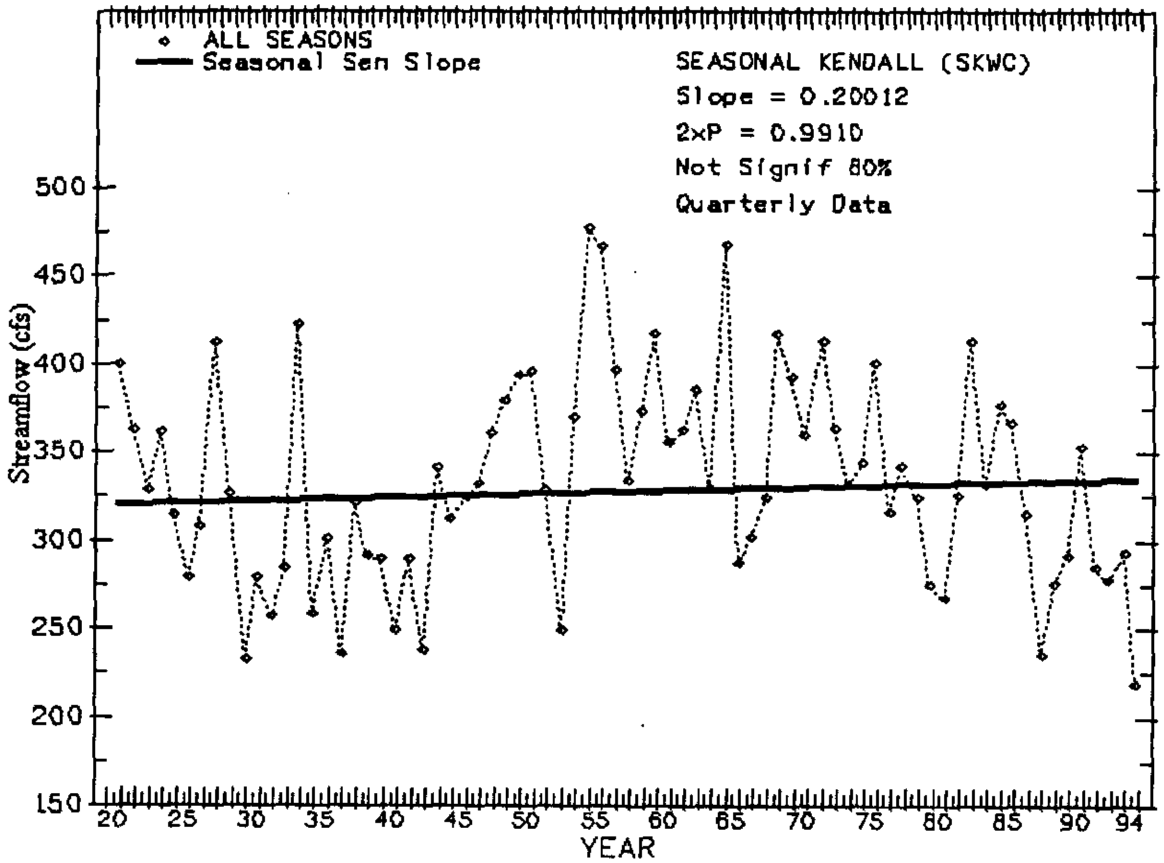
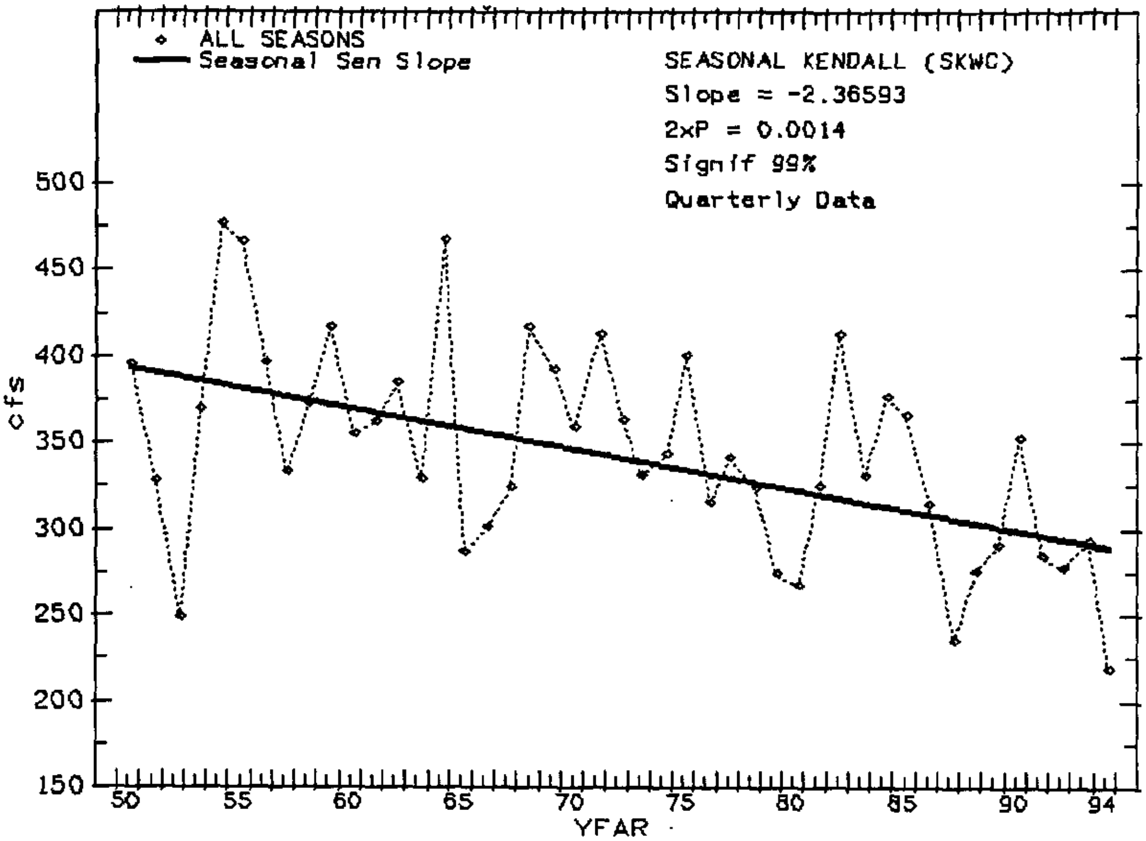


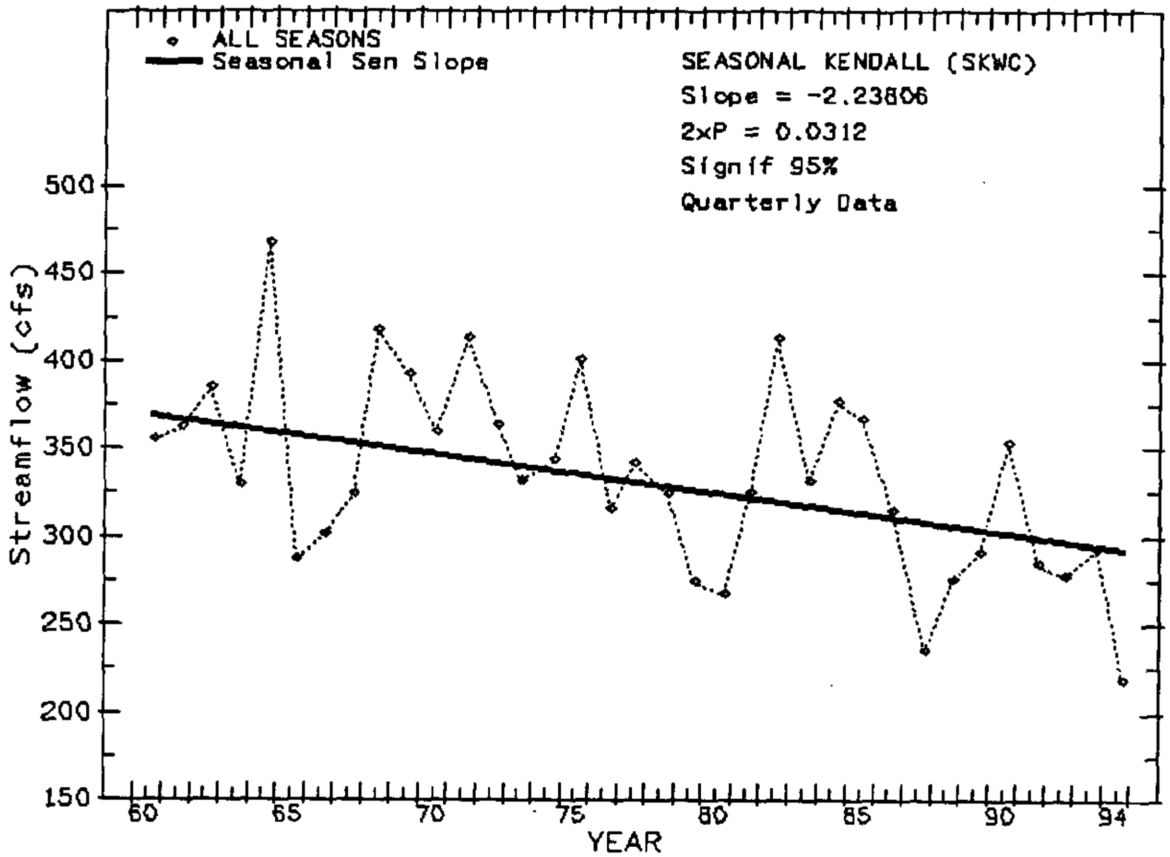
Chart 4-23 illustrates that there is not a significant trend for baseflows for the period of record (1920-1994) in the Sandy River. In order to assess the effects of recent forest management activities the period from 1950-1994 was assessed for any trends. This period was selected because of the harvest and road building activities that began in the 1950's.

Chart 4-24 Baseflow Trends 1950-1994 Sandy River at Marmot Dam



For the period 1950-1994 there is statistically significant decreasing trend with a slope of -2.36 cfs per year. There were a number of forest fires in the Sandy Basin from 1900-1950 which may have influence water yields in the 1950's so the period 1960-1994 was examined.

Chart 4-25 Baseflow Trends 1960-1994 Sandy River at Marmot Dam

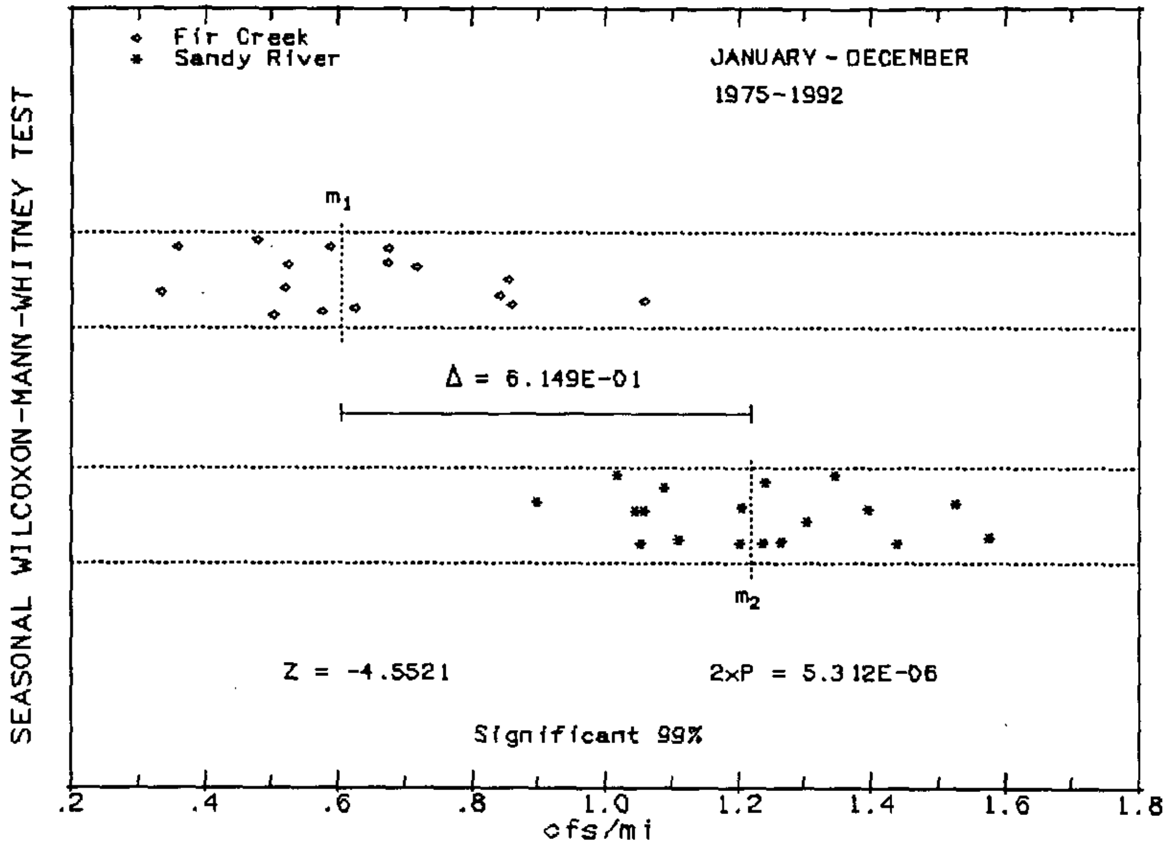


The period 1960-1994 exhibits a very similar trend to the period 1950-1994. This decreasing trend for baseflows at the rate of 2.2 cfs per year could be due to a number of factors including climatic conditions, water withdrawals associated with development in the lower Upper Sandy, and Salmon River watersheds and forest management activities within the Upper Sandy, Salmon River and Zigzag watersheds. Water withdrawals will be assessed by examining waters rights for the area above Marmot Dam. Effects of forest management will be assessed by looking at fog drip and levels of hardwoods in the riparian reserves across the Upper Sandy Watershed.

Differences Between Sandy River at Marmot and Fir Creek

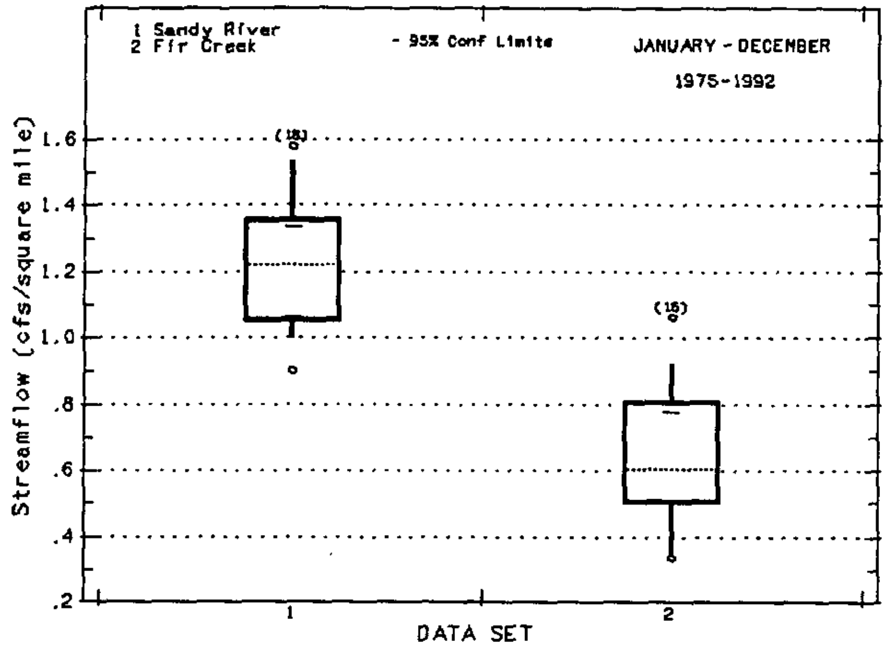
Baseflows were compared by dividing the 30-day duration low- flow per year by the gaged area to derive low-flow (in cfs) per square mile. This was accomplished to attain a per-unit contribution for lowflows to compare different sized gaged areas. As with peakflows this was done to compare the Upper Sandy River to an unmanaged control watershed.

Chart 4-26 Baseflow Comparison Sandy River and Fir Creek



30 day duration baseflows in the Sandy River at Marmot Dam are 0.61 cfs/mile^2 greater than baseflows in Fir Creek and the baseflow per square mile in the Sandy River is approximately double that of Fir Creek. The higher baseflows in the Sandy River are attributed to the influence of the glaciers in the Upper Sandy, Zigzag, and Salmon River watersheds. Chart 4-27 illustrates the distribution of baseflows in Fir Creek and the Sandy River for the comparison period.

Chart 4-27 Distribution of Baseflows Sandy River and Fir Creek



The baseflows within the Sandy River are consistently higher with slightly less variation between the 10 and 90 percentile values than those of Fir Creek. Sandy River streamflows are consistent with an area with baseflows moderated by glacial influence. In addition to glacial influence larger groundwater contributions associated with basin size and larger range of elevation may affect runoff responses.

Water Withdrawals

The effect of water withdrawals on baseflows within the Upper Sandy, Salmon River, and Zigzag watersheds were assessed by utilizing a database obtained from the Oregon Water Resources Department.

Water Withdrawals Upper Sandy Watershed

Water Rights for the Upper Sandy Watershed were stratified by use type and location (Chart 4-28). Only primary water rights were used in this analysis.

Chart 4-28 Water Rights Upper Sandy Watershed

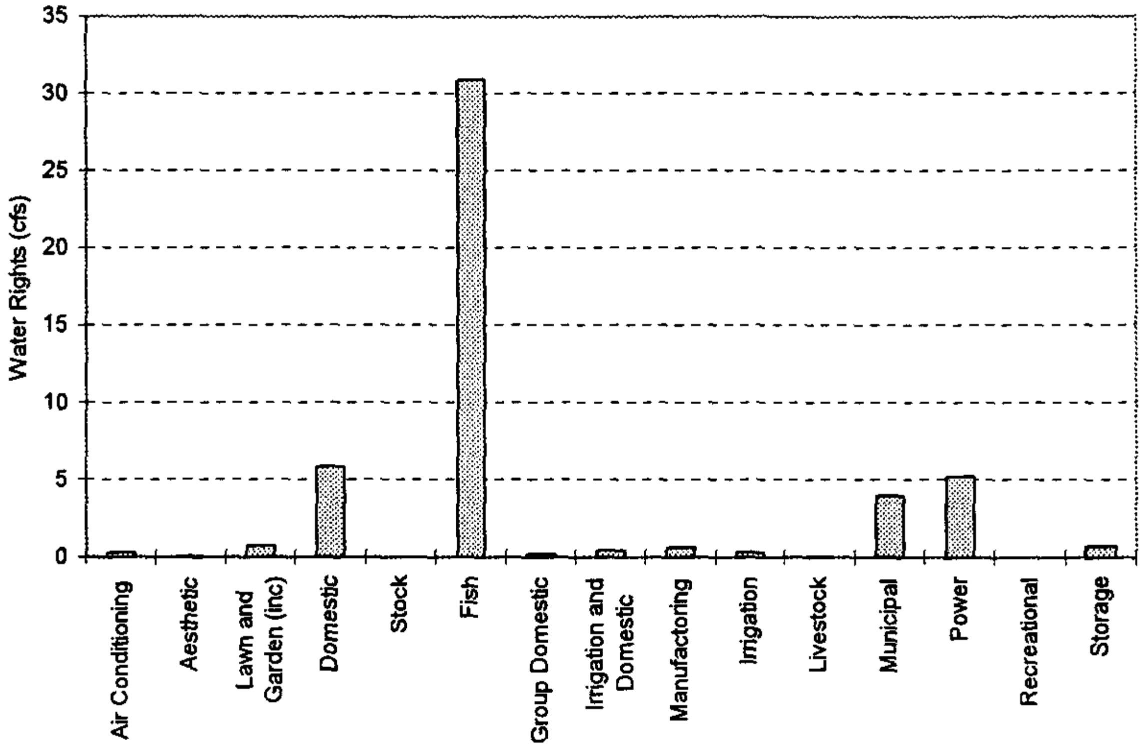


Table 4-31 Water Rights Use Types With More Than 1 cfs

Use Type	Use (cfs)
Lawn and Garden (inc)	1
Domestic	6
Fish	31
Manufacturing	1
Municipal	4
Power	5
Storage	1

Water rights for fisheries exceed all other water rights combined within the Upper Sandy Watershed. The largest single water right is for 25 cfs on Cedar Creek, established in 1949, and associated with the fish hatchery near the confluence of Cedar Creek and the Sandy River (this area is outside the analysis area for the Upper Sandy Watershed).

Water withdrawals were examined for their effect on baseflows within the watershed. For this analysis it was assumed that water rights for fisheries would not affect baseflows. It was assumed that water for fisheries remained in the channel or was returned to the channel.

Effects of Water Withdrawals on Subwatersheds

Subwatersheds with over 1 cfs total water rights were examined for the effect of the water rights on baseflows in those areas. Only Cedar Creek (29.5 cfs) and Alder Creek (6.6 cfs) had water rights totaling over 1 cfs.

Since both these subwatersheds are in the lower part of the watershed and not influenced by glaciers in the upper watershed lowflow yields from the Little Sandy subwatershed were used to estimate baseflows in these subwatersheds. Streamflows from the Little Sandy River were used because of the long period of record for the stream gage (1920-1994), lack of any water withdrawals from the Little Sandy River, and the close proximity of the Little Sandy subwatershed.

Table 4-32 Water Withdrawals Alder and Cedar creeks

Subwatershed	Total Water Rights	Predicted Baseflow Before Withdrawals	Predicted Baseflow After Withdrawals
Alder Creek	6.6	5.7	0
Cedar Creek	29.5	8.0	0

For both these subwatersheds there is not enough water in the streams to meet all the water rights. For Cedar Creek only the acreage in the analysis area was used so the baseflow estimate before withdrawals is low, however, the difference between the water rights and available flows is large enough that the predicted flows after withdrawals would still be zero. It is also important to note that a large portion of the water rights in the Cedar Creek subwatershed are for fisheries and may not be removed from the stream.

For Alder Creek the largest water right is for municipal water use for the City of Sandy's water supply. None of the water rights are for fisheries so most likely to water would be removed leaving little or no water in the lower section of Alder Creek below the City of Sandy's intake.

Effects of Water Withdrawals on the Sandy River at Marmot Dam

For the Upper Sandy Watershed there are 18.5 cfs removed above Marmot Dam that may affect baseflows within this watershed. Since the gage for the Sandy River is located at Marmot Dam it includes those areas drained by Salmon and Zigzag watersheds water rights from these areas must be added in to assess any effects.

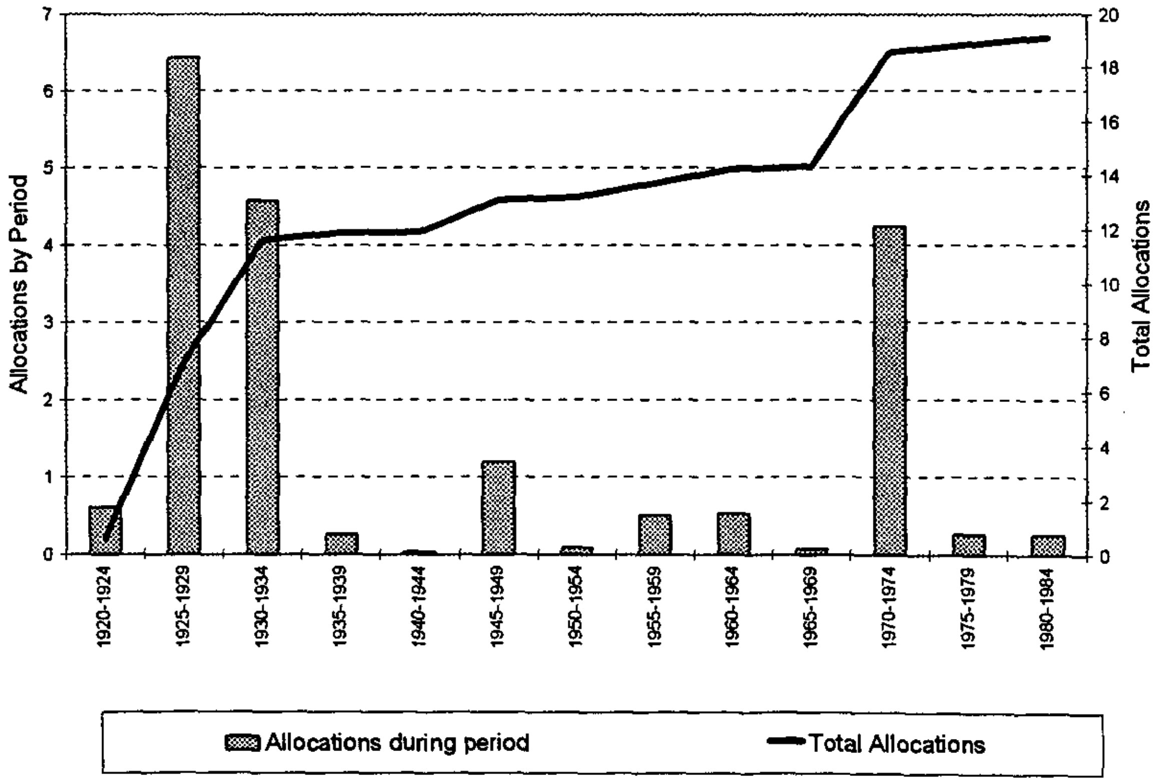
Table 4-33 Water Withdrawals Upper Sandy Subbasin

Watershed	Water Withdrawals Affecting Baseflows
Upper Sandy	18.5
Salmon River	27.8
Zigzag	11.5
Total	57.8

There is a total of 57.8 cfs allocated and the average 30 day duration baseflow for the Sandy River at Marmot from 1920-1994 is 327 cfs, so these withdrawals are a significant portion of the long term average baseflow.

The timing of the water rights within the Upper Sandy watershed was examined for potential effects on the trend for baseflows at Marmot Dam from 1950-1994. From 1970 through 1974 there is a jump in the total allocation with over 4 cfs allocated. This may account, at least in part, for the decreasing trend in baseflows at Marmot Dam.

Chart 4-29 Upper Sandy Watershed Water Rights by 5 year period (does *not include fisheries water rights*)



Forest Management Effects on Baseflows

Baseflows and Fog Drip

Research in the Bull Run watershed's Fox Creek subwatershed revealed that harvesting 25% of a watershed resulted in a decrease in lowflow amounts. This was attributed to a reduction in canopy interception of fog and consequent fog drip precipitation. (Harr, 1982)

Supplemental analysis of streamflow data from Fox Creek indicated a significant recovery from the reduction in summer water yield due to a loss of fog drip. Recovery begins about five or six years following harvest, possibly due to renewed fog drip from prolific revegetation. Apparently, once the temporary reduction in summer yield is offset by renewed fog drip, the expected increase in yield due to decreased evapotranspitation (from the harvested forest canopy) can be observed (Ingwerson, 1985).

Based on these findings, a recovery curve for water yield from fog drip was developed for clearcuts to enable them to recover 20% each year, and be fully recovered at five years. While the distinct recovery rate for fog drip is unknown a linear recovery rate was used based on limited knowledge on the process of fog drip.

This process was addressed in the Upper Sandy watershed due to the close proximity of Fox Creek with similar climates and vegetation.

For this assessment only those subwatersheds with at least 100 acres of timber harvest that would result in a significant loss of canopy (clearcut, shelterwood, or final removal) over the recovery period (1991-1996) were examined. With the exception of Alder Creek subwatershed harvest history was only available for federal lands, so for the most part total harvest acreage is underestimated. For Alder Creek all harvest activities were accounted for.

Table 4-34 Hydrologic Recovery (Fog Drip)

Subwatershed	Hydrologic Recovery with Respect to Fog Drip in 1996
Alder Creek	99%
Cedar Creek	100%
Clear Fork	99%

Based on the figures for hydrologic recovery reductions in baseflow associated with reduced fog drip is not a process of concern on Forest Service or Bureau of Land Management lands in this watershed.

Hardwood Stands within Riparian Areas

Recent studies (Hicks, et al, 1991) suggest reductions in streamflow following timber harvest may be related to the re-growth of deciduous riparian species which transpire greater amounts of water than do native conifer vegetation. Hardwood stands within the Riparian Reserves were identified from the ISAT database.

Figure 4-26 -- Hardwood Stands Within Riparian Reserves

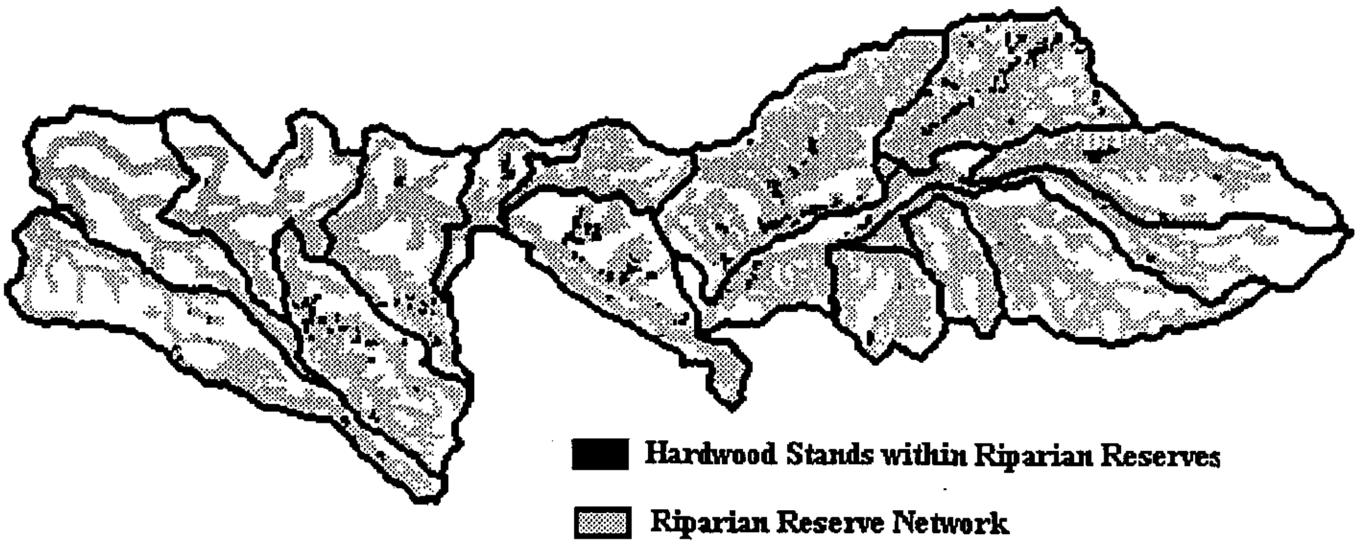


Table 4-35 -- Hardwood Stands in Riparian Reserves

Subwatershed	Hardwood Acres	Percent of Riparian Reserves
Alder Creek	133	8
Badger Creek	5	0
Cedar Creek	49	3
Clear Creek	215	6
Clear Fork	227	10
Horseshoe Creek	27	3
Lost Creek	10	0
Muddy Fork	69	4
North Boulder C	5	1
Sandy River Brightwood	37	7
Sandy River Hackett	153	10
Sandy River Mensinger	7	1
Sandy River Wildcat	77	4
Upper Sandy Riv	91	4
Fir Creek (Bull Run)	45	3

Using the unmanaged control subwatershed within the Bull Run Watershed (Fir Creek) as representative of the unmanaged condition it appears that 0-3% of the Riparian Reserves would be in riparian hardwoods under natural conditions. If the natural condition for hardwoods stands within the Riparian Reserves is adjusted to 0-5% to allow for some natural variation 5 of the 14 subwatersheds would be outside the natural condition including Alder Creek, Clear Creek, Clear Fork, Sandy River Brightwood and Sandy River Hackett. Within Clear Fork and Clear Creek subwatersheds the area within the powerline right of way accounts for the majority of the hardwood stands in the Riparian Reserves. Within the other watersheds the hardwoods are scattered on small private holdings and industrial forest lands.

The effect of riparian hardwoods on the baseflow regime is unknown, however, some watersheds are outside the undisturbed condition for this process and may be affecting baseflows. Hardwoods with the riparian areas play an important function in providing stream shade and reducing surface erosion and the effect on baseflows is not clear. The effect of hardwood stands on baseflows is not clear enough to make a recommendation to convert these areas to conifers.

Conclusions Lowflows

- A decreasing trend exists in low-flow yields for the period 1950-1994 that appears to be associated with water withdrawals and potentially hardwood encroachment into riparian areas.

- Lowflow yields are greater in the Upper Sandy Watershed than in Fir Creek. This is attributed to the influence of the glaciers.

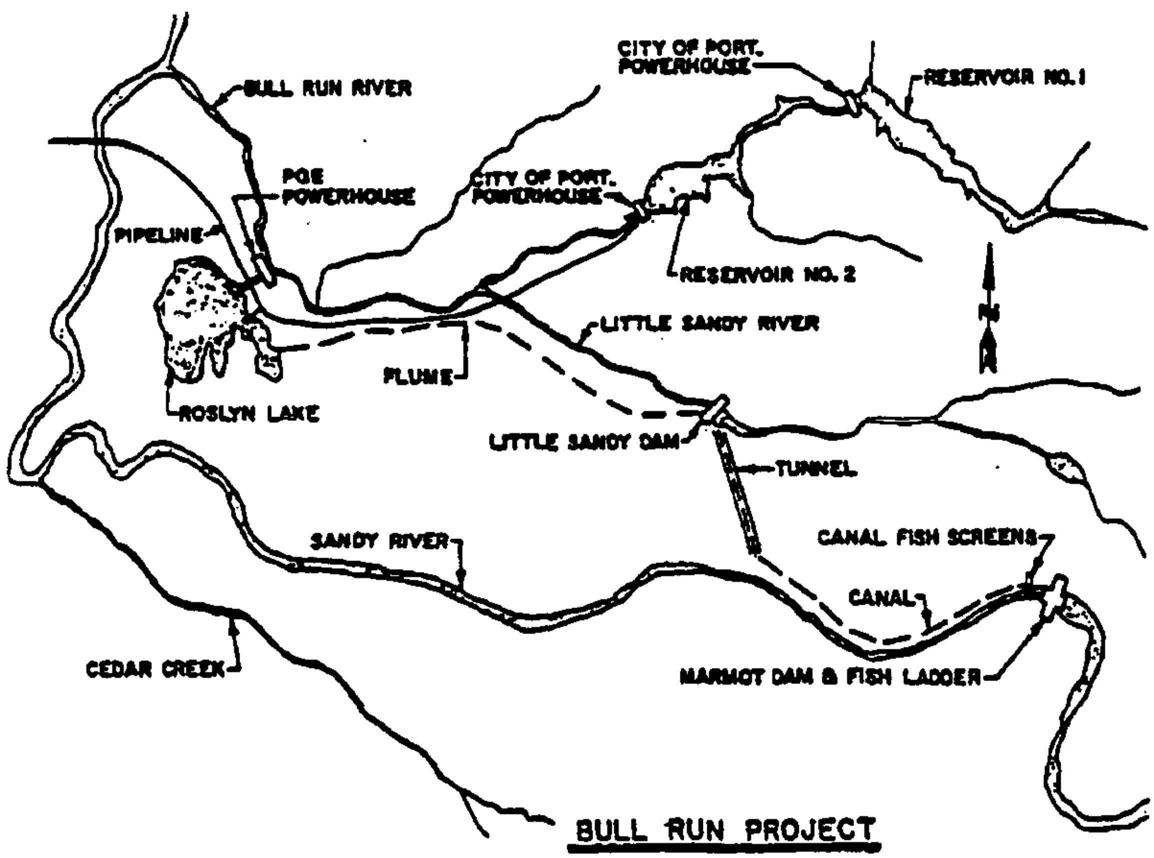
- The influence of recent timber harvest activities on Forest Service and Bureau of Land Management lands was assessed for impacts on fog drip. Based on stand conditions in 1996 there is not a concern for reduced levels of fog drip on Forest Service or Bureau of Land Management lands.

- Water Withdrawals are affecting lowflows in the Sandy River below Marmot Dam and Alder Creek

Flow Regime Sandy River Below Marmot Dam

The flow regime in the Sandy River below Marmot Dam is altered from the natural condition due to diversion of water to the PGE powerhouse on the Bull Run River.

Figure 4-27 -- Dams and Diversions Lower Sandy River



The Bull Run Hydroelectric Project allows for the diversion of up to 800 cfs from the Sandy and Little Sandy Rivers in any combination with the primary goal of not spilling any water past the Little Sandy diversion dam which might falsely attract fish to that stream. There is a minimum flow requirement below Marmot Dam of 200 cfs (June 16 through October 15), 400 cfs (October 16 through October 31), and 460 cfs (November 1 through June 15). Normal operating plans call for the diversion of all the Little Sandy Water (up to 800 cfs). If more water is needed up to 600 cfs of Sandy River water is diverted, if available and subject to meeting minimum flow requirements.

Chart 4-30 Streamflow Sandy River Above and Below Marmot Dam

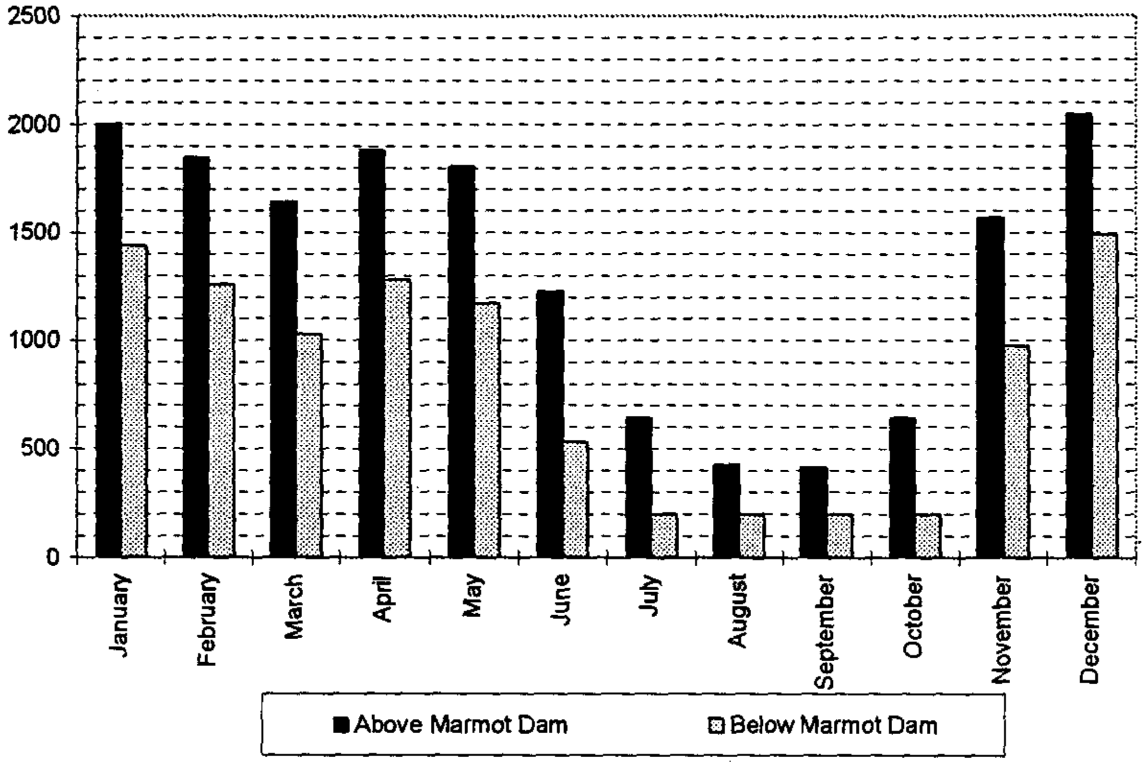


Chart 4-30 details monthly mean streamflows in the Sandy River above and below Marmot Dam. These figures were derived by removing all the water from the Little Sandy River (up to 800 cfs) and then diverting up to 600 cfs of Sandy River (while still meeting minimum flow requirements) to add up to 800 cfs total.

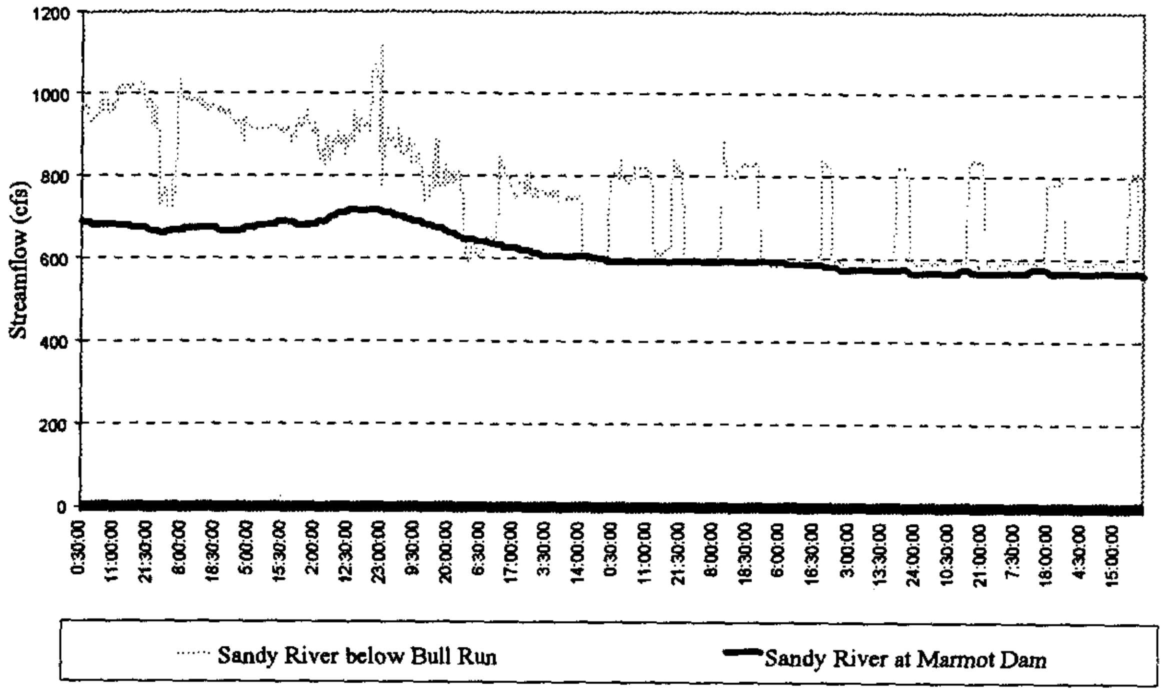
Table 4-36 Percent Change in Flow Above and Below Marmot Dam

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percent change below Marmot Dam	-28	-32	-37	-32	-35	-57	-69	-53	-52	-69	-38	-27

It appears that the flows in the Sandy River directly below Marmot Dam are most altered in the months of June-October.

The water that is diverted at Marmot Dam is released into the Bull Run River and flows back into the Sandy River below the confluence with the Bull Run River. Chart 4-31 details streamflows in the Sandy River above Marmot Dam and below the confluence with the Bull Run River.

Chart 4-31 Streamflow Sandy River July 1 through 14, 1996



The shape of the hydrograph for the Sandy River below the Bull Run should approximate that of the Sandy River at Marmot and as the chart illustrates there is a wide fluctuation in streamflow that is attributed to the operation of the Bull Run powerplant.

Water Quality

Water quality was assessed at three scales:

1. Watershed-wide for deviations of Sandy Basin Water Quality Standards, LRMP Standards, and ACS Objectives.

2. Subwatersheds for assessment of nonpoint pollution sources, including sediment and water temperature.

3. Site Specific

    - Alder Creek subwatershed for turbidity and stream temperatures associated with municipal water supply

    - Sandy River for chloride associated with the salting of Palmer snowfield (inputs would be from the Salmon and Zigzag rivers).

Watershed Scale Assessment of Water Quality

Oregon Department of Environmental Quality (DEQ) Assessment of Water Quality Limited Waters

The Clean Water Act requires each state to identify those waters for which existing required pollution controls are not stringent enough to achieve that states water quality standards. Water quality standards are typically designed to protect the most sensitive beneficial use (i.e. cold water fisheries, or water recreation) within a waterbody. Water Quality Limited Waters are identified every two years.

For the Sandy Basin the only waterbody identified was the Sandy River from the mouth to Marmot Dam with concerns for summer stream temperatures.

DEQ Nonpoint Source Assessment

Initial assessment of water quality was completed using the DEQ 1988 Nonpoint Source Assessment. This assessment is a compilation of responses to a statewide questionnaire sent out in late 1987, the results of which were reviewed in a series of public meetings. Several hundred citizens and resource management professionals representing many kinds of land and water use contributed to the assessment effort over a nine month period.

Much of the information in the assessment, which included water quality and habitat considerations, was not verified by the DEQ, however, this is the only source of information available for water quality and habitat considerations for much of the Upper Sandy Watershed so this resource was utilized.

Chart 4-32 DEQ Nonpoint Source Assessment Summary Map

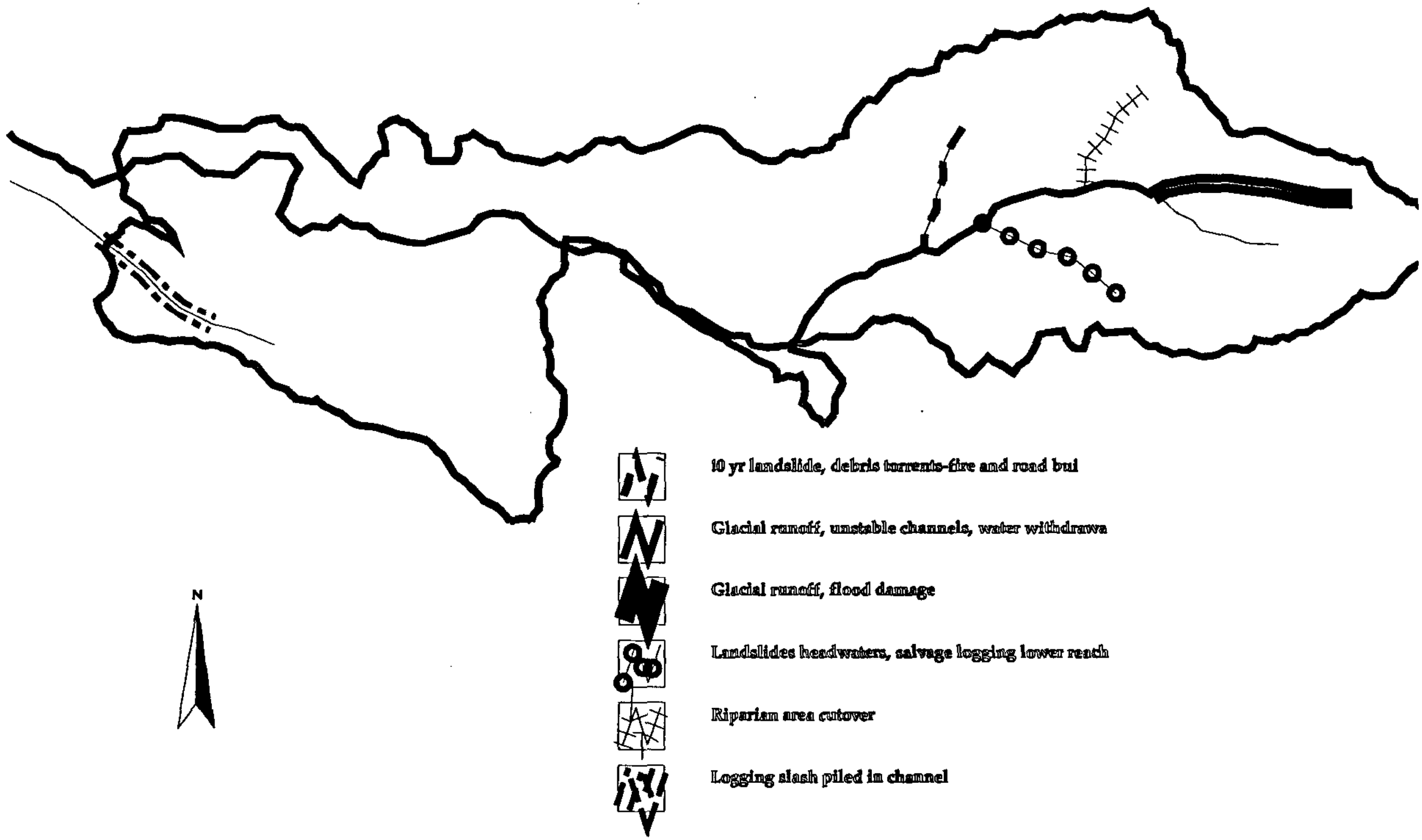


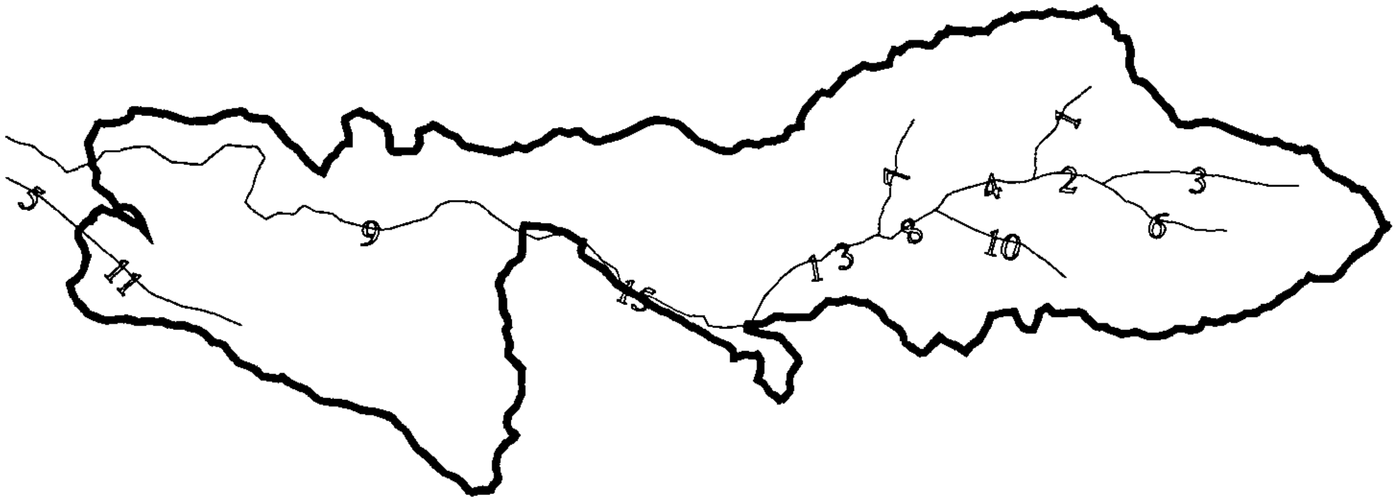
Table 4-37 – Water Quality Concerns Upper Sandy Watershed (DEQ 1988)

Stream	Map Number	Length (miles)	DEQ ID	Turb[1]	Sed[2]	Eros[3]	Lowflow[4]	Struc[5]	Beneficial Use	Comments
Clear Fork	1	2.2	34					M1	Fish[6]	20% riparian cut over/data on temp/woody debris
Sandy River	2	1.3	32	M2	M2	S2	M2	S2	Fish, Rec[7]	Glacier runoff/unstable channel/water withdrawal
Muddy Fork	3	3.7	33	S2	S2	S2		M2	Fish, Rec	Glacier runoff/flood damage
Sandy River	4	2.0	32	M2	M2	S2	M2	S2	Fish, Rec	Glacier runoff/unstable channel/water withdrawal
Cedar Creek	5	1.9							Fish, Rec	
Sandy River	6	2.5							Fish, Rec	
Clear Creek	7	2.4	53		M1	M1		M1	Fish, Rec	10 yr landslide/debris torrents - fires & road building
Sandy River	8	1.2	32	M2	M2	S2	M2	S2	Fish, Rec	Glacier runoff/unstable channel/water withdrawal
Sandy River	9	13.6	32	M2	M2	S2	M2	S2	Fish, Rec	Glacier runoff/unstable channel/water withdrawal
Lost Creek	10	2.8	406	M1	M1	M1		M1	Fish	Landslides in headwaters/salvage logging in lower reaches
Cedar Creek	11	2.6	414						Fish, Rec	Logging slash piled in channel on middle reaches
Sandy River	13	3.1	32	M2	M2	S2	S2	S2	Fish, Rec	Glacier runoff/unstable channel/water withdrawal
Sandy River	15	4.6	32	M2	M2	S2	M2	S2	Fish, Rec	Glacier runoff/unstable channel/water withdrawal

M1-Moderate problem; data available
M2-Moderate problem; observed
S2-Severe problem; observed

[1] Turbidity
[2] *Sediment*
[3] Streambank Erosion
[4] Low flows
[5] Stream Structure (streambank condition, location and amount of boulders and woody debris, pool levels, etc)
[6] Cold water fish
[7] Water contact recreation

Chart 4-33 Map Number



The DEQ assessment (Table 4-37) indicates moderate problems with turbidity, sediment, and lowflows; and severe problems with streambank erosion and stream structure in the Sandy River. Beneficial uses affected include cold water fisheries and water contact recreation. These problems are attributed to glacial runoff, an unstable channel, and water withdrawals.

Clear Fork is assessed as having moderate problems with stream structure and stream temperatures (this was not included on the table because this was the only stream listed with temperature concerns). Beneficial uses affected include cold water fisheries. Impacts are attributed to the riparian area being cut over. Woody debris is also listed as a concern but it is not clear whether the concern is to much or not enough woody debris.

The Muddy Fork of the Sandy is assessed with moderate problems with stream structure and severe problems with turbidity, sediment and erosion affecting cold water fisheries and water contact recreation. Problems are attributed to glacial runoff and flood damage (the specific flood is not referenced).

Lost Creek is assessed with moderate problems with turbidity, sediment, erosion, and stream structure affecting cold water fisheries. Problems are attributed to landslides in the headwaters and salvage logging in the lower reaches.

Clear Creek is assessed with moderate problems with sediment, erosion, and stream structure affecting cold water fisheries and water contact recreation. Problems are attributed to landslides and debris torrents associated with road building and fires. It appears that this is referencing the fill failure on road 1820 and the associated debris torrent from February 1986.

Cedar Creek is assessed without any water quality concerns. Concerns are expressed with logging slash piled in the middle reaches of Cedar Creek.

At the landscape level the 1988 DEQ nonpoint pollution assessment was felt to reflect conditions within the Upper Sandy Watershed. Documented sources of nonpoint pollution including glacial runoff, unstable stream channels, cut-over riparian areas and debris torrents associated with the road network. All these conditions have been observed within the watershed.

Many of the concerns based on this assessment have been or will be addressed in this analysis. Stream channel stability was assessed in the geomorphology section. Large woody debris and pool levels will be assessed in the fish habitat section. Alterations of the low flow regime were examined with the flow regime. Sediment associated with management activities (timber harvest and roads) will be assessed in this section. Stream temperatures will also be assessed in this section

Storage and Retrieval (STORET) Database

The STORET database is national database that is maintained by the Environmental Protection Agency for aquatic and biological data. State water quality agencies are the primary users and contributors to the database, however, federal land management agencies also contribute data to the database. The STORET database was queried for any information on the Upper Sandy Watershed. There were a number entries for the period detailing water temperature from 1973-1981. There was one dataset detailing turbidity in Alder Creek from June of 1978 through June of 1980 with 21 samples analyzed. The highest turbidity value was recorded was less than 0.06 NTU's (nephelometric turbidity units). Due to the age of the dataset and the limited sample size the data is not presented, however, daily turbidity data from the Alder Creek intake from 1991 through the summer of 1996 will be summarized later in this section..

Table 4-38 STORET Water Temperature Data Upper Sandy Watershed

Site	Period of Record	Years where temperatures exceeded 14.4^0 C
Gowan's Pond	1973-1979	1977, 1979
Gowan Creek lower powerline right of way	1973-1977	1973
Gowan Creek at confluence with Clear Fork	1973-1981	1979
Clear Fork	1973-1980	1973, 1974, 1978
Top of Clear Fork	1973-1981	1973, 1976, 1979, 1980
Clear Fork above Gowan Creek	1973-1981	1973, 1976, 1978
Clear Fork below Gowan Creek	1973-1979	1973, 1978, 1979
Clear Fork above Chance Creek	1973-1979	1973, 1976, 1977
Clear Fork below Chance Creek	1973-1979	1973, 1978, 1979
Chance Creek	1978-1979	1978
Clear Creek above S-14	1974-1981	1975, 1976, 1977, 1978, 1979, 1981
North Fork Alder Creek at forest boundary	1980-1981	1981
Alder Creek at intake	1979-1980	1979

It is important to note that the datasets summarized in Table 4-38 were not from continuous stream temperature samplers and were not collected on a daily basis so assessing any trends is not possible. Compliance with the water quality standard for stream temperature, at the time the data was collected, of 14.4^0 C, was assessed for these datasets. The current state water quality standards (1996 revision) are a seven day average of 12.8^{0}C for periods of salmonid spawning, egg incubation, and fry emergence, and an absolute numeric criterion of a seven day average of 17.8^{0}C. Assessment of compliance with the new standards was not possible since the data was not collected in a manner that allowed calculation of the seven day average.

Stream temperature data for the Upper Sandy Watershed for the year 1990 was obtained from the WQDATA database that is maintained at the Mt. Hood National Forest Supervisors Office to assess more current conditions.

Table 4-39 Stream Temperatures 1990

Site	Daily Temperature Exceeds 14.4°C	Maximum Daily Temperature	Temperature Exceeds Seven-day Average of 12.8°C	Maximum Seven-day Average Temperature
Alder Creek	No	14.3	Yes	13.6
Cedar Creek	No	13.4	No	12.5
Clear Creek	Yes	15.1	Yes	14.6
Lower Chance Creek	Yes	14.6	Yes	13.6
Upper Clear Fork	No	10.4	No	9.8
Middle Clear Fork	Yes	14.5	Yes	13.7
Lower Clear Fork	Yes	15.0	Yes	14.1

The majority of samples collected in Clear Fork confirm the conclusion from the DEQ *nonpoint water quality assessment identifying stream temperature as a concern in the Clear* Fork. Stream temperatures within Clear Fork very from a daily high of 10.4°C at the upper site to 15.0°C at the lower site

Stream temperature data from 1990 was compared to the existing standard of 14.4°C and the current standard of 12.8°C for periods of salmonid spawning, egg incubation, and fry emergence. Clear Creek, Chance Creek, Middle Clear Fork, and Lower Clear Fork exceeded the water quality standard of 14.4°C. Alder Creek, Clear Creek, Chance Creek, Middle Clear Fork, and Lower Clear Fork exceed the current standard of 12.8°C.

Nonpoint Sources

Based on the DEQ assessment concerns are raised with respect to turbidity, suspended sediment and stream temperature.

Suspended Sediment

An increase in sediment load is often the most important adverse effect of forest management activities on streams. Large increases in the amount of sediment delivered to the stream channel can greatly impair or even eliminate fish and aquatic invertebrate habitat. These increases can also alter the structure and width of the streambanks and adjacent riparian zone (EPA, 1991).

The physical effects of increased fine sediment load can be as equally far-reaching. The amount of sediment can affect channel shape, sinuosity, and the relative balance between pools and riffles. Changes in sediment load will affect the bed material size, and, in turn, alter both the quality and quantity of the habitat for fish and benthic invertebrates (EPA, 1991).

The Sandy River is noted for the presence of fine suspended sediment known as "glacial flour". The "flour" originates on the glaciers at the river's source and is formed by the grinding of rock under the weight of the glaciers on the slopes of Mt. Hood. The glacial flour gives the Sandy River a pale green opacity or milky-gray color, which is most apparent in middle to late summer during the peak of glacial melt, when the flow contribution from non-glacial tributaries is relatively less. The Sandy River has been attributed as having one of the highest percentages of glacial melt of all the major Oregon rivers (USDI-BLM Sandy River Wild and Scenic River and State Scenic Waterway Environmental Assessment, 1992). The Muddy Fork, is aptly named and contributes a high proportion of suspended sediments as a result of bank erosion and landslides associated with steep, unstable volcanic mudflow deposits through which the river flows (Upper Sandy National Wild and Scenic River Environmental Assessment, 1993).

Temperature

Increased stream temperatures are often a concern in forested watersheds due to created openings from timber harvest, roads and recreational facilities. Direct solar radiation intercepting the stream surface is the principle factor in raising stream temperature within forested watersheds (Brown, 1969). Based on the DEQ's identification of the Sandy River as Water Quality Limited due to summer stream temperatures, the DEQ nonpoint assessment identifying temperature as a concern in the Clear Fork and the high stream temperatures identified in the STORET data effects on stream temperature were assessed.

Stream Shade

Management activities have the potential to alter the amount of solar radiation intercepted by the stream surface through altering riparian vegetation and channel form. To assess the effects of management on stream shade and the associated increase in solar radiation intercepted by the stream surface, canopy closure within the Riparian Reserves was calculated by subwatershed.

Chart 4-34 -- Stream Shade Distribution

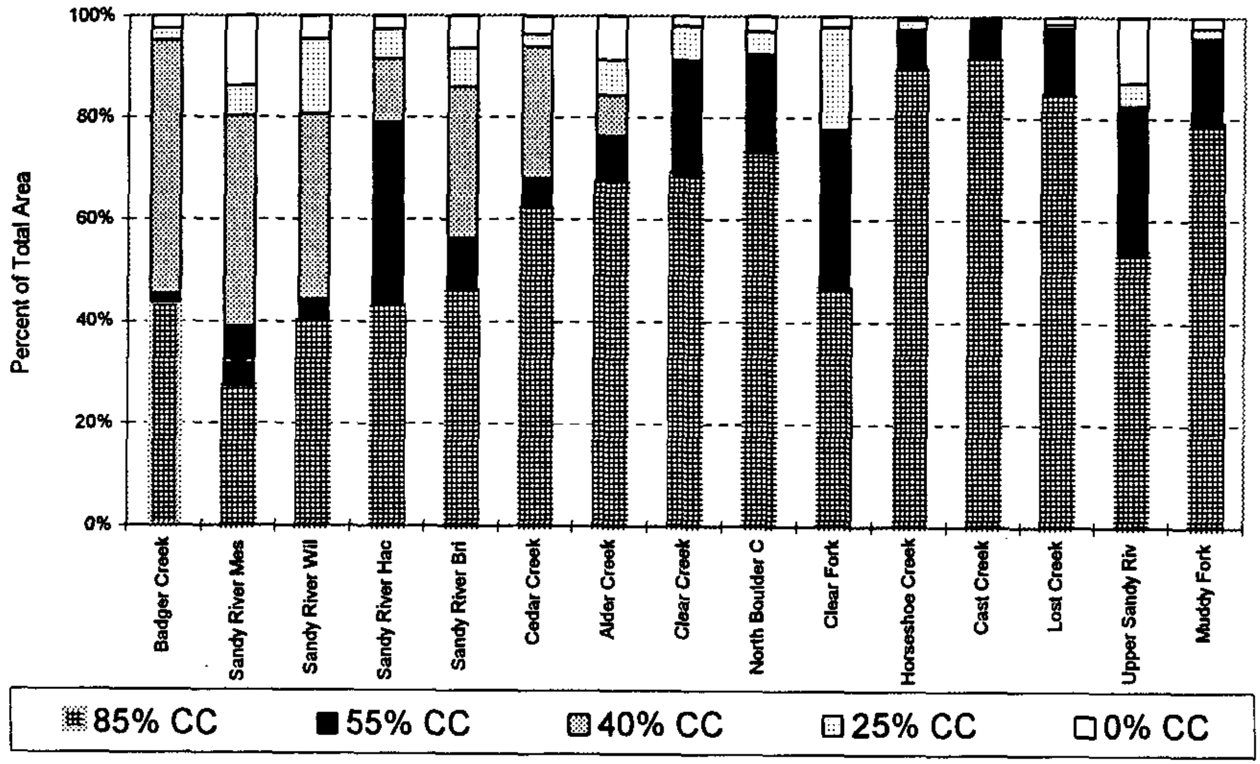
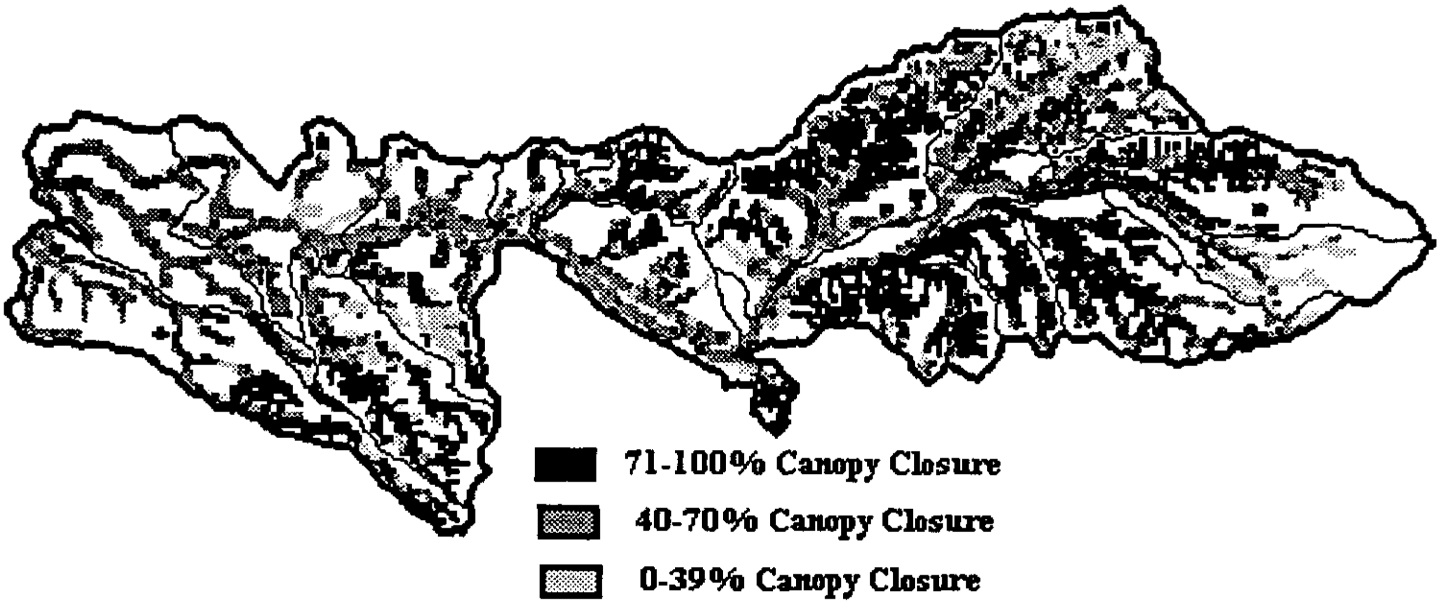


Chart 4-35 -- Riparian Reserve Canopy Closure



If levels of canopy closure from Fir Creek are used as an indication of the natural or unmanaged condition for stream shade approximately 90% of the area in the riparian reserves should have greater than 70% canopy closure. As Chart 4-34 and Chart 4-35 illustrate Lost Creek, Muddy Fork, Cast Creek and Horseshoe Creek are the only subwatersheds that approximate the natural condition with greater than 80% of the area in the riparian reserves with greater than 70% canopy closure. The majority of these subwatersheds are in the Upper Sandy Wild and Scenic River corridor, or the Mt. Hood Wilderness area which may account for the higher levels of canopy closure. Forest management actives with the potential to alter stream shade will be assessed. These activities include the powerline right of way, timber harvest, and roads.

Chart 4-36 Powerline Right of Way, Roads, and Timber Harvest (1985-1996) within Riparian Areas (Federal Ownership)

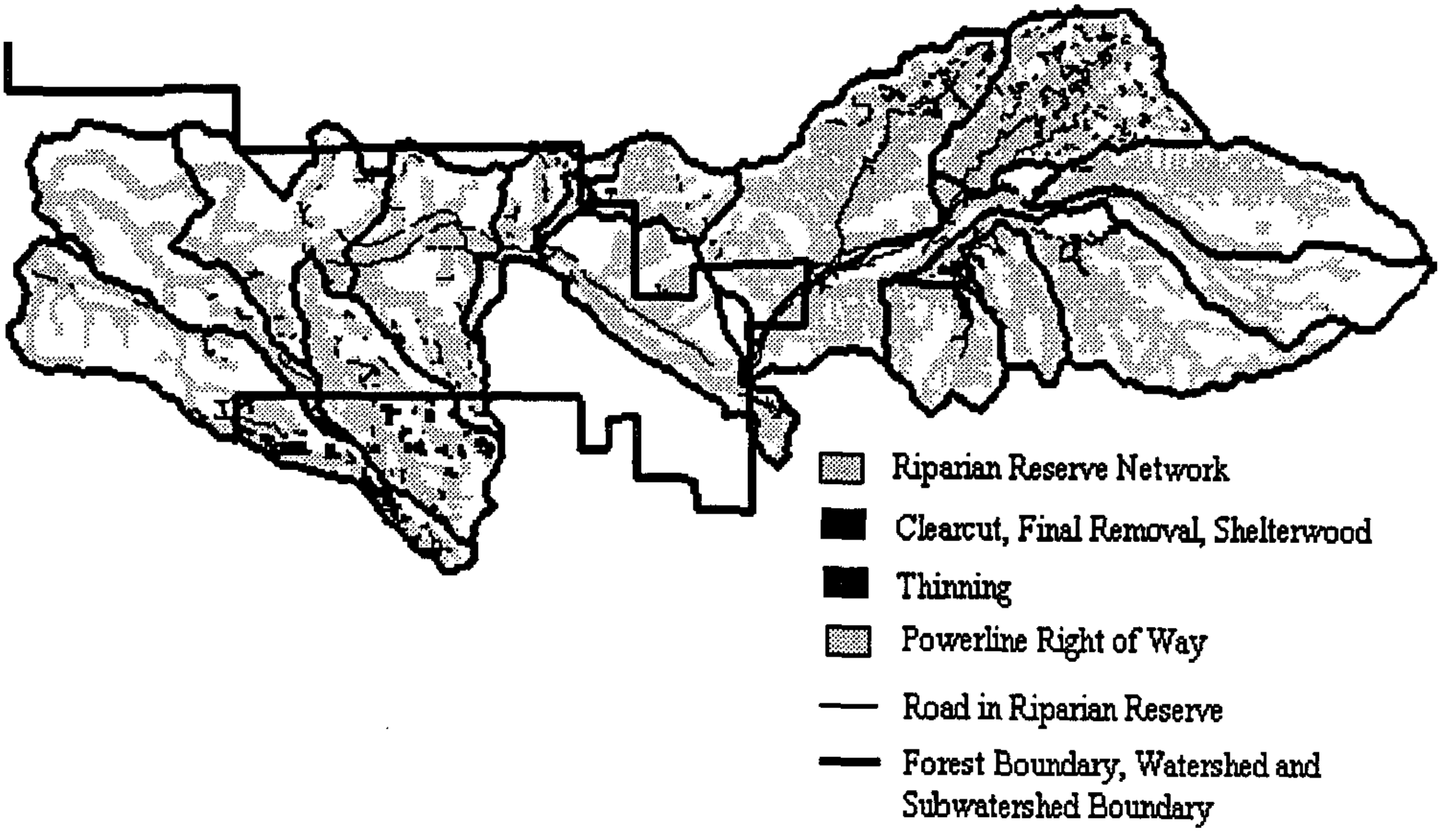


Chart 4-37 Miles of Road in Riparian Areas by Subwatershed

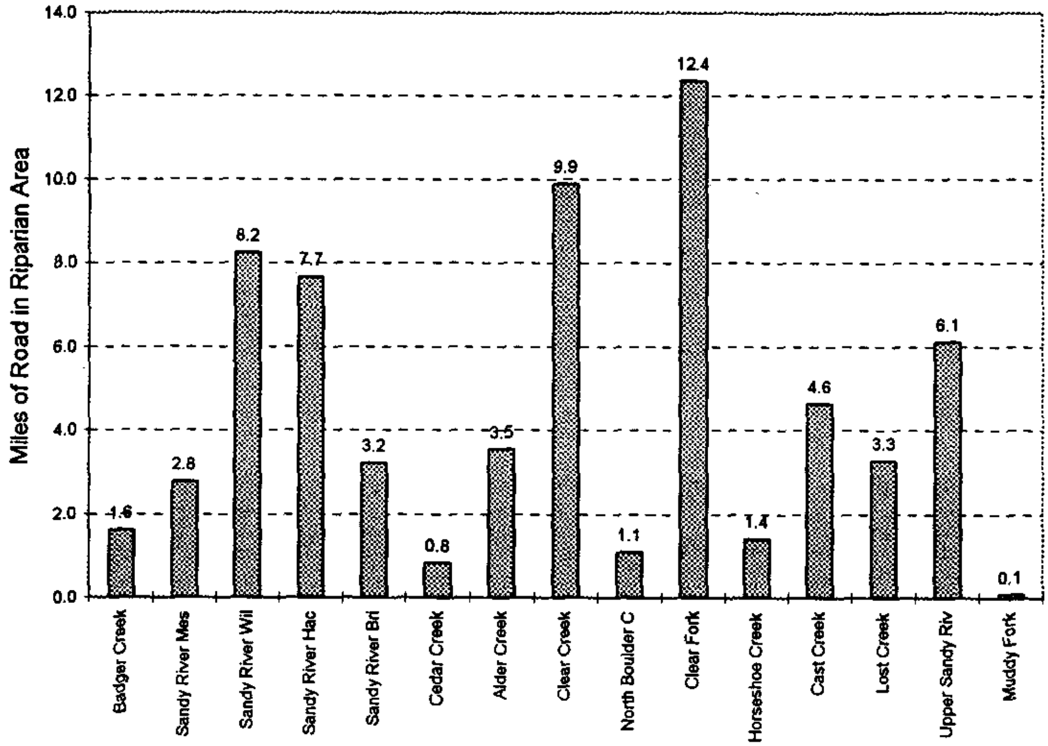
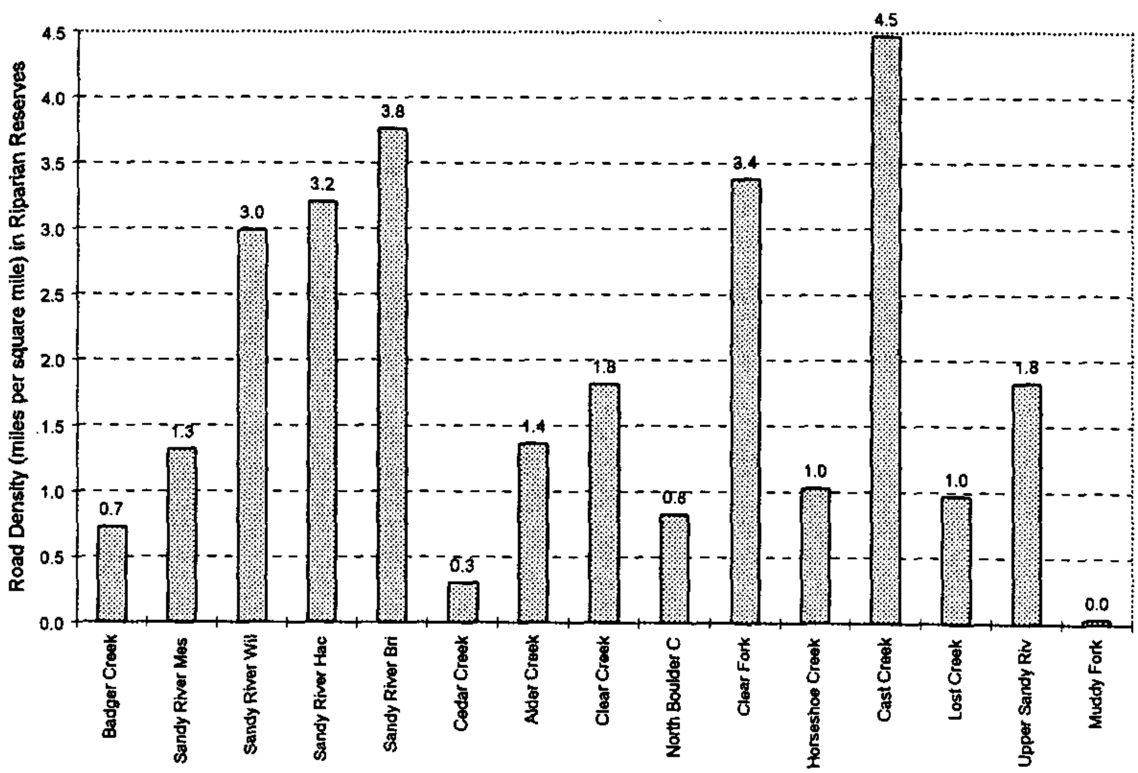


Chart 4-38 Road Density within Riparian Reserves



Within the riparian reserves road densities are high (greater than 2.5 miles per square mile) in the Sandy River Wildcat, Sandy River Hackett, Sandy River Brightwood, Clear Fork, and Cast Creek subwatersheds.

Chart 4-39 Acres of Timber Harvest (1985-1996) in Riparian Areas (Federal Ownership) by Subwatershed

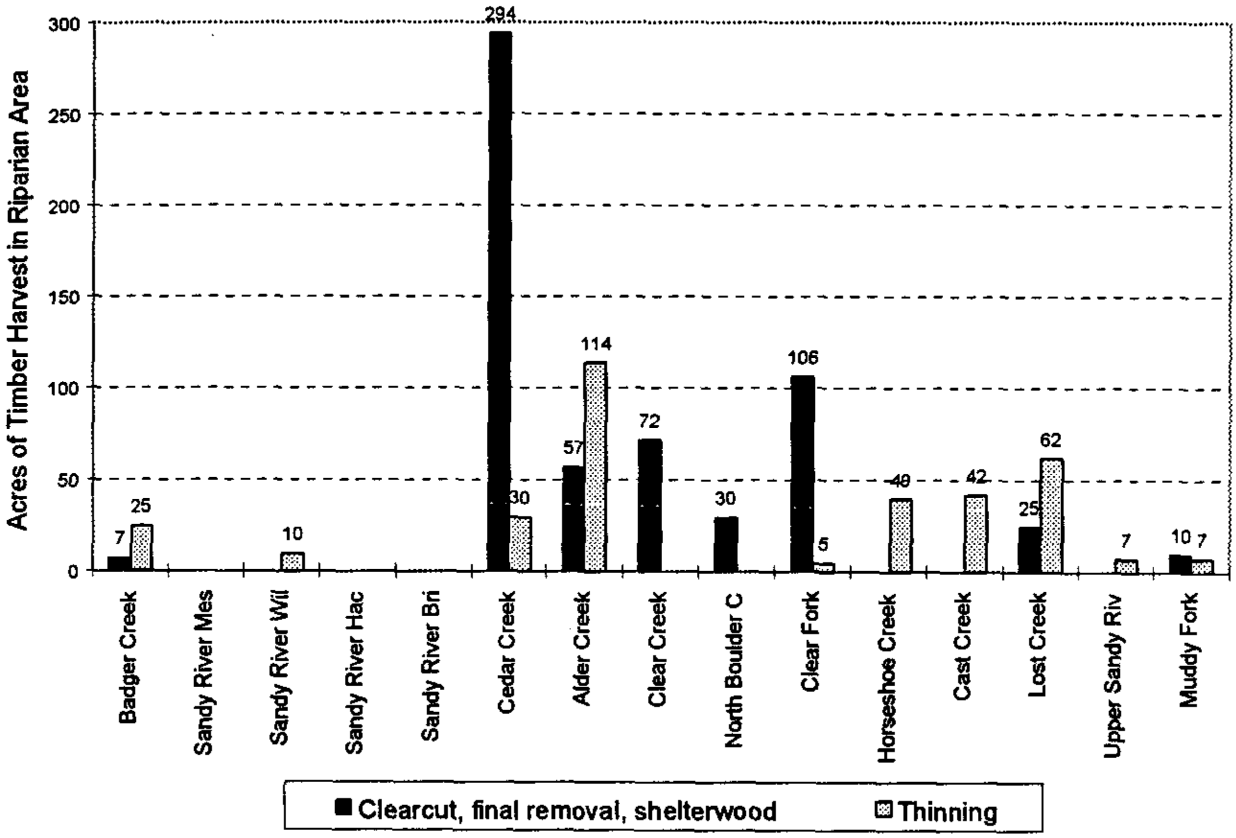
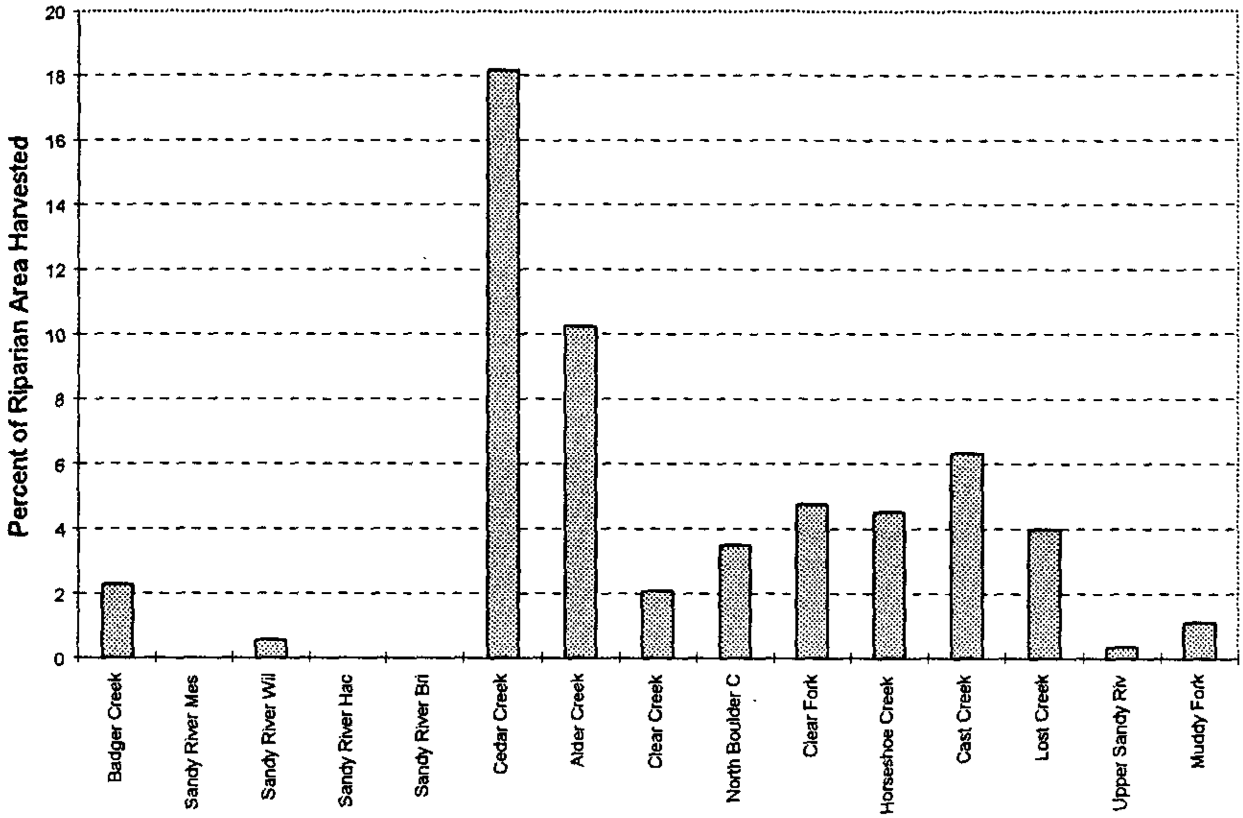
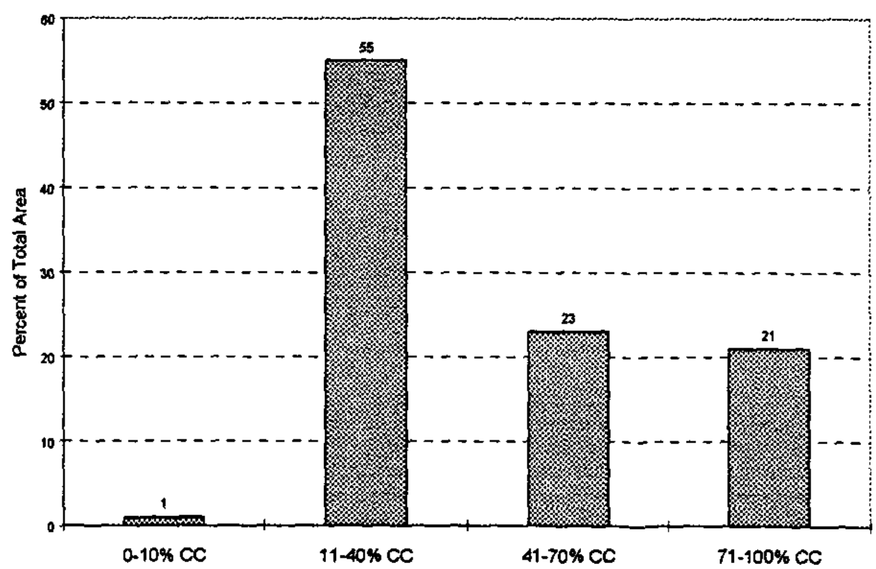


Chart 4-40 Percent of Riparian Reserves Harvested (1985-1996) on Federal Ownership (except Alder Creek which includes all harvest activity)



With respect to timber harvest greater than 10% of the riparian reserves (on Federal Lands) have been harvested in the Cedar Creek and Alder Creek subwatershed.

Chart 4-41 Canopy Closure Powerline Right of Way in Riparian Reserves



358 acres of riparian reserves are within the powerline right of way with 321 of the acres in the Clear Fork subwatershed. 79% of the area has canopy closures less than 70% (Chart 4-41).

Many of the subwatersheds within the Upper Sandy River Watershed are well outside the undisturbed condition for canopy closure within the riparian reserves (90% of the area with greater than 70% canopy closure). Badger Creek, the lower Sandy River Subwatersheds (Sandy River Mensinger, Sandy River Wildcat, Sandy River Hackett, Sandy River Brightwood), and Clear Fork subwatersheds have less than 50% of the riparian area with over 70% canopy closure. On federal lands timber harvest, roads, and the powerline right of way are responsible for reductions in stream shade, however, only Clear Fork subwatershed has a majority of the land base on federal lands and has less than 50% of the area in riparian reserves with less than 70% canopy closure. Causes of low canopy closure levels on private land were not determined.

Recommendation (analysis gap): the Sandy River is identified as water quality limited by DEQ for summer stream temperatures and within the Upper Sandy Watershed canopy closure is outside the undisturbed condition. In order to quantify the relationship between canopy closure and stream temperature it would be appropriate to run a stream temperature model such as SHADOW.

Site Specific Analyses

During the completion of this watershed analysis, two site specific water quality analyses were completed

1. Assessment of water quality at the intake for the city of Sandy's water system on Alder Creek.

2. Assessment of the effect of the salting of Palmer snowfield on water quality within the Sandy River (from inputs associated with Salmon and Zigzag rivers).

Alder Creek

The City of Sandy has expressed concerns with management activities within the Alder Creek watershed and their effect on raw water quality for the City's municipal supply. In order to address this concern daily water quality data from Alder Creek has been analyzed for trends over time and compared to the unmanaged control subwatershed (Fir Creek) in the Bull Run watershed.

Turbidity and stream temperature have been gathered on a daily basis since January 1991 at the city of Sandy's intake on Alder Creek. This data was used to complete the trends analysis and comparison to Fir Creek. It is notable that when turbidity levels reach a certain threshold where the water cannot be treated for municipal use the city does not record turbidity levels in the stream. This practice will tend to lower the turbidity readings collected at Alder Creek. Since the trends analysis and comparison test to Fir Creek are completed on the monthly mean the higher turbidity values that may have not been recorded should not have a significant effect on the analysis.

Turbidity

Seasonal Kendall Trends Analysis

Chart 4-42 Daily Data Summarized by Quarter Entire Year

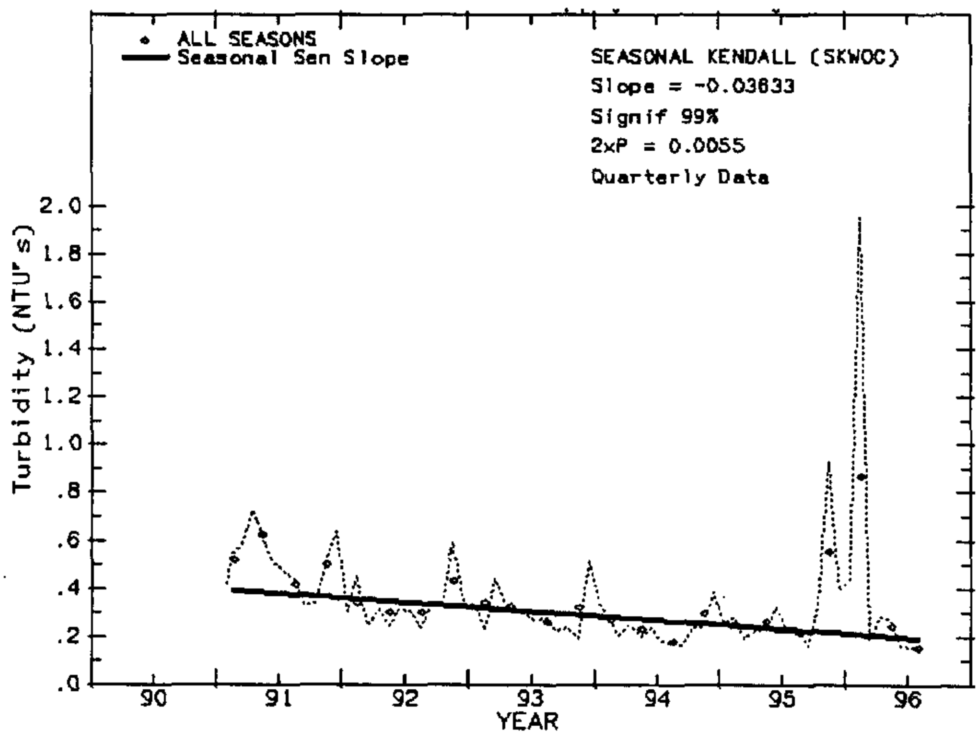
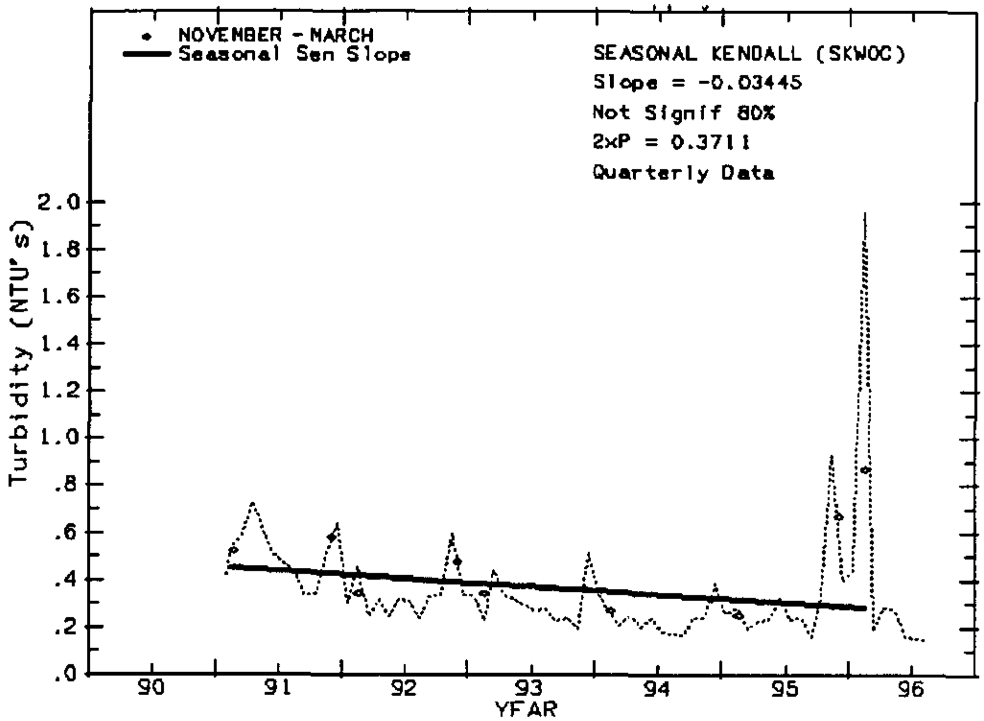


Chart 4-43 Daily Data Summarized By Quarter November-March



Even though the highest peaks in the dataset are associated with the November 1995 and February 1996 storms the overall trends are for decreasing turbidity levels. Seasonal Kendall trends analysis indicates a slight decreasing trend (0.04 NTU's per year) that is statistically significant at the 99% confidence level for data for the entire year. If the data for the months of November through March, when high flows associated with rain-on-snow events would be expected, is analyzed there is a similar trend, however, it is not statistically significant.

Comparison to Fir Creek

Chart 4-44 Seasonal Wilcoxen-Mann-Whitney Test Entire Year

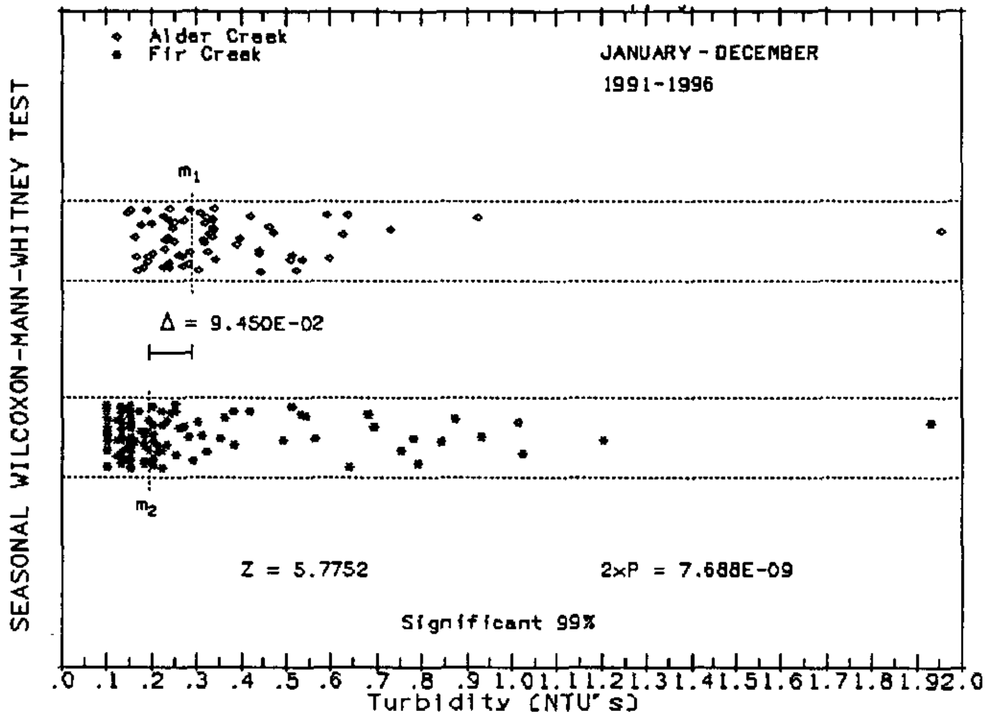
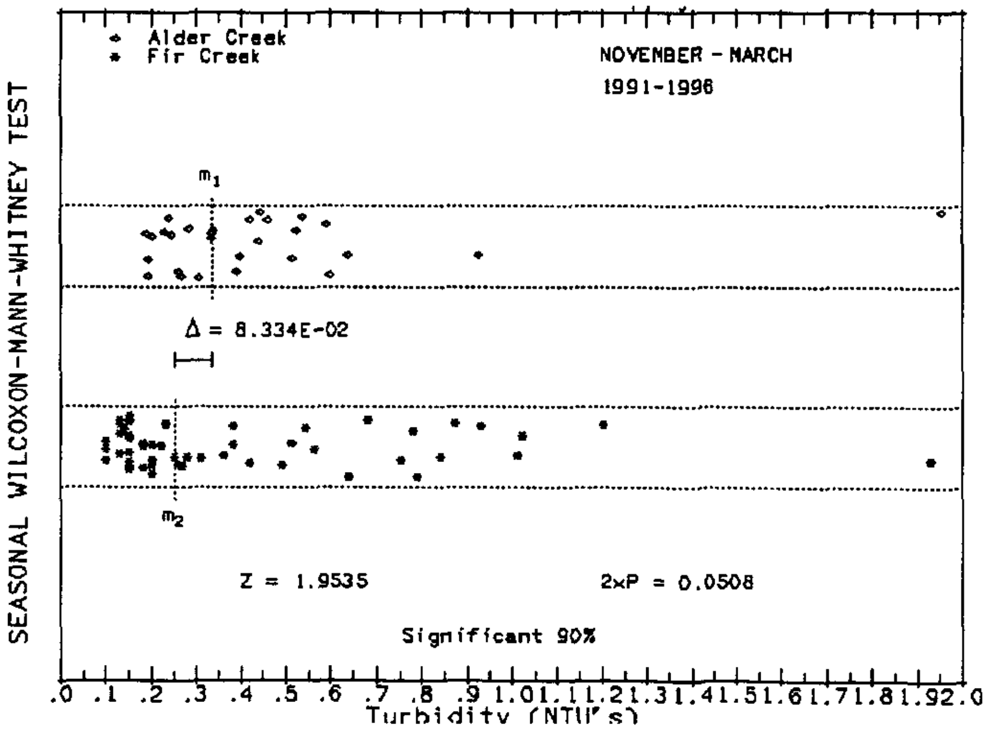


Chart 4-45 Seasonal Wilcoxen-Mann-Whitney Test - November through March



When turbidity levels from Alder Creek are compared to the unmanaged control watershed in the Bull Run there are statistically significant differences for both the entire year and the period from November through March, however, the magnitude of the differences (0.09 and 0.08 NTU's) has no practical significance.

Temperature

Seasonal Kendall Trends Analysis

Chart 4-46 Daily Data Summarized by Quarter Entire Year

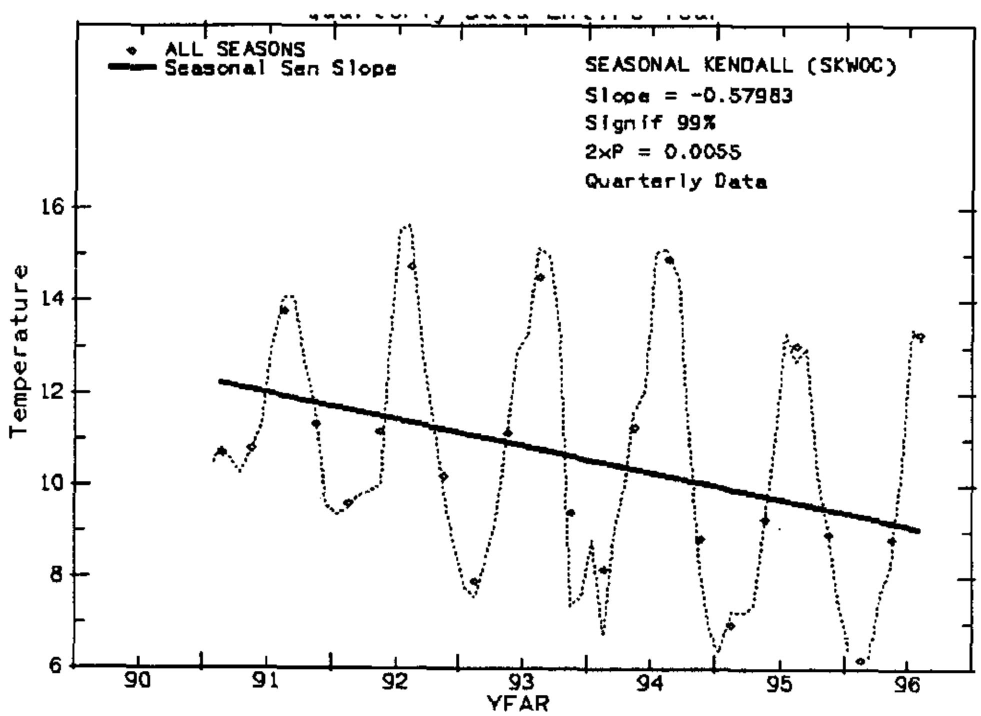
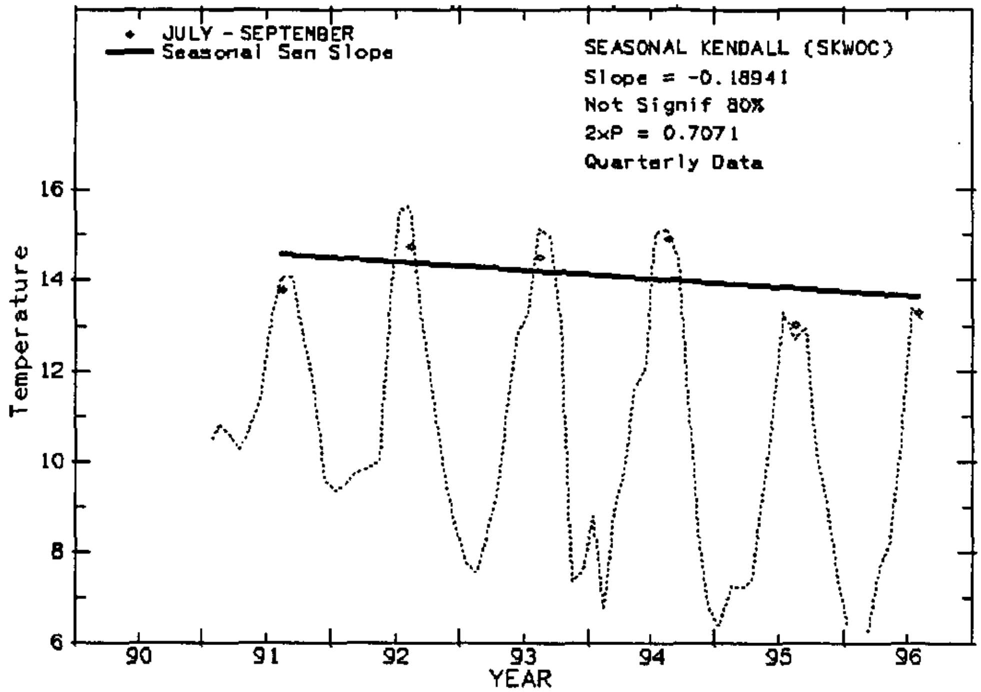


Chart 4-47 Daily Data Summarized by Quarter - July through September Only



There is a statistically significant decreasing trend for the period 1991-1996 for stream temperature at the rate of 0.580 Celsius per year based on data for the entire year. For the months of July to September, where increases in summer stream temperatures would be expected due to increased interception of solar radiation from created openings, there is a slight decreasing trend that is not statistically significant.

Comparison to Fir Creek

Chart 4-48 Seasonal Wilcoxen-Mann-Whitney Test - Entire Year

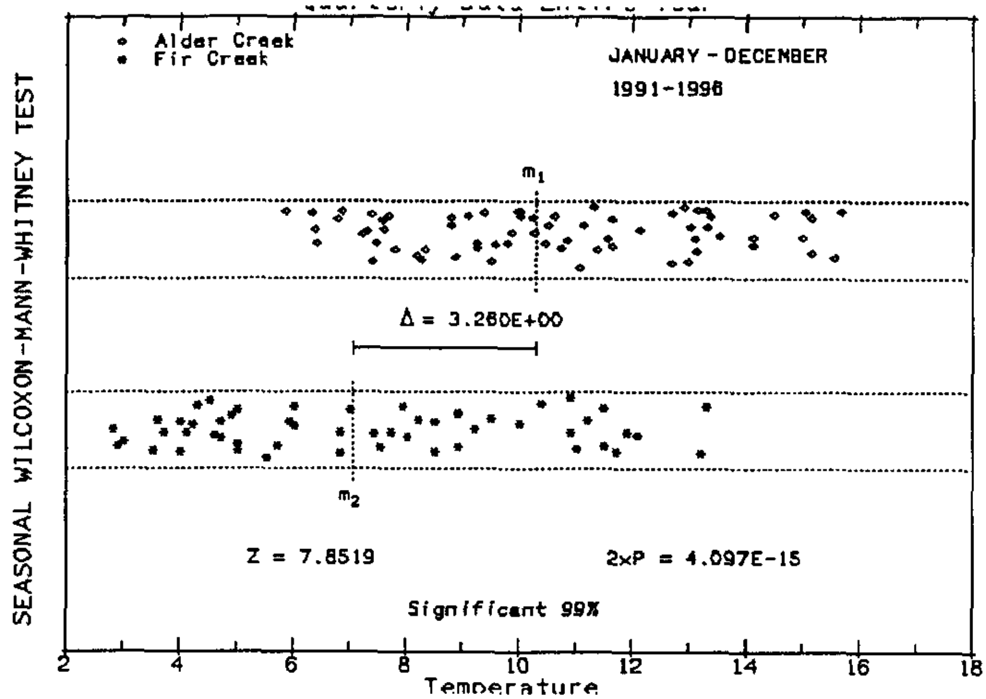
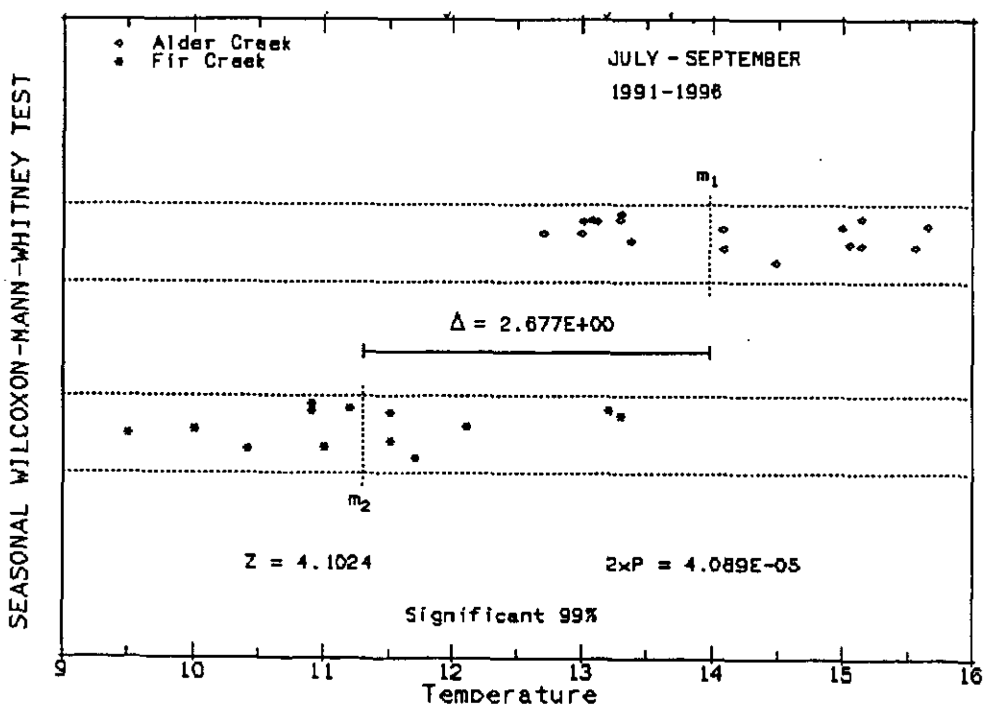


Chart 4-49 Seasonal Wilcoxen-Mann-Whitney Test - July through September



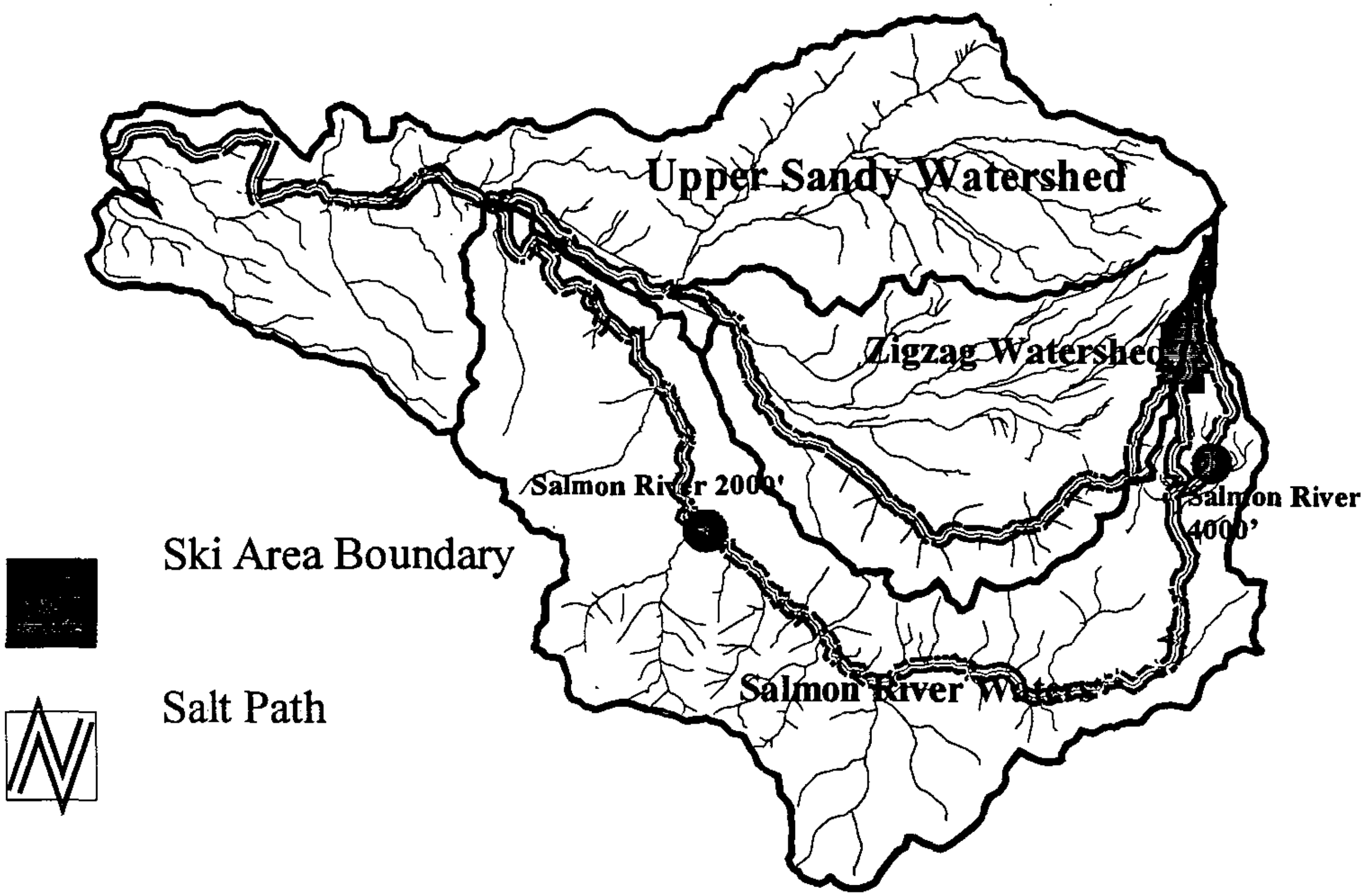
When stream temperatures from Alder Creek are compared to Fir Creek there are statistically significant differences for the entire year and for the period July through September. For the entire year the difference is 3.3^0 Celsius and for the period July through September the difference is 2.7^0 Celsius. These differences are both statistically significant and of practical significance. In Alder Creek stream temperatures exceeded State Water Quality Standards (14.4^0 C for 1991-1995 and 12.8^{0}C for 1996) for the Sandy Basin in 1991, 1992, 1993, 1994 and 1996.

Palmer Snowfield Salting

Sodium chloride has been applied in the spring and summer at the rate of 600,000 to 1,2000,000 pounds per year to Palmer snowfield to maintain skiing conditions for Timberlines ski operations (A.Smart, 1996). Chloride and specific conductance levels of receiving streams are elevated moderately above background levels when salt is applied. Concentrations of chloride and specific conductance decrease as one compares the sampling sites from upstream to downstream. Elevated levels during salt application are less at the lower elevation and more distant sites downstream. This is due to dilution from additional flow of surface and groundwaters as flow accumulate in the downstream direction. A return to background levels (by the next month) was observed at all the stations after salt applications stopped (A.Smart, 1996).

Most of the snowfield drains into Salmon River, and a small portion drains into Still Creek. Salmon River and Zigzag River (of which Still Creek is a tributary) are tributaries to the Sandy River within the Upper Sandy Watershed analysis area.

Figure 4-28 Flow Path from Palmer Snowfield



Using data from the Water Quality Analysis for Timberline Ski Area 1995-1996 (Golder Associates Inc., 1996) an attempt was made to calculate dilution factors to determine chloride inputs from Palmer snowfield salting into the Sandy River from Salmon and Zigzag Rivers. Data from the Salmon River at 4000' and the Salmon River at 2000' were used for this analysis because this is the largest stream system monitored and was felt to give the best indication of dilution rate.

Studies of sodium chloride movement in soils have indicated that the chloride ion is a conservative ion and is not involved in biological or soil chemistry processes (Wilcox, 1986). The chloride ion moves with soil water and can be used as a tracer to track the rate of water movement (Megahan and Clayton, 1983). For these reasons Chloride concentrations were used to determine the dilution rate.

The dilution rate was calculated by determining the difference between the chloride concentrations at the upper and lower sites on the Salmon River, calculating the difference in flow between the two sites and then calculating the dilution factor in mg/L per cfs. The average 30 day duration lowflow from the gage on the Sandy River at Marmot was calculated and from this the lowflow rate per square mile was determined. The 30 day duration low flow was selected because this would give an indication of chloride concentrations during summer lowflows. The difference in chloride concentrations was calculated by determining the mean for the two sites from May 24 through September 25, 1995 and then calculating the differences between the means. This period was used to give an indication of chloride concentrations over the entire period of salting.

Site	Mean Chloride Concentration (mg/L)	Flow (cfs)
Salmon River 4000'	9.8	3.2
Salmon River 2000'	1.6	89.4
Difference	8.2	86.2

There is mean difference of 8.2 mg/L of chloride concentration and 86.2 cfs which calculates out to a dilution rate of 0.095 mg/L per cfs. Using this dilution rate to calculate chloride concentration in the Salmon River at the confluence with the Sandy River results in a chloride concentration that is less than zero. This would appear to indicate that the dilution rate is not linear and additional monitoring is required to determine the effect of the salting of Palmer snowfield on water quality in the Sandy River.

Recommendation (monitoring): monitor chloride concentrations in the Sandy River to determine the effects of Palmer snowfield salting on water quality in the Sandy River.

Conclusions: Water Quality

- The Sandy River below Marmot Dam is water quality limited with respect to summer stream temperatures

- Moderate problems with turbidity and sediment are identified in the Sandy River associated with glacial runoff.

- Stream temperatures are of concern in Clear Creek, Clear Fork, Chance Creek and Alder Creek due to exceedances of state standards.

- Stream shade and associated effects on stream temperature are of concern in the lower Sandy subwatersheds, and Clear Fork

- There is a statistically significant (P-level less than 0.10) difference between turbidity levels in Alder Creek and Fir Creek, however, the magnitude of the difference (0.09 and 0.08) is not of practical significance.

- There is a statistically significant (P-level less than 0.10) difference between stream temperatures in Alder Creek and Fir Creek that is of practical significance.

Fisheries

Introduction

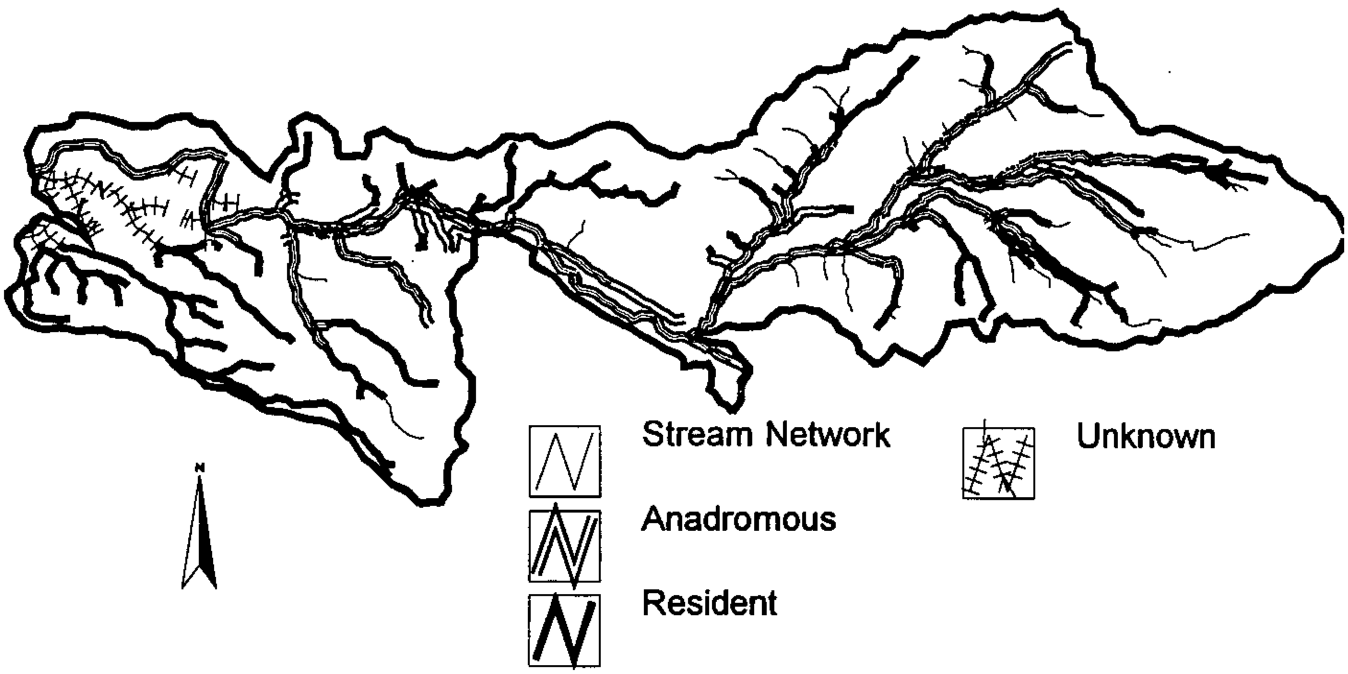
The Aquatic Conservation Strategy was developed to restore and maintain the ecological health of watersheds and aquatic systems contained within them on public lands. This strategy will protect salmon and steelhead habitat on federal lands managed by the Forest Service and Bureau of land Management.

The Aquatic Conservation Strategy strives to maintain and restore ecosystem health at watershed and landscape scales to protect habitat for fish and other riparian dependent species and resources and restore currently degraded habitats.

The Mt. Hood National Forest uses salmonids (salmon, trout and char) as management indicator species for aquatic habitats. Because of their value as game fish and their sensitivity to habitat changes and water quality degradation, salmonids have been selected to monitor trends within Mt. Hood National Forest's streams and lakes. Although other fish species are present in the rivers, (sculpins and dace, for example), population trends are unknown. Because more information exists on salmonids, this group serves as a more optimum choice for monitoring aquatic environments.

The Upper Watershed supports both anadromous (sea-run forms) and resident species of salmonids. Within these species are distinct stocks, some native to the Sandy Basin and some introduced. Native stocks, as defined in this analysis, are those stocks found historically in the Sandy River Subbasin that have maintained a high degree of genetic integrity and have little genetic influence from other introduced stocks. The native stocks are uniquely adapted to the special conditions found within the Upper Sandy Watershed.

Figure 4-29 Fish Distribution Upper Sandy Watershed

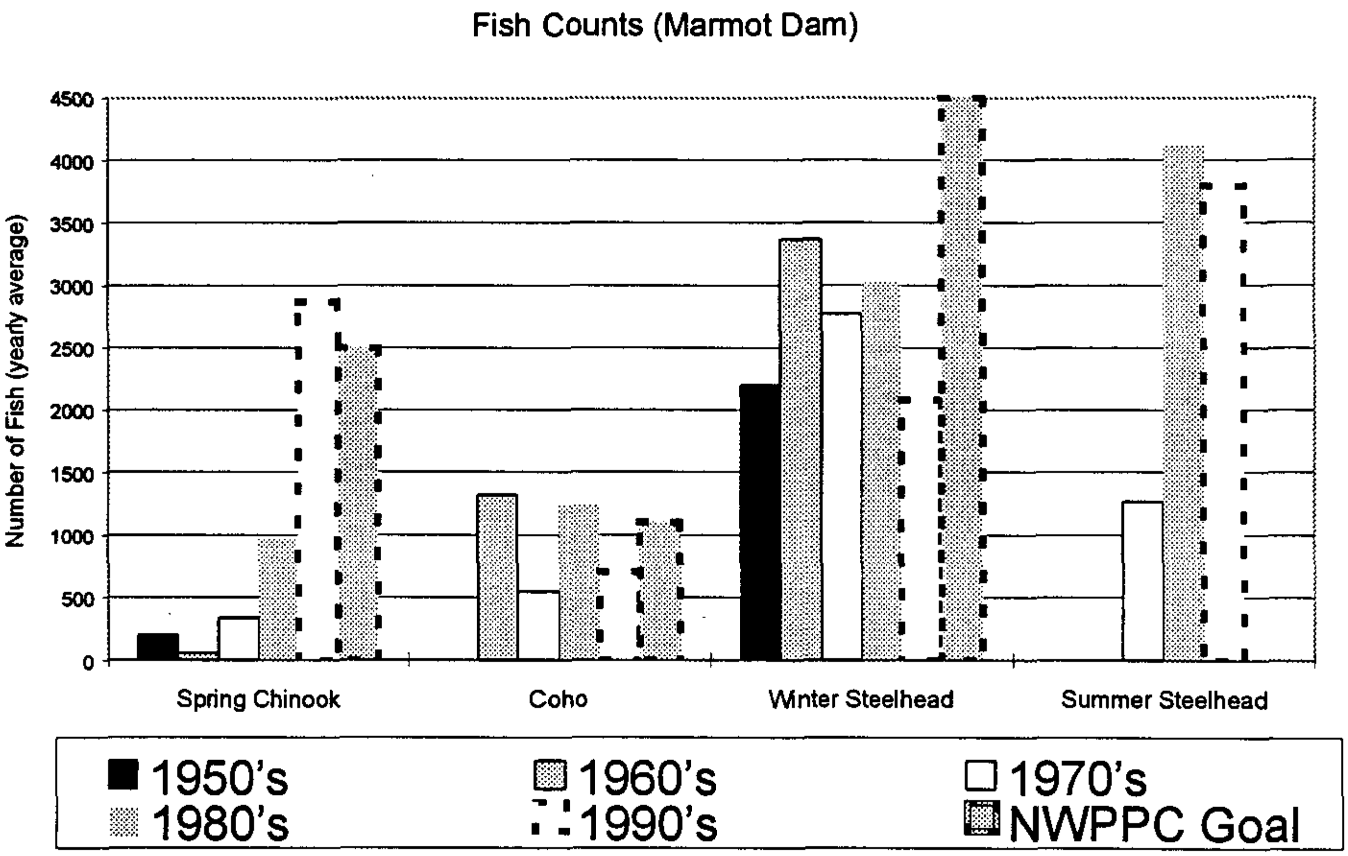


Historical Trends -- Sandy Subbasin

Salmon and steelhead counts passing into the upper Sandy Basin appear to be greatly reduced from the levels present before the 1850s. Scant information is available on historical run size. Information from Salmon River and Still Creek are used as indicators of conditions in the Upper Sandy Subbasin (which includes Bull Run, Upper Sandy, Zigzag, and Salmon River watersheds). Comparisons of records from an old hatchery within the Salmon River Watershed, along with recent spawning surveys in the Salmon and Zigzag watersheds, indicate that current spawning returns are only 10-25% of 1890s' levels (which were already reduced by decades of heavy fishing on the Columbia River). Recent returns to the upper Sandy Basin (counts at Marmot Dam) illustrate these recent trends in returns. To indicate the drastic relative change in fish numbers in upper Sandy tributaries from 1890-1950, historical Salmon River hatchery records are also included. (Note: historical data is extrapolated.)

Information sources for this fish stock discussion include: Oregon Department of Fish and Wildlife's (ODFW) *Sandy River Subbasin Salmon and Steelhead Plan*, 1990; Portland General Electric's (PGE) *Hydroelectric Development and Fisheries Resources on the Clackamas, Sandy and Deschutes Rivers*, 1995; and Mt. Hood National Forest habitat and population inventories.

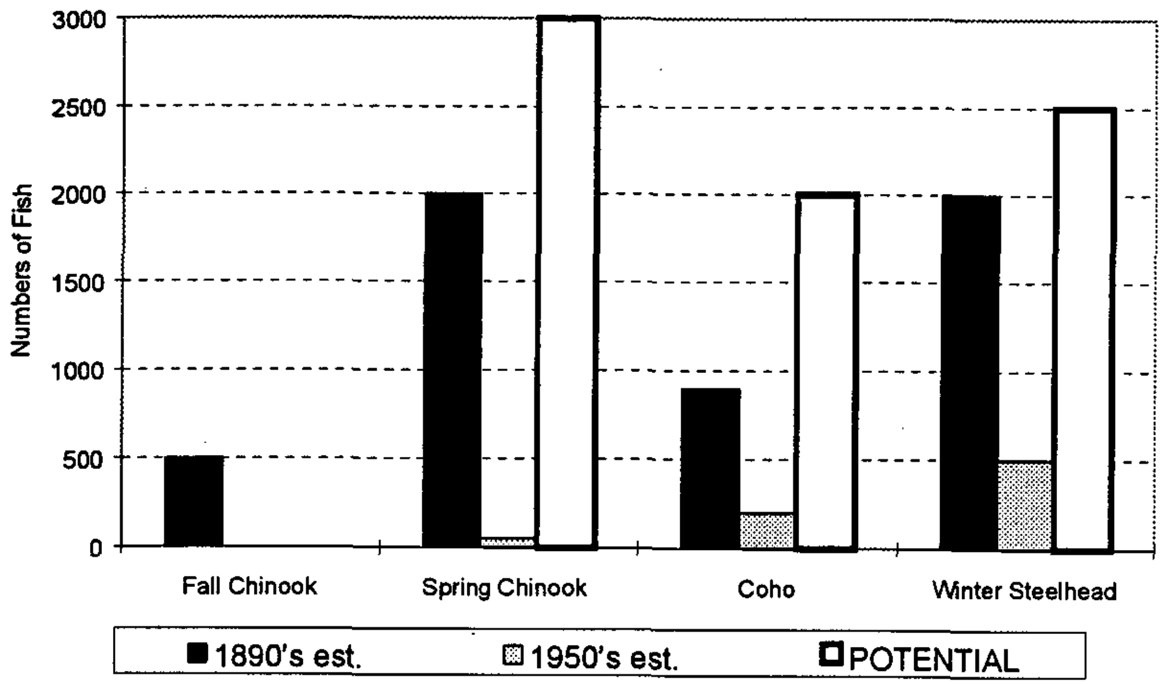
Chart 4-30 -- Fish Counts and Existing Escapement Goals, Upper Sandy River



NWPPC-Northwest Power Planning Council

Figure 4-31 – Estimated Population and Potential, Salmon River

(Mattson, 1955)



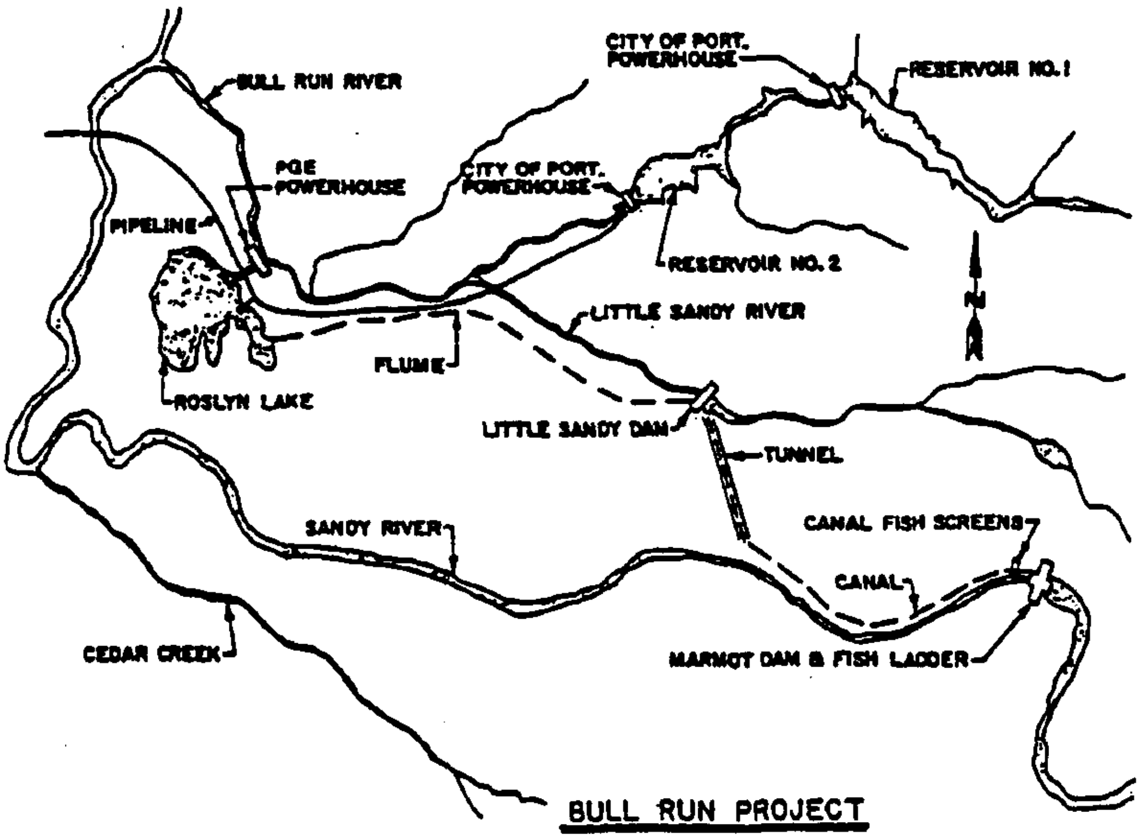
Historical trends in anadromous fish numbers are, in a large part, related to the history of dams within the Sandy Subbasin. Hydropower development in the Sandy Subbasin began in the early 1900s. Construction of the Little Sandy Diversion Dam began in 1906. Marmot Dam on the Sandy River was constructed in 1912 (Figure 4-32).

Since Marmot Dam's construction an operating fish ladder has been in service on the Sandy River (PGE, 1995). In its early years of operation, the Marmot Dam fish ladder was used as a trap to obtain adults for egg-taking. Egg take operations for steelhead occurred from 1913 to 1946. For an extended number of years, apparently few fish, if any, were allowed to proceed upstream to spawn naturally (Exhibit S - Project No. 477, Bull Run Project). Problems with fish passage with the fish ladder at Marmot Dam were documented as late at 1970 (Oregon State Game Commission, 1970).

The diversion canal at Marmot Dam was not screened until 1951. During this period, much of the smolt production was diverted and killed by the Bull Run power generating facilities. In 1951, the diversion at Marmot Dam was screened to prevent smolt mortality associated with hydropower generation.

Through 1973, water withdrawal associated with hydropower developments on the Sandy River de-watered long reaches of the river below Marmot Dam. In 1974 minimum flows were established on the Sandy River below Marmot Dam to provide fish passage and increased rearing areas (PGE 1995).

Figure 4-32 -- Dams Upper Sandy Subbasin



Fish Distribution and Habitat

Fish distribution and miles of available habitat in the Upper Sandy Subbasin are detailed in the following pages. The miles of habitat summarized in these figures and table are estimates to be used for comparison purposes .

Figure 4-33 -- Anadromous Fish Distribution Prior to 1912 and after 1951

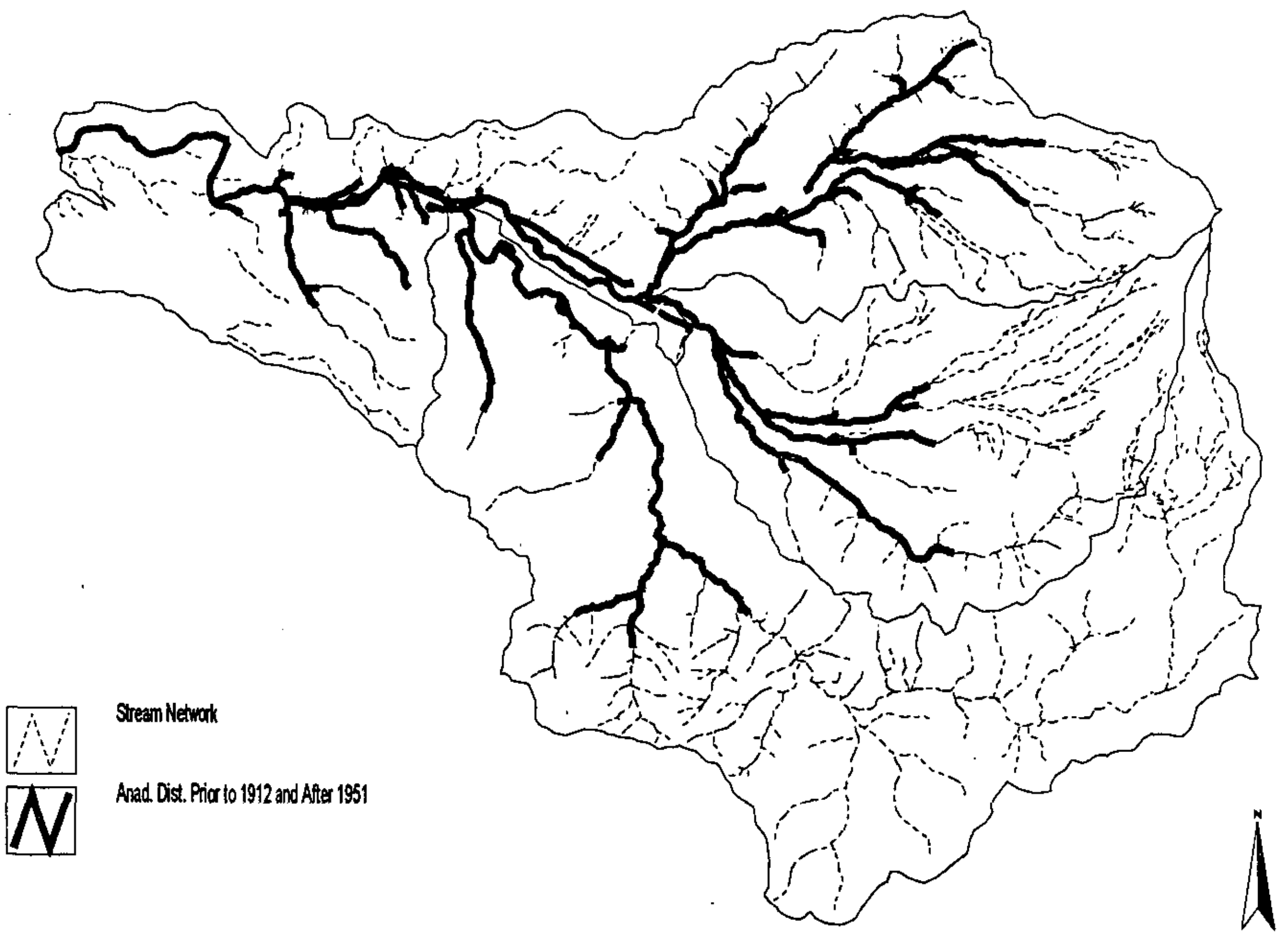


Figure 4-34 -- Anadromous Fish Distribution 1912-1951

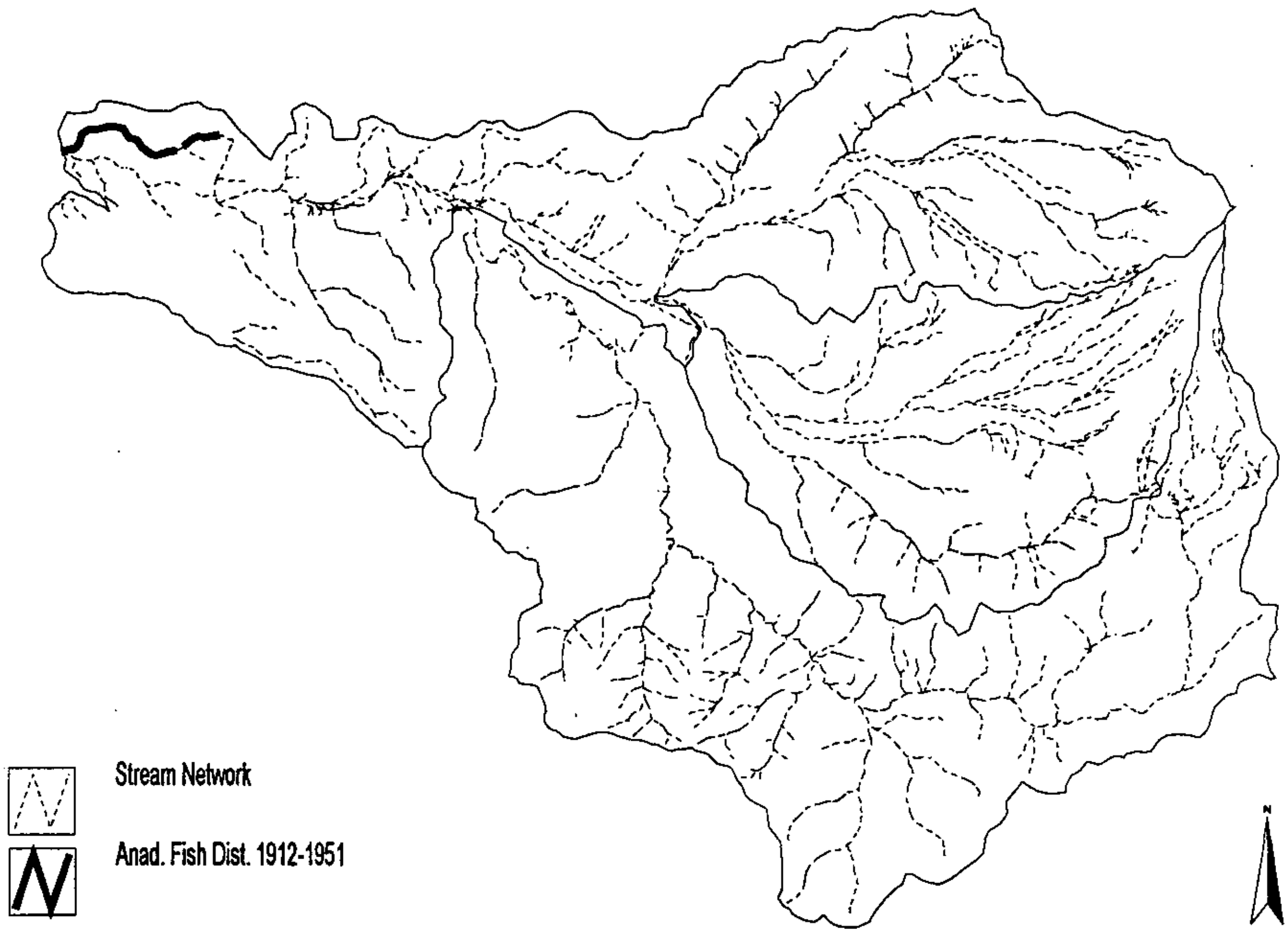


Table 4-40 --Miles of Anadromous Fish Habitat Upper Sandy Basin

Period	Miles of Anadromous Habitat Upper Sandy Subbasin	Percent of Historical Habitat Available in the Upper Sandy Subbasin
Prior to 1912	167.7	100
1912-1921 Installation of Marmot Dam and Little Sandy Diversion	44.3	26
1921-1951 Installation of new headworks facility on the Bull Run River, egg taking operations at Marmot Dam[8]	12.8	8
1951-Present[9]	136.6	81

Because of the dams with no fish passage on the Bull Run and Little Sandy rivers only 81% of the historical habitat is available in the Upper Sandy Subbasin.

Fish Stocks

The term "stock" is referred as a group of fish that is genetically self-sustaining and isolated geographically or temporally during reproduction. Within the Sandy River Basin, there are native stocks (fish which are indigenous to the basin), nonnative stocks (fish which were supplemented into the basin from hatchery stocks), and mixed stocks (native and nonnative stocks which have interbred). Fish distribution maps presented in this section were prepared from the ARCINFO streams coverage for the Mt. Hood National Forest. The fish distribution was determined from stream surveys.

[8]Egg taking operations were active below Marmot Dam from 1913-1954 for chinook salmon and from 1913-1945 for steelhead trout and coho salmon (Collins, 1974).

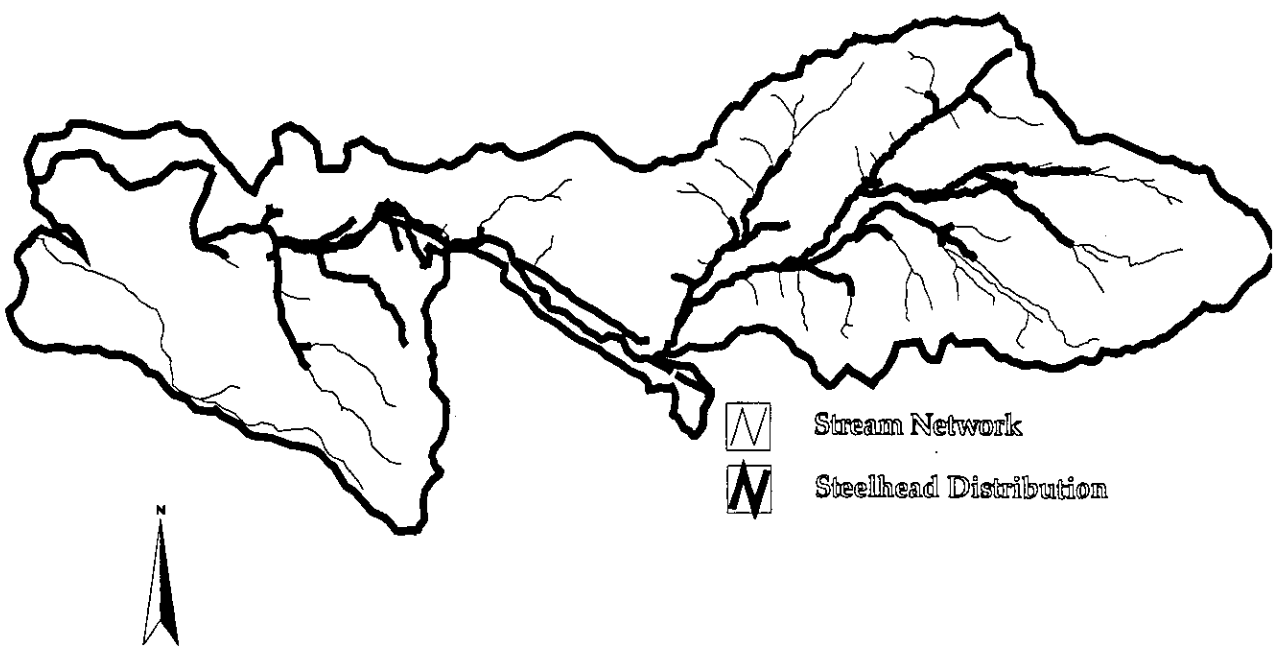
[9] The diversion canal at Marmot Dam was screened in 1951 preventing smolt mortality and egg taking operations were ending.

Steelhead Trout *Onchorynchus mykiss*

Steelhead exhibit one of the most complex array of life history traits of any salmon species. Steelhead my exhibit anadromy (meaning they migrate from fresh water to the ocean, and then return to spawn in fresh water) or nonanadromy (meaning they reside their entire life in fresh water). Resident forms are usually referred to as "rainbow" or "redband" trout, while anadromous life forms are termed "steelhead".

Two major genetic groups or "subspecies" of steelhead occur on the west coast of the United States: A coastal group and an inland group. Both coastal and inland steelhead occur in Washington and Oregon. The anadromous and non anadromous forms of *Onchorynchus mykiss* are grouped together for each "subspecies". The Sandy River watershed supports an anadromous and resident form. Two stocks of steelhead (summer and winter), utilize the Sandy River for a major portion of their life history. The terms "summer" and "winter" refers to the timing in which these stocks return from their ocean rearing and enter the fresh water system.

Figure 4-35 Steelhead Distribution



Steelhead Status

The National Marine Fisheries Service (NMFS) has the responsibility to review the status of anadromous fish which may warrant listing as threatened or endangered pursuant to the Endangered Species Act of 1973 (ESA). NMFS identified the Sandy River watershed to be included in the Ecological Significant unit (ESU) as part of the Lower Columbia River ESU number 4. Through this status review process, NMFS has proposed Lower Columbia River ESU west coast steelhead to be under the "threatened" status.

Summer Steelhead

Native Stock

It is possible that the Sandy River did support a summer race of steelhead. Angler reports from the late 1950's show small numbers of steelhead being caught in the Sandy River. However, if a native run was supported, it is believed to have been very small (pers comm Tom Murtagh, ODFW biologist, Sandy Basin Planner).

Hatchery/Mixed Stocks

Summer Steelhead enter the lower Sandy River as early as late February and generally peak in May and June. Peak migration past Marmot Dam occurs in June; most spawning is complete by the end of August.

Introduced Stock

Sport fishing of summer steelhead has become an important resource for anglers in the Sandy Subbasin. Hatchery summer steelhead were introduced into the Sandy Subbasin in 1975. The Skamania Hatchery developed this stock from eggs taken on the Washougal River in southwest Washington. Eggs were taken from spawners in the Washougal River from 1967-73, and transferred to South Santiam Hatchery for rearing. Since 1974 most eggs have been taken from adults returning to South Santiam Hatchery. This stock is identified as the Foster/Skamania stock #24. The release of these fish has resulted in a popular fishery in both the upper and lower river from April through December. Most hatchery smolts have been released into clear water tributaries of the Sandy which are unaffected by the glacier silt (with the exception of the Zigzag River). Smolt releases occur into the Salmon River, Zigzag River, and Still Creek.

Although it was once assumed that this hatchery stock would not naturally reproduce or compete with indigenous steelhead and juvenile coho, natural production is known to occur as evidenced by sport catch in the upper Sandy Basin and in Marmot Dam counts. The USFS monitors the emigration of salmonid smolts in the Still Creek subbasin of the Zigzag Watershed with the aid of a trap. The smolts released above the trap in mid March have been documented leaving as late as June. A high percentage of the releases have not been trapped during the emigration, so it is unclear whether or not the smolts are delaying departure or whether they are remaining in the subbasin. Competition with native fish stocks is a concern. Additionally, holdover of smolts is suspected which may negatively effect the survival of presmolts or juvenile of native stocks. Straying of summer steelhead into the upper Sandy subbasin has not been evaluated to date. Since summer steelhead are not released into the upper Sandy watershed, escapement is believed to be low.

Life history of summer steelhead

Summer steelhead enter the Sandy River around February and begin migrating past Marmot Dam in March or April. The migration generally peaks in June and concludes in August. Summer steelhead return to the Sandy River as reproductively immature adults and will not reach maturation until mid winter of the following year. Spawning timing is believed to occur between December through mid-February. Their distribution is determined by the location of the smolt releases. The smolts migrate to the ocean by early summer. Apparently, most summer steelhead will remain in the ocean for two summers before returning as adults. Unlike other salmon species which die after spawning, steelhead have the ability to spawn in freshwater and return to the ocean.

Winter Steelhead

Three stocks of winter steelhead return to the Sandy River; the native stock (late run), Big Creek and Eagle Creek hatchery stocks (early runs). Current ODFW guidelines give management direction to protect the late-run natives. Under these guidelines, only 10% of the naturally spawning winter steelhead should consist of hatchery stock. Since 1989, hatchery stocking has occurred below Marmot Dam in an effort to concentrate the sport fishery to the lower Sandy Subbasin and to reduce juvenile competition in the upper subbasin. Most adults passing Marmot Dam are believed to be of wild or native origin. Straying of hatchery winter steelhead into the upper subbasin may still be continuing.

Native Stock

Winter steelhead which are native to the Sandy Subbasin, pass Marmot Dam from April through May. From the early 1980s to the early 1990s, the percentage of natives comprising the winter steelhead run declined from 28% to 18% (ODFW; May 3, 1994).

The Sandy subbasin plan (in progress) identifies that the production of native steelhead in the Sandy subbasin has been impacted and constrained since the early 1900's by several factors which include:

1. Municipal water supply development,
2. Water diversion projects,
3. Channelization and instream clearing projects in the upper subbasin following the 1964 flood,
4. Commercial harvest of steelhead in the Columbia river through 1974,
5. Egg take operations for hatchery production at the salmon river hatchery (1896 to 1913) and at marmot dam (1913 to 1946),
6. Sport angling effects both at the adult and juvenile life history phase,
7. Inter and intraspecific competition from introduced hatchery fish,
8. Habitat degradation caused by urbanization, road construction, logging and agricultural and nursery practices.

Hatchery Stocks

The hatchery winter steelhead program was initiated on the Sandy River in 1955 by the Oregon Game Commission to enhance the early season sport fishery. The Sandy River is consistently rated as one of Oregon's top ten winter steelhead producers. Recreational fishing is popular primarily below Marmot Dam. Two stocks of winter steelhead have been introduced into the Sandy subbasin; the Big Creek and to a lesser degree, the Eagle Creek stock. The Big Creek stock was developed in the early 1940's from an indigenous population of winter steelhead in Big Creek which is a tributary to the lower Columbia River. The Eagle Creek stock is proprogated at the Eagle Creek Fish Hatchery located on Eagle Creek, a tributary to the Clackamas River. This stock is a cross between Big Creek and native winter Clackamas River steelhead. All hatchery winter steelhead are fin clipped for identification. The intent of the hatchery program is to provide a sport fishery, while protecting native winter steelhead through catch and release regulations. Since 1989, all hatchery smolts have been released below Marmot Dam to concentrate the sport fishery below the dam and to maintain the upper basin for native production.

Life history of winter steelhead

The return of the steelhead timing is related to the stock of origin. The native stock of winter steelhead began their spawning migration in late February, which peaked in April or May (time of passing over Marmot Dam). Historically, native winter steelhead entered the Sandy River in November and held in the lower river (perhaps for months) prior to moving upstream to spawn. This delay in migration may be flow and temperature related. Prior to catch and release regulations (in effect since 1990), these native steelhead were susceptible to harvest during their prolonged stay in the lower basin before migrating upstream. Steelhead generally spawn in tributaries higher in the drainages than coho or chinook. After fertilization, winter steelhead eggs may incubate in the gravel and hatch in 35-50 days (temperature dependent). After hatching, the sac fry remain in the gravel two to three weeks before emerging. Oxygen levels in the gravel affect the survivability of the fish. This is especially an important concern in the Upper Sandy subbasin since there are naturally high levels of glacier silt within the system. Good quality stream habitat is especially important since steelhead commonly stay in the system for 2-3 years before migrating out to the ocean. Sandy subbasin winter steelhead generally spend two summers in the ocean before returning to spawn.

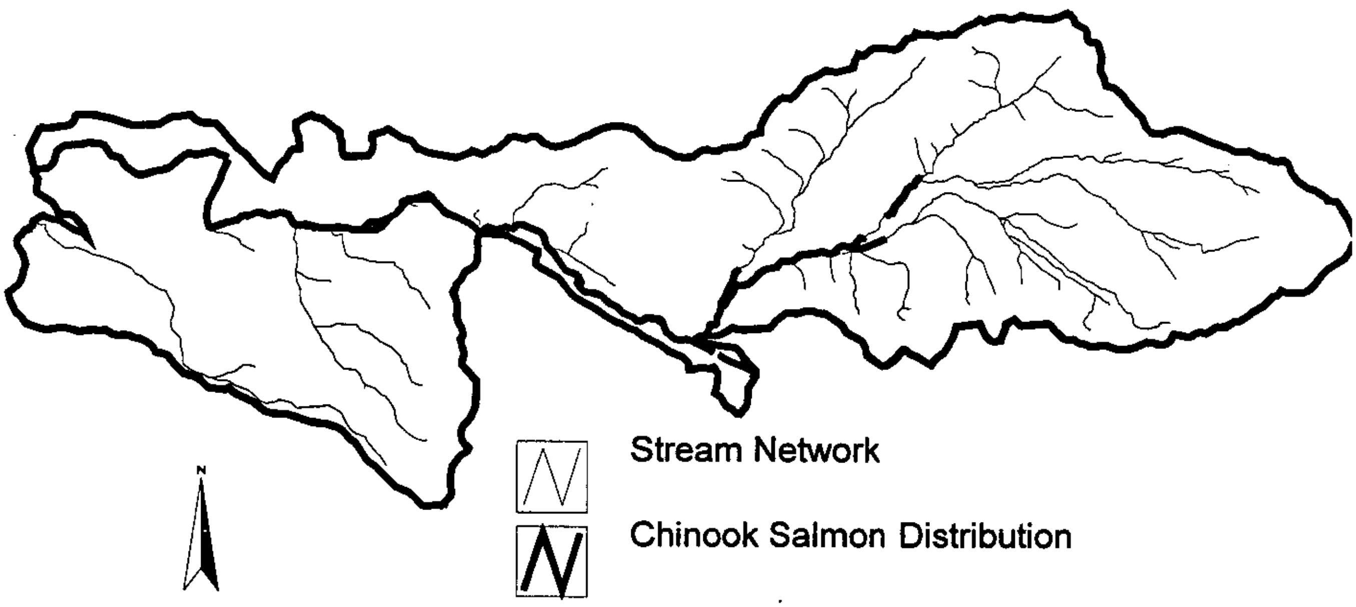
The hatchery winter steelhead were introduced to extend the period of sport fishing. The majority of the Big Creek stock return from December through January, and most of the Eagle Creek stock return from January through February.

Chinook Salmon *Oncorhynchus tshawytscha*

The Sandy River supports both a fall and spring stock. Based upon genetic differences and maturation schedules, the fall chinook have been broken into two run components; the early maturing tule, and the late maturing Sandy stock. Until recently, the late maturing Sandy stock was considered to have two runs. One run spawns in October to early December and the other spawns in December to early February (commonly referred as "winter" chinook). ODFW combined the two runs since there is a lack of genetic information describing stock differences, as well as stock management purposes. It is believed that the "winter" may be a segment of the same Sandy Stock with a later return time.

Spring chinook are indigenous to the Sandy Subbasin. Hatchery practices have influenced the stock structure within the basin. Initial releases were of progeny of the native Sandy stock which had been raised at the hatchery. With the decline in this run, an aggressive hatchery program was initiated utilizing stocks from outside the basin, the Carson stock (from Washington), and the Willamette stock (stock derived from Willamette River, Oregon). Natural spawning of spring chinook occurs primarily above Marmot Dam. Natural inputs of glacial sediments in the Muddy Fork, Zigzag, and Sandy may decrease potential productivity within theses areas. However, these systems offer travel to clear water tributaries which offer more optimal habitat components.

Figure 4-36 Chinook Salmon Distribution



Chinook Status

Chinook stocks in the coastal basins of Oregon, California, and Washington are currently under review by NMFS for listing as threatened or endangered. To aid in management concerns and conservation strategies, ODFW has defined two gene conservation groups for the fall chinook within the Sandy Subbasin: 1) the late maturing Sandy fall chinook stock, and 2) the early maturing tule (grouped with the Lower River Wild chinook stock). Lower Columbia River fall chinook stocks are currently listed on ODFW's Sensitive species list.

Fall Chinook

Historically, fall chinook spawned in the lower reaches and above Marmot Dam on the mainstem of the Sandy River . There are historical records of fall chinook in the lower reaches of the Salmon River and near the confluence of Boulder Creek from egg taking records from the hatchery facility on Boulder Creek. In November of 1994 and 1995, fall chinook were observed spawning in the Salmon

River. Spawning is currently concentrated on the mainstem and tributaries in the lower basin near Oxbow Park.

Fall chinook have been negatively impacted by activities within the basin as well as outside the basin including (Sandy Subbasin Plan (in progress)):

1. Exploitation of Columbia River fish stocks beginning in the 1800's,
2. Abundance of sediments (both natural and unnatural related to land use activities) which settle out in low gradient spawning areas,
3. Blockage of habitat which was historically present prior to the construction of the dams on the Bull Run River ,
4. Historic dewatering activities of the mainstem Sandy River during the years 1912 to 1974, current reduced flows in the lower Sandy river as a result of municipal water diversions from the Bull Run River, and passage conditions to and above Marmot Dam during low flow periods.

Native Fall Chinook

Late maturing Sandy stock is indigenous to the Sandy subasin. Recent studies show that this stock has similar genetic characteristics and run timing to stocks in the Lewis and Cowlits Rivers in Washingtion (collectively known as the Lower River Wild Chinook Stock).

Introduced/Hatchery/Mixed Fall Chinook Stocks

Since the early 1900's, hatchery operations have been utilizing fall chinook within the Sandy Basin. The first hatchery within the basin located on Boulder Creek records show that fall chinook eggs were taken between 1903 and 1912 from adults returning to the hatchery or trapped in lower river areas then transferred to the hatchery for rearing (Craig and Suomela, 1940). It is believed that some mixing of spring and fall chinook stocks may have occurred at this facility. In addition, fall chinook have been collected at three sites within the basin: racks which were placed at a tributary located 3 miles north of Troutdale and racks which were located in the lower Bull Run, and racks which were on Cedar Creek. Fall chinook eggs from the Bonneville and Oxbow facilities have been raised at the Sandy Hatchery, however, it is unknown if these fish were released within or outside the basin. The Sandy Hatchery produced Sandy stock fall chinook from 1954 to 1976 for release into the Sandy Basin as well as for transfer outside the basin (Wallis 1966). The majority of these releases occurred in Cedar Creek and the lower mainstem Sandy River.

The early maturing tule run is believed to be a composite of: 1) descendants from naturally reproduced hatchery strays, and 2) progeny of stray hatchery releases made in the subbasin through 1977 from the Sandy Hatchery. It is unknown if the tules were indigenous to the subbasin prior to hatchery influences.

Life History of Fall Chinook

The early maturing tule stock of fall chinook enter the Columbia River in July. They appear to enter the Sandy River in August. These chinook spawn from late September to mid-October.

The late maturing Sandy stock enter the Columbia River in August and September, and enter the Sandy River in October. Spawning generally occurs from late October through December. Based upon spawning surveys, the "winter" run spawn from December through February. Hatching and emergence is dependent upon time of spawning and temperatures. Hatching of early maturing tule stock would be expected from mid-November to early January. Emergence of the tule stock would follow 70 to 80 days later, around February. The late maturing Sandy stock would likely be spawning higher in the system, where water temperatures are cooler, delaying the hatching time. The late maturing Sandy stock which spawned in November would likely emerge in April. The "winter" stock which spawns in January might hatch in April or May, and emerge from the gravels in late May or June.

In general, fall chinook which inhabit small tributaries move out earlier than fall chinook which inhabit larger rivers. Some juveniles may overwinter in fresh waters, but the majority emigrate out of the Columbia River during the late summer and fall of their first year. The fall chinook smolts which emigrate from the Sandy River are suspected to follow the same ocean migration patterns as other fall chinook in the lower Columbia River which tend to move north once they enter the ocean.

Based upon analysis conducted by ODFW, the age of fall chinook returning to the fresh water varies between stocks. Apparently, the late maturing Sandy stock seem to return at an older age than early maturing tule stock. Fall chinook return from the ocean anywhere from 2-5 years.

Spring Chinook

Native Stock

Large runs of native spring chinook once returned to the Sandy and Bull Run rivers. This run is thought to be extinct in the Sandy River Subbasin. Its decline is most likely due to:

1. The early Marmot Dam operations,
2. Decreased access to historical spawning grounds,
3. Influences of hatchery practices,
4. High harvest levels in commercial and recreational fisheries,
5. Long reaches of the Sandy River were dewatered between 1912 and 1974, when Sandy River water withdrawal at Marmot Dam began
6. Additionally, high smolt mortality occurred on the Sandy River between 1912 and 1951 when the diversion canal was unscreened and smolts were diverted into the PGE power generating facilities at Bull Run.

Natural reproduction is occurring above Marmot Dam. Since the original hatchery releases were of the native Sandy stock, there may be a remnant gene component of the native stock. It is unknown if the indigenous Sandy stock has maintained itself as a separate subpopulation from the introduced Willamette stock.

Introduced/Hatchery/Mixed Stocks

Extensive introductions of spring chinook have occurred in the Sandy basin. Prior to 1970, most of the introductions were from spring chinook indigenous to the Sandy River. An intensified hatchery program was initiated in the early 1970's to supplement the depleted native runs. Two stocks of spring chinook have been released, the Carson stock (from Washington), and most prominately, the Willamette stock. Since 1994 hatchery releases have been moved below Marmot Dam.

Life History of Spring Chinook

Information from anglers reveals that spring chinook enter the Sandy River in February. The peak of the migration usually occurs in April and May. Counts at Marmot Dam at river mile 30 show that those moving to the upper basin generally do so between May to early October. A few stragglers will pass the dam as late as

November. Those fish that do migrate to the upper basin are holding in large pools in the lower subbasin for several months before moving upstream. This make them susceptible to the poor flow conditions and warmer stream temperatures resulting from the manipulated flows.

Peak spawning time for spring chinook in the upper basin is September to early October. There is little information on the distribution patterns of juveniles in the Sandy basin. Some juveniles may move out of the upper tributaries to hold in the larger river until the following spring for departure into the ocean. Most juvenile spring chinook seem to move out to the Columbia River in the spring of their second year as 1+ smolts. Once the Willamette stock reaches the ocean, they likely migrate north to British Columbia and Alaska.. The age composition of returning adults of the Willamette stock spring chinook to the Sandy basin is unknown. Spring chinook generally return anywhere from 3, 4, 5 and a few at 6 years of age.

Coho Salmon *Onchorynchus kisutch*

Coho Status

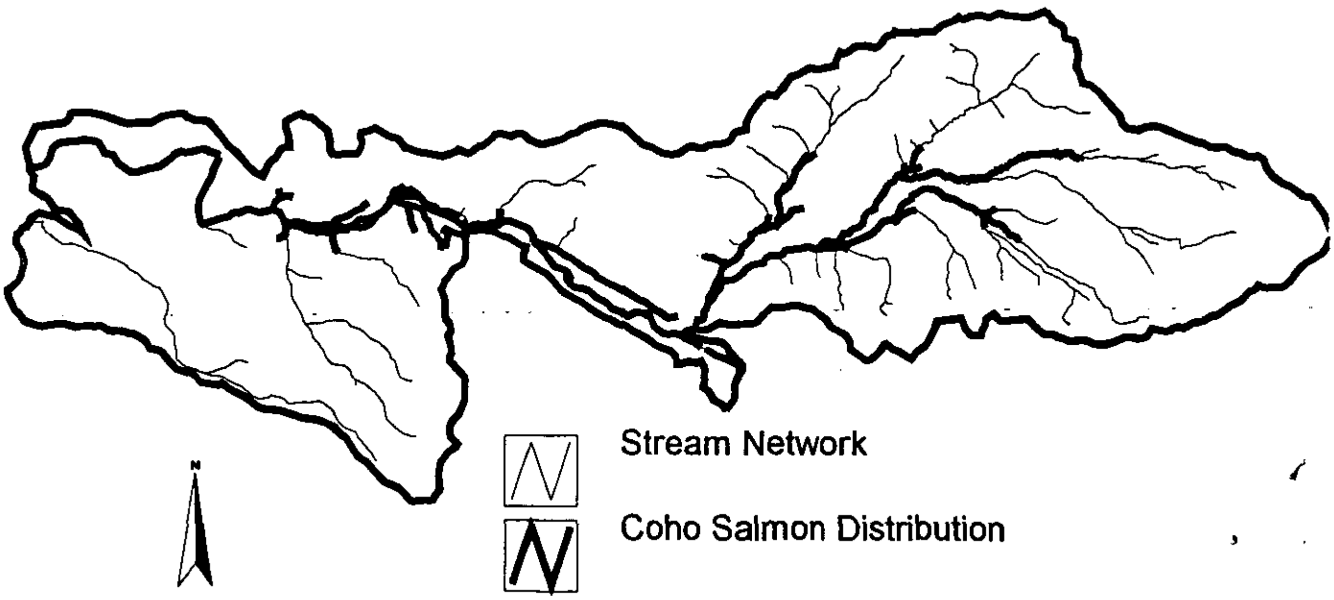
NMFS identified the Lower Columbia River/Southwest Washington ESU coho salmon as a candidate species under review by NFMS to determine if they warrant consideration for listing. Coho are listed by the ODFW and the USDA Forest Service as a sensitive species.

Factors contributing to the decline of coho populations include:

1. Habitat degradation; loss of slow water areas associated with the loss of large woody debris, side channels and stream channelization,
2. Overfishing (ocean and Columbia river fisheries),
3. Poor ocean rearing conditions,
4. Supplementation with early run coho hatchery stock,
5. Hydroelectric dam operations,
6. Agriculture, urban development, and timber management.

Substantially fewer coho are returning than historical records though the population is considered stable. The most optimal habitat for coho is in tributaries to the mainstem Sandy River above Marmot Dam. Two stocks of coho utilize the Sandy River, a native stock (commonly referred as the late run coho), and a hatchery stock (commonly referred as the early run coho, Sandy Hatchery stock). Supplementation of the early run coho has been extensive. It is believed that the majority of the coho that are reproducing naturally in the basin are of the Sandy Hatchery stock.

Figure 4-37 Coho Salmon Distribution



Native Stock

Coho salmon are indigenous to the Sandy River Subbasin. The introduction of the early run coho is a primary factor to the decline of the native stock. The introduction of this stock has made it difficult to separate the two stocks. It is unclear if the pure native stock continues to exist. However, hatchery influence would have resulted primarily from supplementation releases of native stocks from the Sandy River Hatchery coho. There is no documented break in the lineage of naturally produced coho in the Sandy River.

Hatchery/Introduced/mixed Stocks

In 1896, the first hatchery in the Sandy Basin began operation on Boulder Creek, a tributary to the Salmon River (Collins, 1974). Hatchery operations were conducted periodically from 1912-1955 below Marmot Dam. Fishery managers constructed racks across the river below the dam to intercept coho. Eggs were taken from the coho and used for hatchery production. This hatchery operated until 1955, primarily as an egg taking facility for the Sandy Hatchery on Cedar Creek. The Cedar Creek hatchery was constructed in 1950, at rivermile 0.5 on Cedar Creek above its confluence to the Sandy River. In 1965, hatchery operations accelerated with the supplementation of fry, pre-smolt, and adults. Most releases consisted of Sandy stock coho produced at the Sandy Hatchery. Since 1990, all stocking of coho has been limited to below Marmot Dam.

Life history of Coho

In general, coho spawn higher in the basin than chinook. They share many of the tributaries with steelhead. Data specific to the late-run coho is lacking within the Sandy Basin. Upstream migrations of late run coho in the lower Columbia River tributaries occur from mid-September to mid-February with a peak in late October. Large numbers have been counted in October, November, and December (Willis 1962).

Natural reproduction of early coho run is poorly documented. Surveys in the upper basin have not been consistently conducted. Observations by ODFW and Forest Service biologists indicate that spawning generally occurs from October to late November. This timing coincides with the spawning time of the hatchery stock.

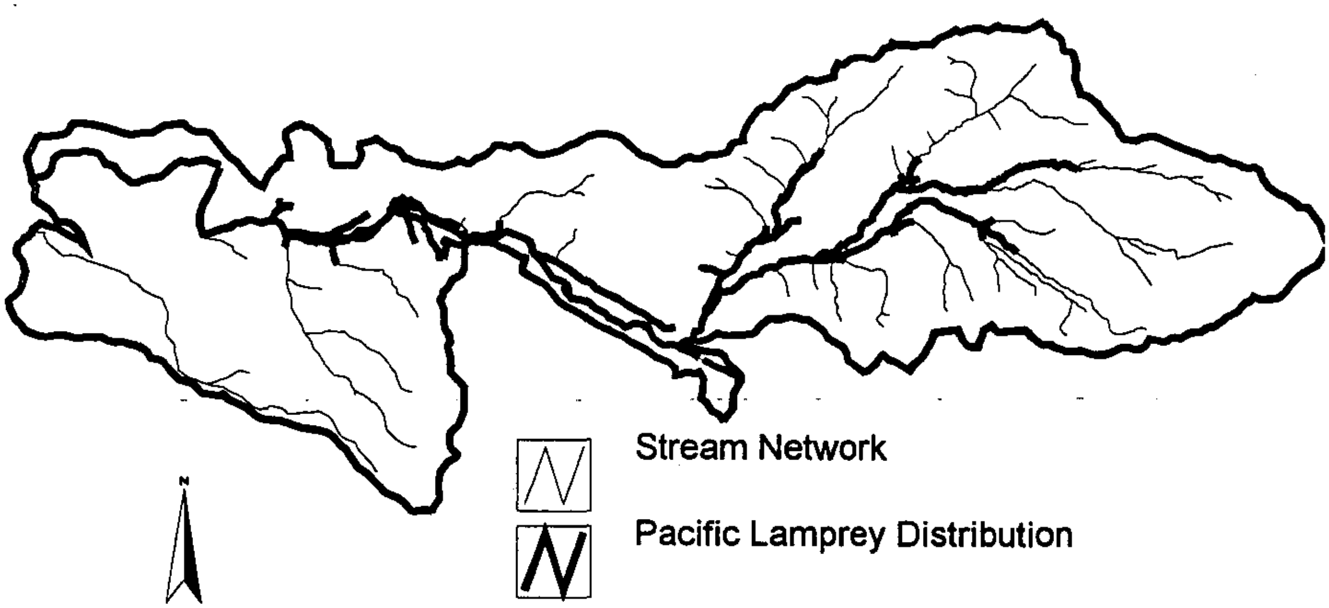
Once spawning is completed, egg development is dependent upon temperature. In general, eggs will remain in the gravels for 60 days before hatching occurs. Once the fish emerge, they remain in the gravels until they have nearly absorbed their yolk sac. They rise above the gravels approximately 98 days after fertilization (based on temperatures of 40-45 degrees). Fry should emerge around February to early April.

Typically, coho juveniles migrate out of the subbasin and into the Columbia River at 12 to 14 months of age, although some migrate out prior to receiving their first annulus. The first returning adult coho probably enter the lower Sandy River in August. Returning coho are 2 year old jacks or 3 year old adults.

Pacific Lamprey

Pacific lamprey, a primitive eel-like fish is native to the Sandy Basin. Adults are parasitic. The larvae (ammocoetes) may spend 3 to 8 years in gravel and fine sediment substrates in shallow backwaters. They are especially susceptible to the deleterious effects of dewatering below the dams.

Figure 4-38 Pacific Lamprey Distribution



Pacific Lamprey Status

Pacific Lamprey are listed as a sensitive species by the State of Oregon and are considered a species of concern by the Oregon Natural Heritage database.

While survey information is lacking for this species, a widespread perception exists that population numbers have notably declined during the last several decades. Likely threats or factors contributing to this decline include: rapid or prolonged water withdrawal, high water temperatures, impacts to water quality, a declining prey base, and barriers of great size.

Cutthroat Trout

Cutthroat trout, both anadromous and resident forms, are indigenous to the Sandy Subbasin. Three life history forms are believed to reside in the Upper Sandy Watershed:

- Resident cutthroat trout -- Generally live and spawn in small headwater streams.

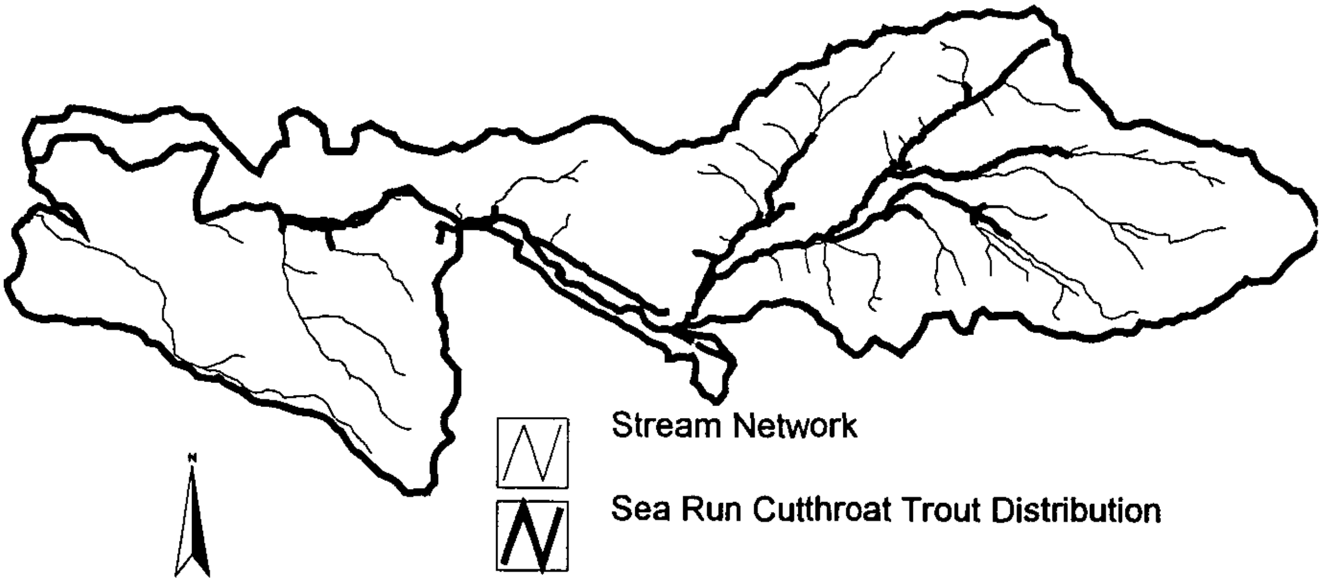
- Fluvial cutthroat trout -- Live in main rivers and migrate to upstream tributaries to spawn.

- Anadromous -- Live in the ocean and spawn in freshwater streams.

Sea-run Cutthroat Status

The anadromous sea-run cutthroat trout are currently under review by NMFS for listing as threatened or endangered. This review is expected to be completed by late fall of 1997 (pers comm - Jim Lynch, NMFS, Portland Office, May, 1996). Populations of sea-run cutthroat trout are in severe decline throughout their range and are considered sensitive by ODFW.

Figure 4-39 Sea-run Cutthroat Trout



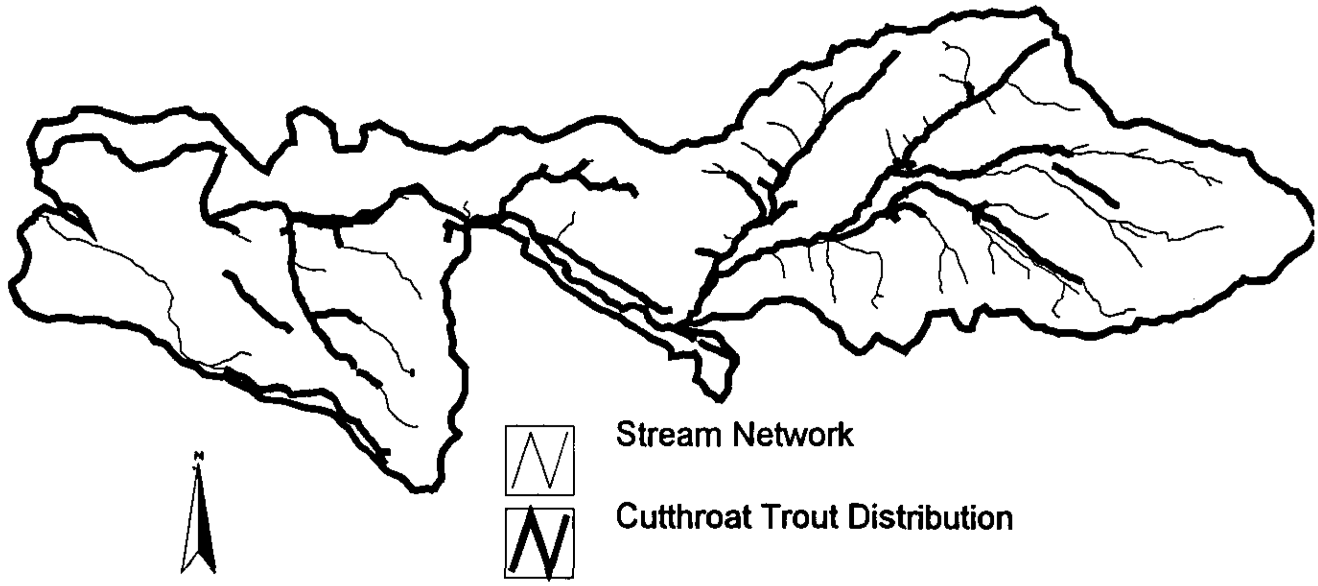
Native Stock

Sea-run cutthroat trout are native to the Sandy Basin. While very few sea-run cutthroat now return to the lower Sandy River hatchery each fall, two to three dozen sea-run cutthroat once returned there (ODFW, 1995 Biennial Report).

Resident Cutthroat Trout

The resident form is well distributed throughout the drainage, but several factors may combine to limit its numbers in some areas. It is easily caught, and areas near roads and development may literally be "fished out" in a short period of time. It does not compete well for food and space with some other salmonid stocks and may be displaced from its habitat. Cutthroat also readily hybridize with rainbow trout and this likely happened historically in areas accessible to anadromous fish where both species were naturally present. The introduction of hatchery strains of rainbow trout present the opportunity for hybridization with cutthroat. For these reasons, the "refuge" habitat provided in remote drainages, above migration barriers, is especially important to sustain this stock of fish.

Figure 4-40 Resident Cutthroat Trout Distribution



Bull Trout

Bull trout are presently identified in the Hood River drainage and were historically known to inhabit the Clackamas River drainage. While the presence of Bull trout in the Sandy Basin is uncertain, there is reference to this species in the Sandy Subbasin by Leonards (1960). The presence of Bull trout in the Upper Sandy Watershed has not been documented.

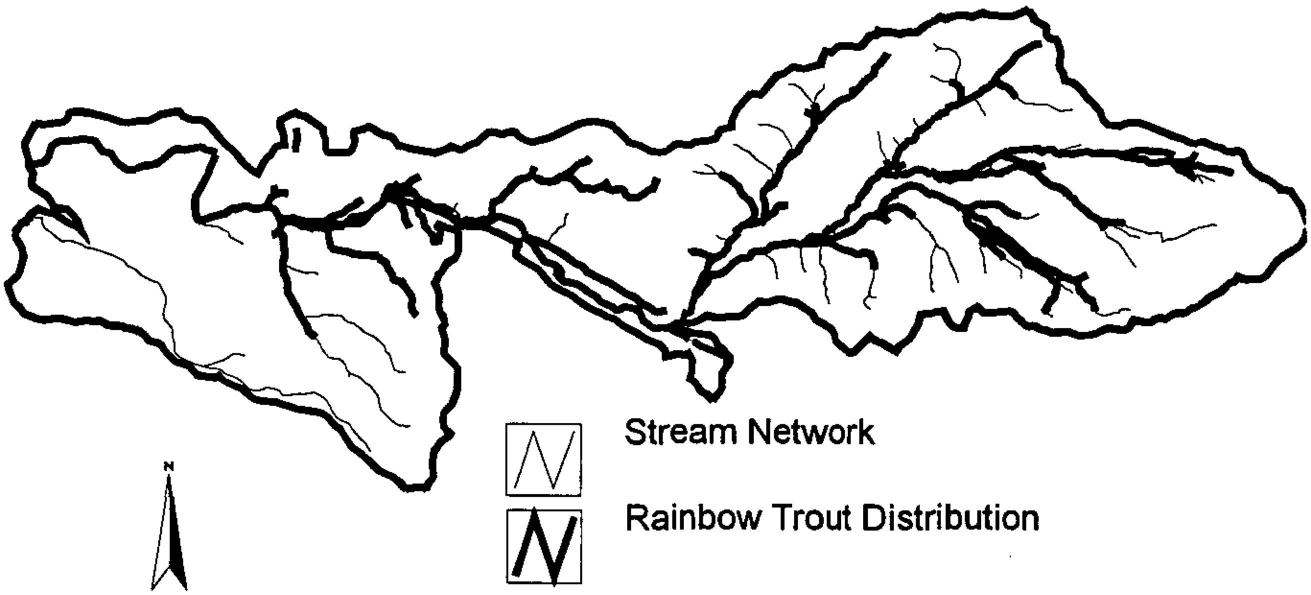
Rainbow Trout

Rainbow trout from several sources have been utilized by hatcheries to develop stock for outplanting into the upper Sandy basin. Stocking of rainbow with the Cape Cod stock (Leaburg, Roaring River Hatchery) has occurred in the upper Sandy River tributaries. Stocking was discontinued in 1994. It appears that if stocked fish are not quickly harvested, they do not usually survive through the following winter. Although the majority of these fish are harvested, there are indications that some of these fish successfully over winter.

These fish compete with resident and juvenile anadromous fish for food and space, and potentially interbreed with native stocks, changing the genetic make-up of the populations (Upper Sandy Wild and Scenic River, Environmental Assessment, 1993).

Fish sampling is inconclusive on their present distribution. Juveniles are indistinguishable from steelhead in anadromous habitat..

Figure 4-41 -- Rainbow Trout Distribution

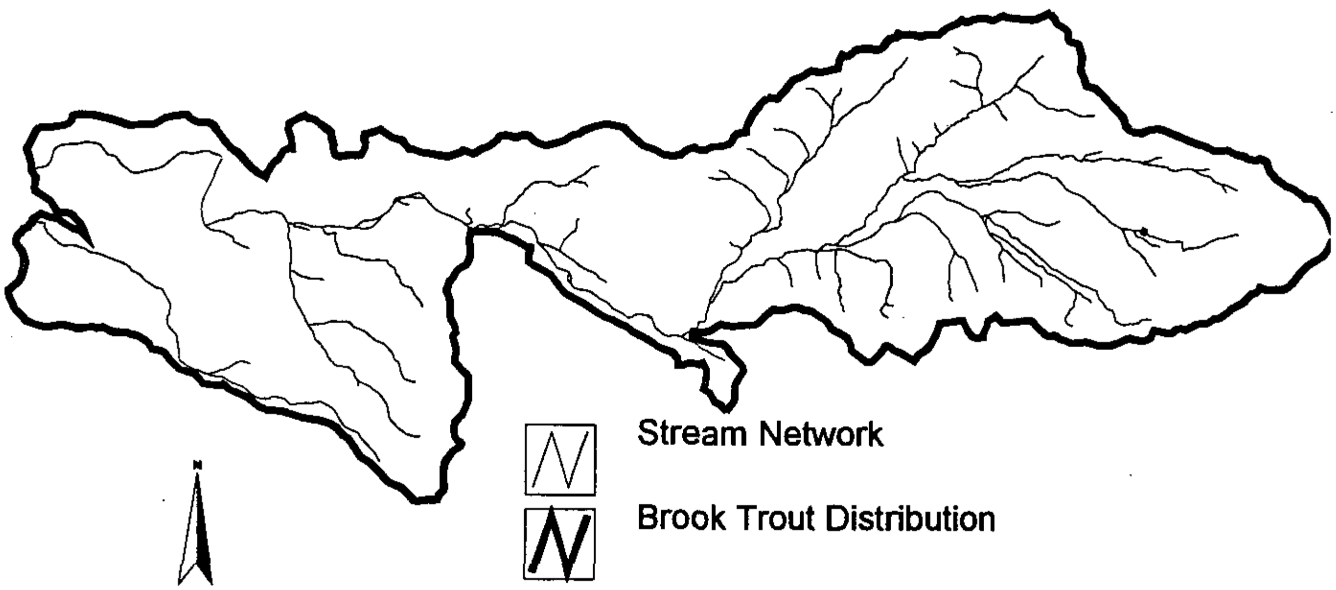


The upper Little Sandy River has a unique stock of rainbow trout shown by electophoretic studies to be pure rainbow trout. Current information indicates this stock may be the ancient inland redband trout. Further studies are needed to make this determination (pers comm, Kathryn Kostow, Geneticist, ODFW, March, 1996). While no stocks believed to be redband have been found in the Upper Sandy Watershed; suitable habitat is present. Redband trout are currently proposed for listing by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act.

Brook Trout

Brook trout are a competitive non-native introduced into several Sandy Subbasin high mountain lakes during the late 1800s to provide angling opportunities in a wilderness setting. The only site with brook trout identified in the Upper Sandy Watershed is a small section of Upper Sandy River.

Figure 4-42 Brook Trout Distribution



Other Species

Longnose dace, mountain whitefish, and torrent and shortnose sculpin are native to the Upper Sandy Watershed. Complete distribution information on these species is lacking.

Table 4-41 Summary of Fish Stocks Upper Sandy Watershed

Species/Stock	Origin	Listing Status (NMFS)	Population Trend
Summer Steelhead	Native Hatchery/Wild Spawning (naturalized)	Proposed as threatened	Extinct Stable
Winter Steelhead	Native Hatchery/Wild Spawning (naturalized)	Proposed as threatened	Decrease Decrease (since 1991)
Fall Chinook	Native Hatchery/Wild Spawning (naturalized)	Under review for listing as threatened or endangered	Decrease Decrease
Spring Chinook	Native Hatchery/Wild Spawning (naturalized)	Under review for listing as threatened or endangered	Extinct Stable/decrease
Coho Salmon	Native Hatchery/Wild Spawning (naturalized)	Candidate for listing	Decrease/stable Decrease
Pacific Lamprey	Native		Decrease
Sea-run Cutthroat	Native	Under review for listing as threatened or endangered	Decrease
Resident Cutthroat	Native		Decrease
Rainbow Trout	Native Hatchery/Wild Spawning (naturalized)		Unknown Decreasing
Brook Trout	Hatchery/Wild Spawning (naturalized)		Unknown
Longnose Dace	Native		Unknown
Mountain Whitefish	Native		Unknown
Sculpin (shortnose)	Native		Unknown
Sculpin (torrent)	Native		Unknown

Macroinvertebrates and Mollusks

Within the adjacent Zigzag Watershed Mt. Hood brachycentrid caddisfly, Mt. Hood farulan caddisfly, and Columbia dusky snail are present or suitable habitat has been documented. These species require clear, cold, well oxygenated water. Due to the high levels of glacial silt in the higher elevation streams in this watershed this habitat is very limited.

Fish Habitat

Introduction

In the discussion of fish stocks a number of critical habitat components were identified. These components include streamflow, aquatic habitat types, pools, and in-channel large woody debris. These habitat components will be discussed by the appropriate stratification unit (stream system, subwatershed, species of concern) for the habitat component and the associated data.

Flows

Marmot Dam and summer water withdrawals have been identified as conditons within the Upper Sandy Watershed affecting habitat by dewatering stream sections (see hydrology section).

The flow regime in the Sandy River below Marmot Dam is in an altered condition due to diversions to the Bull Run powerhouse (see hydrology section for a more detailed discussion).

Chart 4-50 Streamflow Sandy River Above and Below Marmot Dam

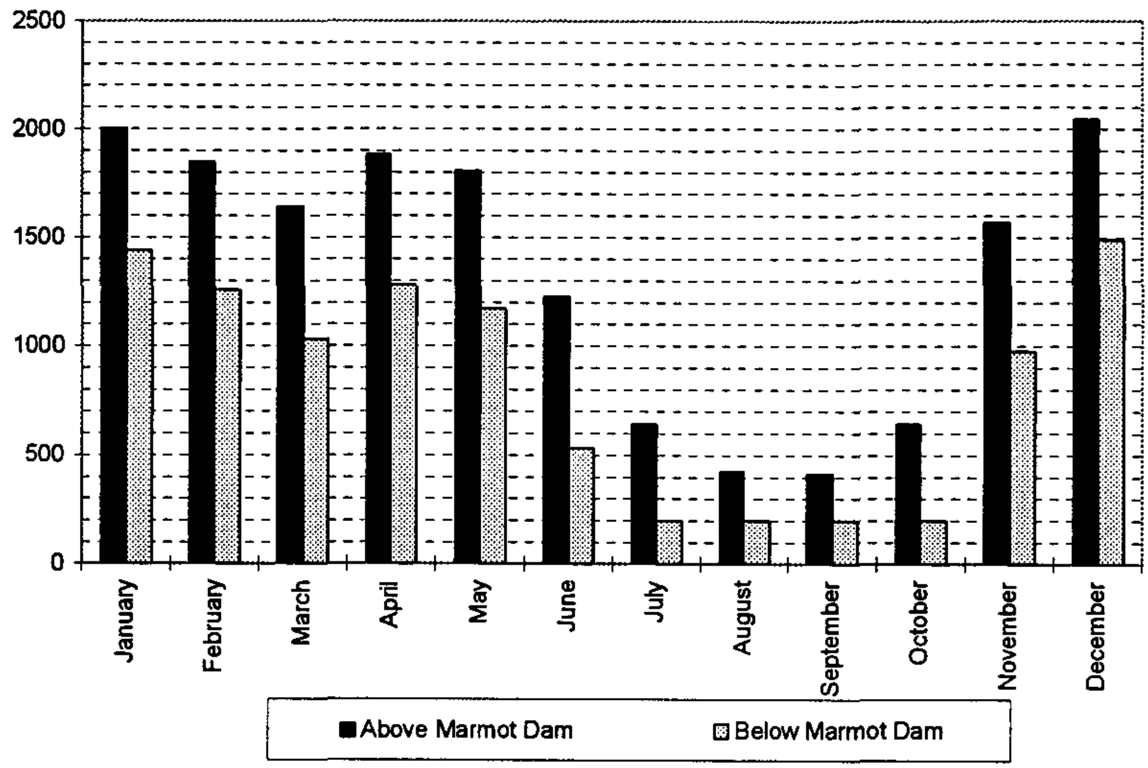


Chart 4-50 details monthly mean streamflows in the Sandy River above and below Marmot Dam. These figures were derived by removing all the water from the Little Sandy River (up to 800 cfs) and then diverting up to 600 cfs of Sandy River (while still meeting minimum flow requirements) to add up to 800 cfs total.

Table 4-42 Percent Change in Flow Above and Below Marmot Dam

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percent change below Marmot Dam	-28	-32	-37	-32	-35	-57	-69	-53	-52	-69	-38	-27

The flows in the Sandy River directly below Marmot Dam are most altered in the months of June-October. This has the potential to affect passage for summer steelhead and chinook salmon and to limit habitat for resident trout in the lower Sandy River.

Water withdrawals associated with water rights in Cedar Creek and Alder Creek have the potential to remove all the water in the lower section of these streams during the summer lowflow period (see hydrology section for a more detailed discussion). This has the potential to affect passage for summer steelhead and chinook salmon. This situation may also lead to stranding of fish in isolated pools as streamflow decreases.

Stream Barriers

Stream barriers are critical habitat components in establishing the range of anadromy within a watershed. Artificial stream barriers exclude anadromous fish from the natural range of anadromy.

Figure 4-43 Stream Barriers

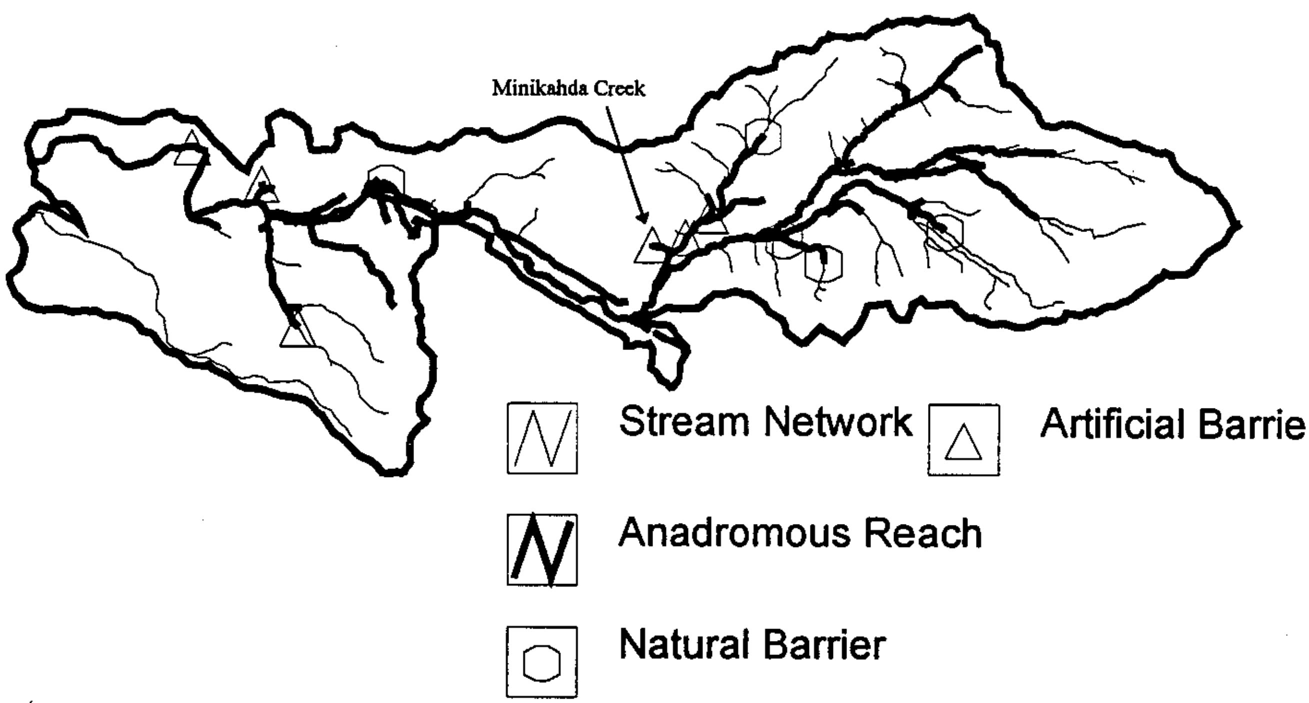


Figure 4-43 details the stream barriers in the Upper Sandy Watershed. This coverage with developed in 1994 with input from fisheries, GIS, and hydrology staff from the Mt. Hood National Forest. Not all the stream barriers identified are full barriers to fish passage as the range of anadromy extends beyond these barriers. Artificial stream barriers are identified as limiting fish passage in Alder Creek, Minikahda Creek, and an unamed tributary in the Mensinger bottom area.

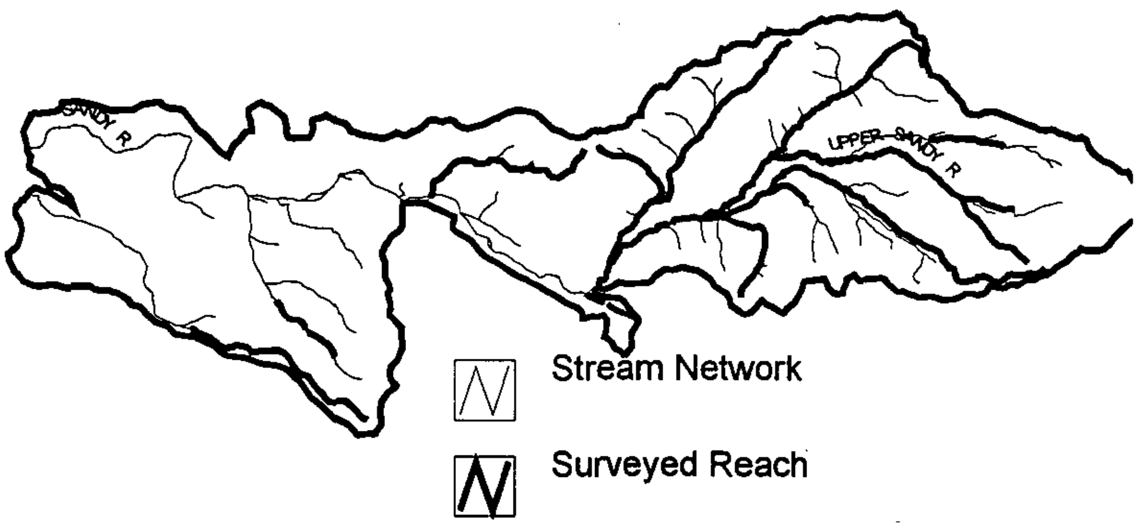
Alder Creek was inaccessible to anadromous fish beyond an impassable waterfall below Highway 26 until a fish passage structure was installed in the late 1980's . The barrier identified in Figure 4-43 is considered a potential anadromous barrier. Steelhead trout have been have been identified up to a mile upstream of this barrier (Alder Creek, 1993).

The barrier identified on Minikahda Creek is a small hydropower facility which is a complete barrier to anadromous fish passage based on the range of anadromy.

Upper Sandy River Stream Survey Data

Data on aquatic habitat types, woody debris, and pools is available from the Stream Management, Analysis, Reporting and Tracking (SMART) database. For the Upper Sandy Watershed this data is only available for streams within the National Forest boundary. Details on stream conditions outside the National Forest boundary are not available, however general conditions of streams outside the National Forest will be summarized at the end of this section.

Figure 4-44 Surveyed Streams



For the assessment of physical components of fish habitat (pools and large woody debris) from surveyed streams within the Upper Sandy Watershed were stratified by stream order[10] to facilitate comparison with the range of natural variation..

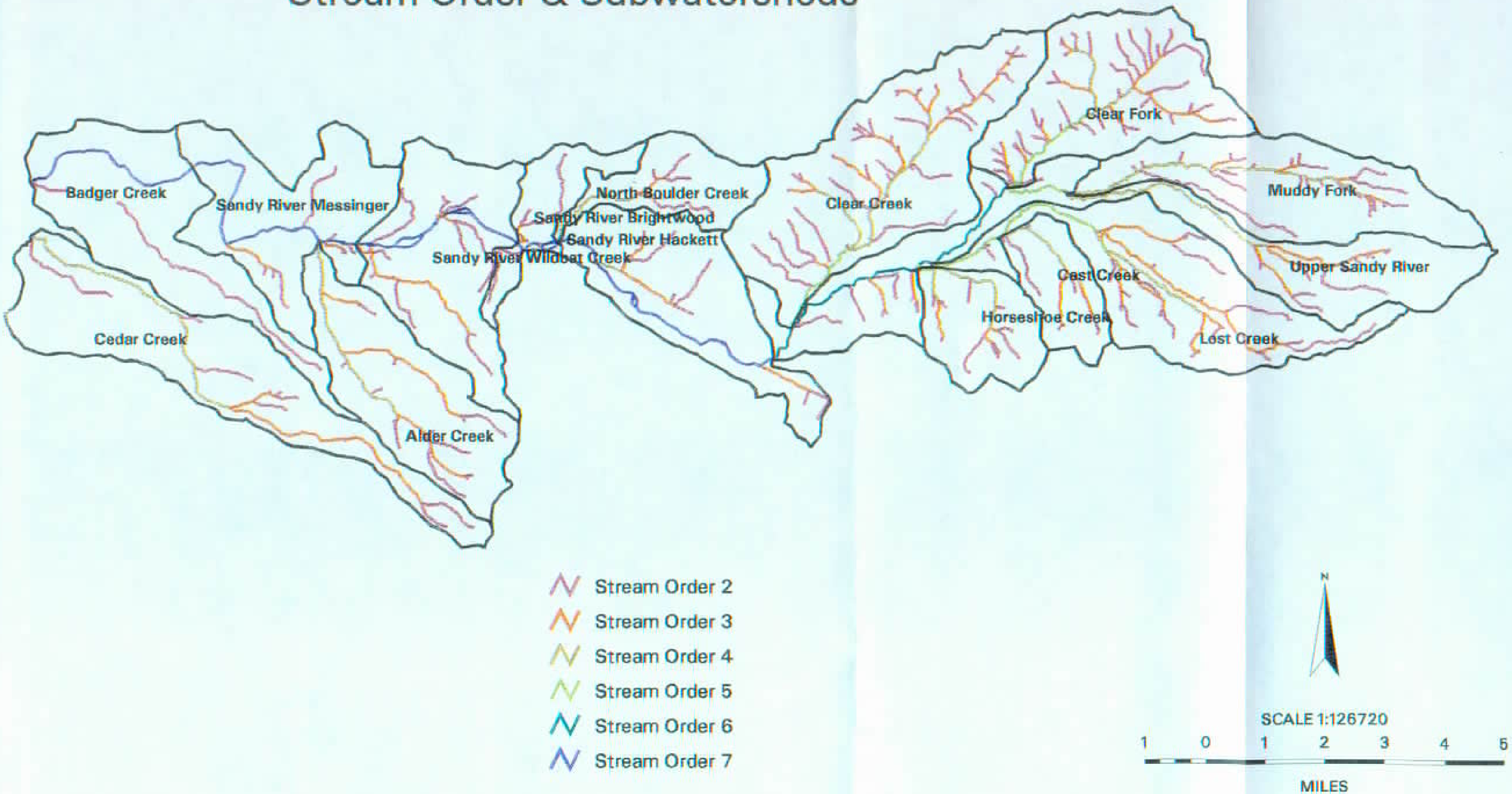
[10] Stream Order - A method of numbering streams as part of a drainage basin network. The smallest unbranched mapped tributary is called first order, the stream receiving the tributary is called second order, and so on.

Range of Natural Variation (RNV)[11]

The *range of natural variation* (RNV) *was approximated for in*-channel woody debris and pools from unmanaged stream reaches by stream order across the Sandy Basin. Stream reaches from unmanaged areas (Wilderness and Fir Creek subwatershed) in the Sandy Subbasin were selected from the SMART database and were stratified by stream order. For this analysis the RNV was determined as the median of the unmanaged stream reaches plus one standard deviation on either side of the median. This was done to eliminate outliers with the potential to bring the RNV from 0-100%.

[11] Range of Variability (Natural Variability, Historic Variability) - The spectrum of conditions possible in ecosystem composition, structure, and function considering both temporal and spatial factors.

Upper Sandy Watershed
Stream Order & Subwatersheds



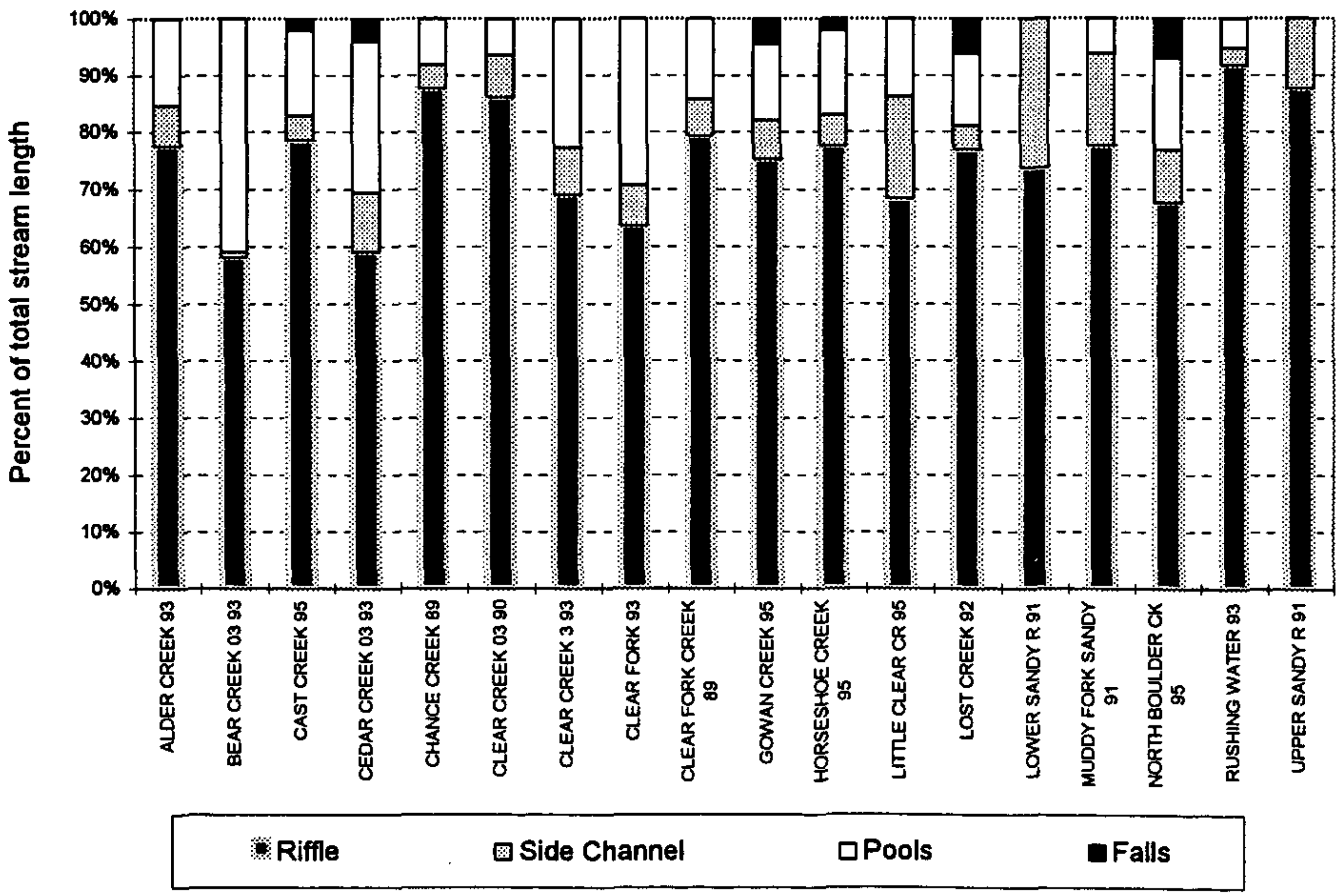
Aquatic Habitat Types

Pool, riffle, glide and side channel habitat types provide habitat for salmonid species. Different habitat types are preferred by different species at different stages of their life cycle.

- Fast water habitats (riffles and glides) - trout and steelhead
- Large mainstem glides and pools - chinook salmon
- Side channels - coho salmon
- Small meandering streams with glides and pools - resident cutthroat and brook trout

Habitat types for the Upper Sandy Watershed were evaluated to assess habitat quality for different anadromous and resident fish. This analysis was completed by using the habitat type from the SMART database.

Chart 4-51 Aquatic Habitat Surveyed Streams



Within the Upper Sandy Watershed riffle habitat is the dominant habitat for the surveyed streams. The Upper and Lower Sandy River have no area in pools and the Muddy Fork has very limited area in pools. These streams are located in the Mt. Hood Wilderness and the Upper Sandy Wild and Scenic River Corridor (Figure 4-46) so the habitat mix would not be expected to have been altered by management activities. This is most likely the natural condition for this area due to the lack of large woody debris in the alpine area and unconsolidated mudflow deposits that the stream is running through (Figure 4-47).

Figure 4-46 Upper Sandy River Land Allocations

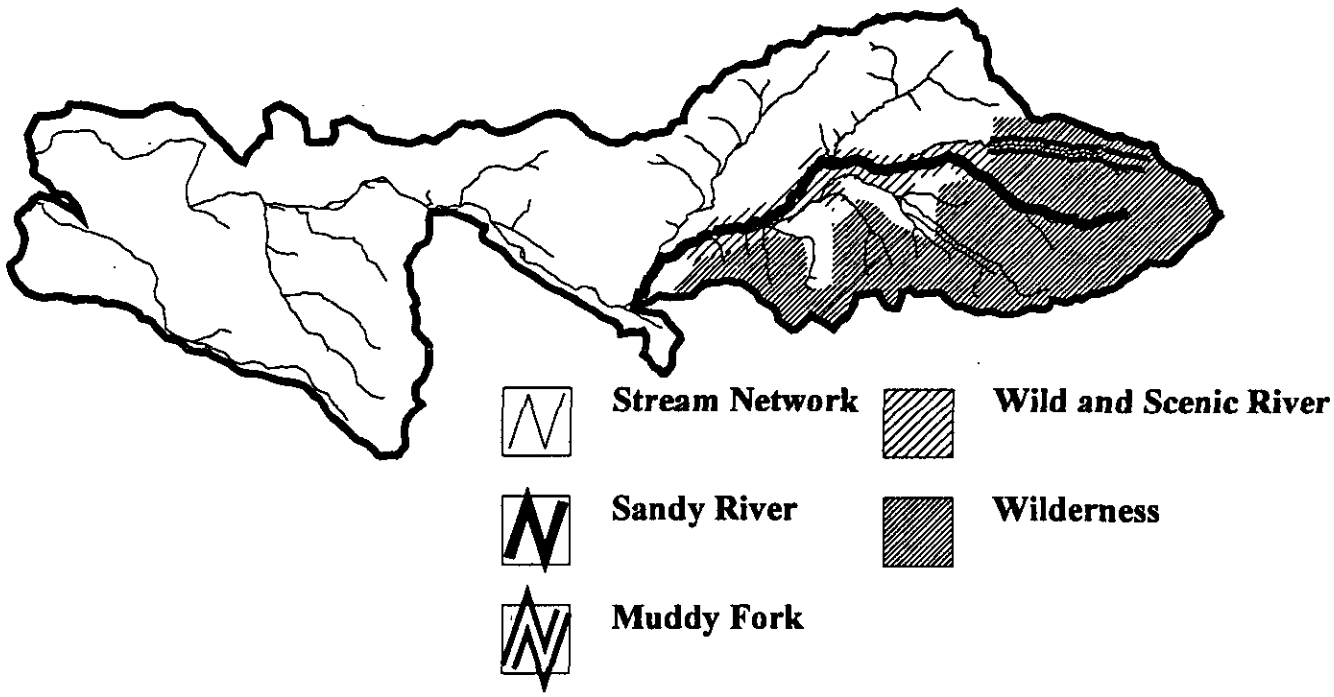
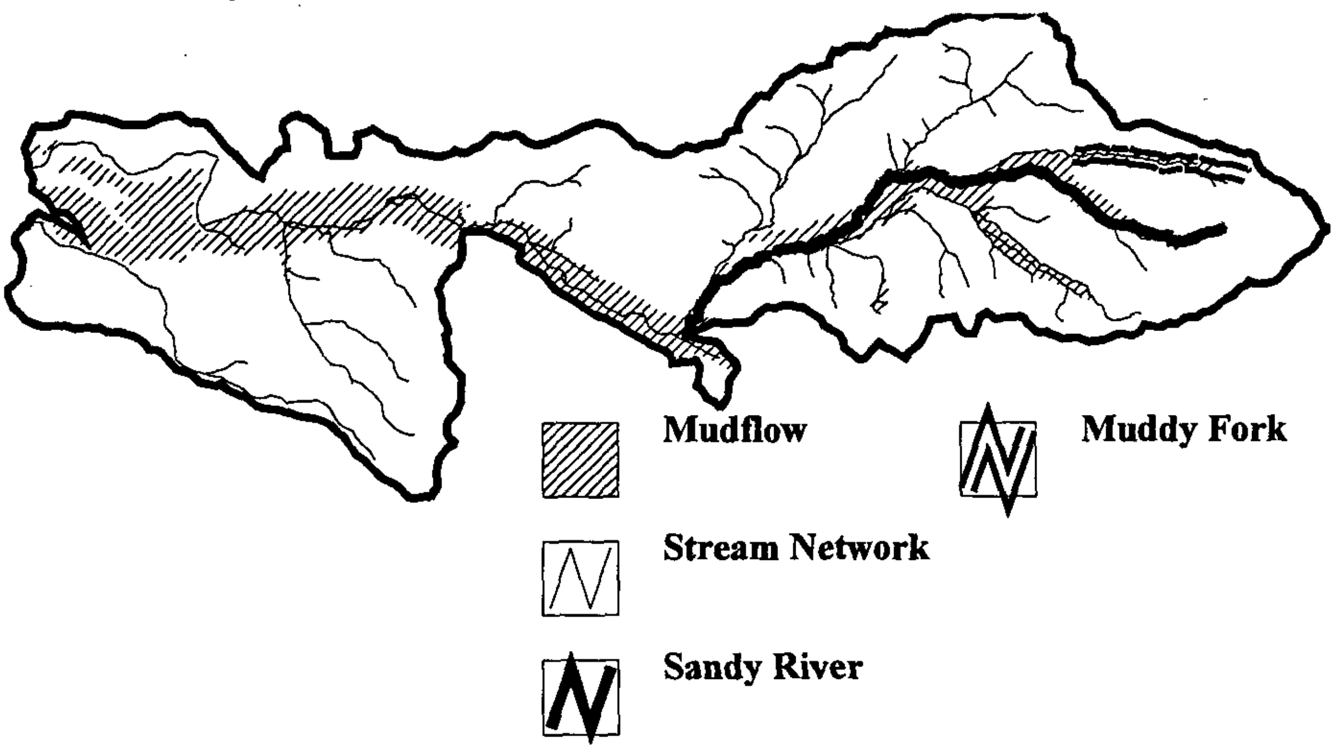


Figure 4-47 Mudflow Deposits and the Sandy River

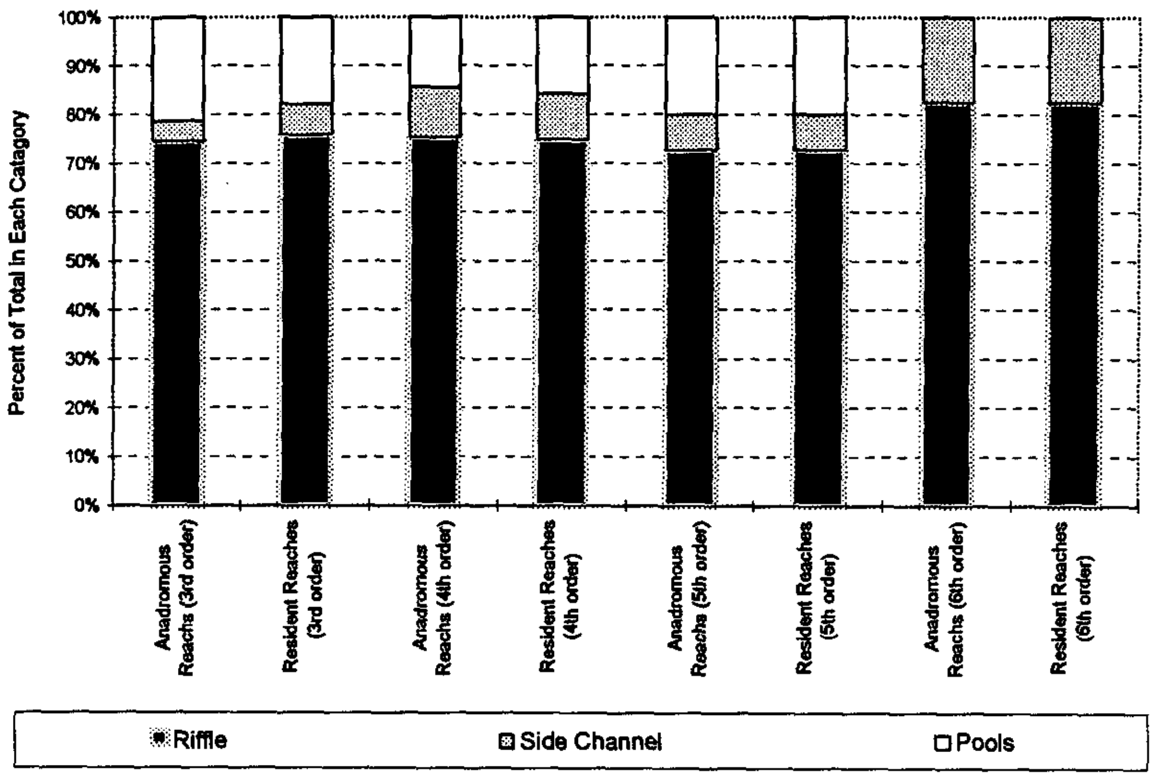


Aquatic habitat types on Clear Fork and Clear Creek are different between the earlier surveys and the surveys in 1993. This in not necessarily an indication change with in the streams . Pool definitions changed with the stream survey protocol in the early 1990's.

Fir Creek is an unmanaged basin within the adjacent Bull Run Watershed and is an indication of the undisturbed condition for a fourth order stream. Fir Creek has 69% of the stream length in riffles, 15% in pools, and 13% in side channels.. Similar conditions would be expected in Alder Creek, Cedar Creek, Clear Creek, Clear Fork and North Boulder Creek due to similar stream orders and vegetation types. Similar distributions of habitat types are seen all these streams.

Aquatic Habitat Types and Fish Stocks

Chart 4-52 Aquatic Habitat and Fish Stocks



For this assessment areas stream reaches that support resident fish overlap and include those that support anadromous fish. Third, forth and fifth order streams within the watershed that support anadromous and resident fish approximate the mix of habitat types in Fir Creek. Sixth order streams have no pool habitat within anadromous or resident reaches. This indicates limited habitat for chinook salmon which utilize mainstem pools.

Pool Levels

Pools provide resting habitat for adult salmonids on their spawning migrations, baseflow thermal refugia, protective cover, and slow water rearing and overwintering habitat for juvenile steelhead and salmon, resident fishes, and amphibians. The habitat capability of individual pools increases with depth, volume, substrate complexity, and large woody debris for cover and habitat partitioning.

The natural range of pool frequencies is highly variable and dependent on gradient, confinement, and stream width. Habitat complexity and the number of pools per mile increases with decreasing stream order and width.

Pool levels were calculated from queries of the SMART database. The assessment was completed to compare pool quantity to the range of natural variation, and the Columbia River Basin Policy and Implementation Guide/Salmon Summit (PIG) standards.

Chart 4-53 Pool Levels Upper Sandy Watershed

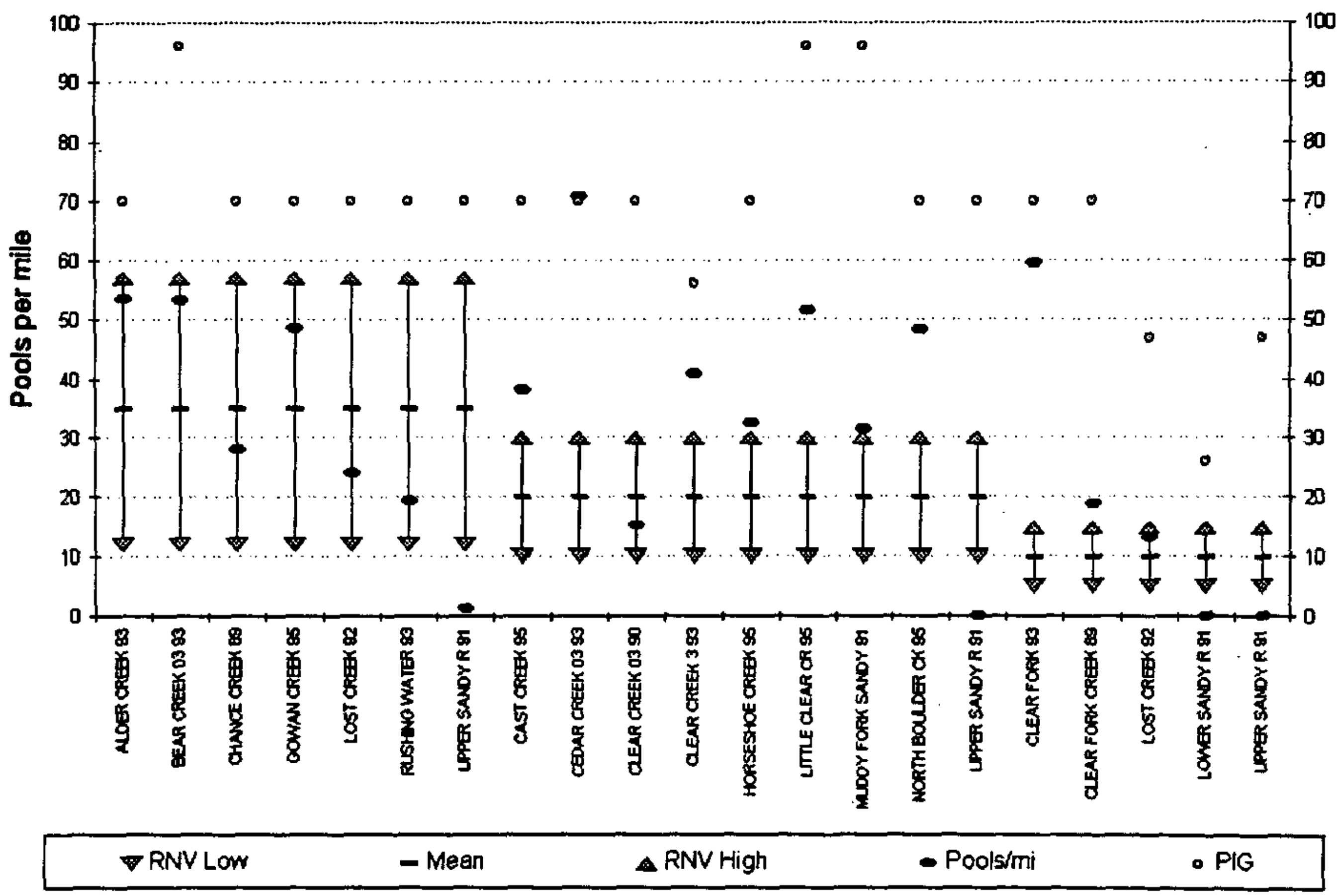
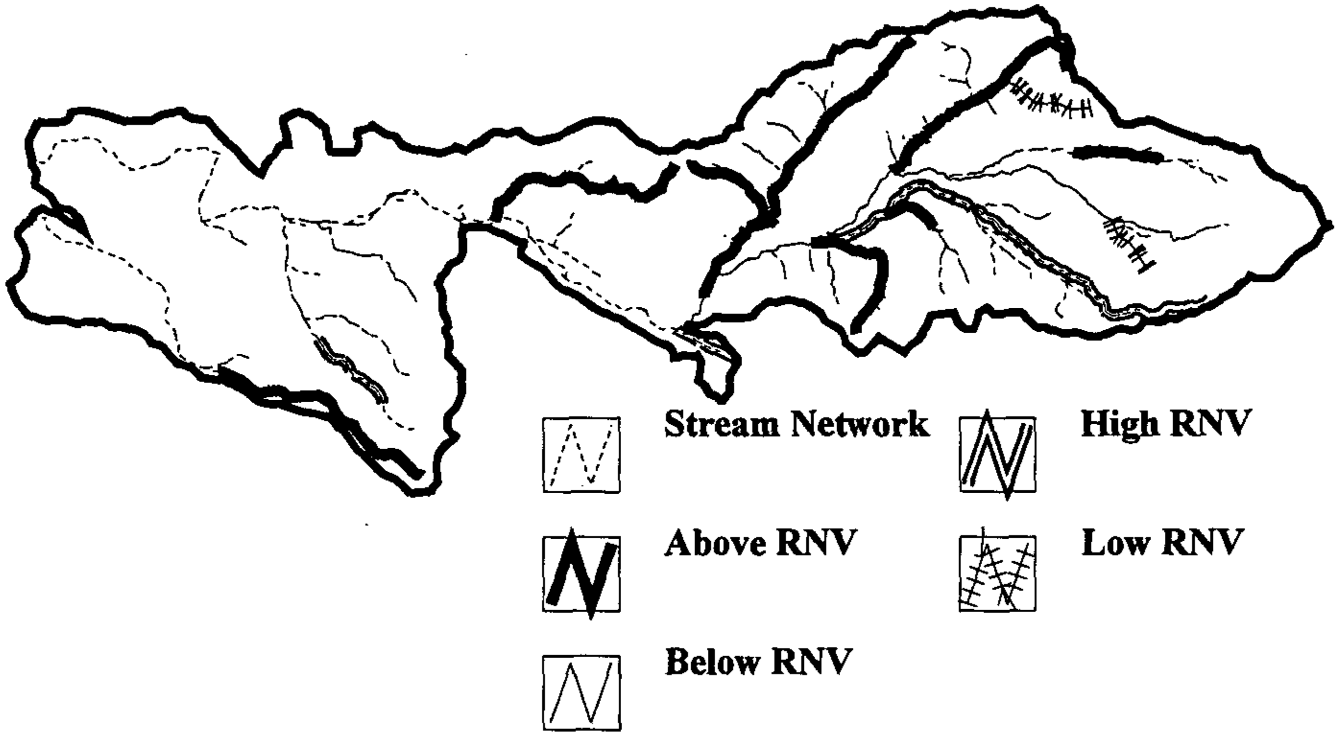


Table 4-43 Pools per mile

Stream	Pools/mi	PIG Standard
Alder Creek 93	54	70
Bear Creek 03 93	53	96
Chance Creek 89	28	70
Gowan Creek 95	49	70
Lost Creek 92	24	70
Rushing Water 93	19	70
Upper Sandy R 91	1	70
Cast Creek 95	38	70
Cedar Creek 03 93	71	70
Clear Creek 03 90	15	70
Clear Creek 3 93	41	56
Horseshoe Creek 95	33	70
Little Clear Cr 95	52	96
Muddy Fork Sandy 91	32	96
North Boulder Ck 95	48	70
Upper Sandy R 91	0	70
Clear Fork 93	60	70
Clear Fork Creek 89	19	70
Lost Creek 92	13	47
Lower Sandy R 91	0	26
Upper Sandy R 91	0	47

Figure 4-48 Pool Levels



One stream surveyed within the watershed meets the PIG standards (Cedar Creek) and many of the streams are outside and above the RNV (Cast Creek, Cedar Creek, Clear Creek, Horseshoe Creek, Little Clear Creek, and North Boulder Creek).

The streams that are at the low end of the RNV (or outside the RNV) are the upper and lower Sandy River. Since a large portion of the Sandy River is in the Mt. Hood Wilderness and the Upper Sandy Wild and Scenic River Corridor this may be the natural condition for this section of the river. This portion of the Sandy River is also flowing through mudflow deposits will little opportunity for pool formation.

Pool Volumes

The relationship between pool levels and pool volume (which was determined in the same manner as pool levels) was examined to determine if the number of pools was well correlated with the pool quality as expressed by pool volume.

Chart 4-54 Pool Volume Surveyed Streams

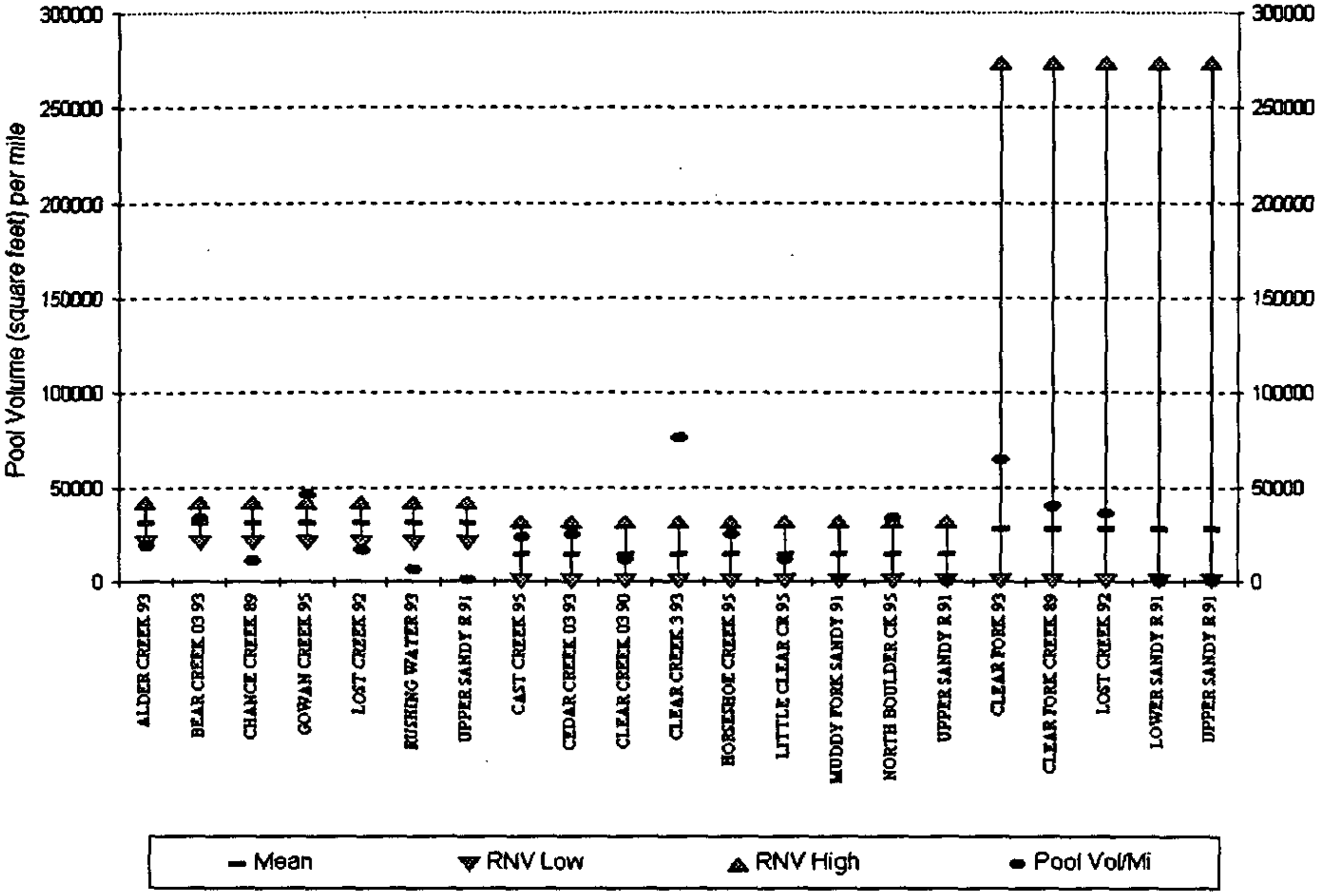
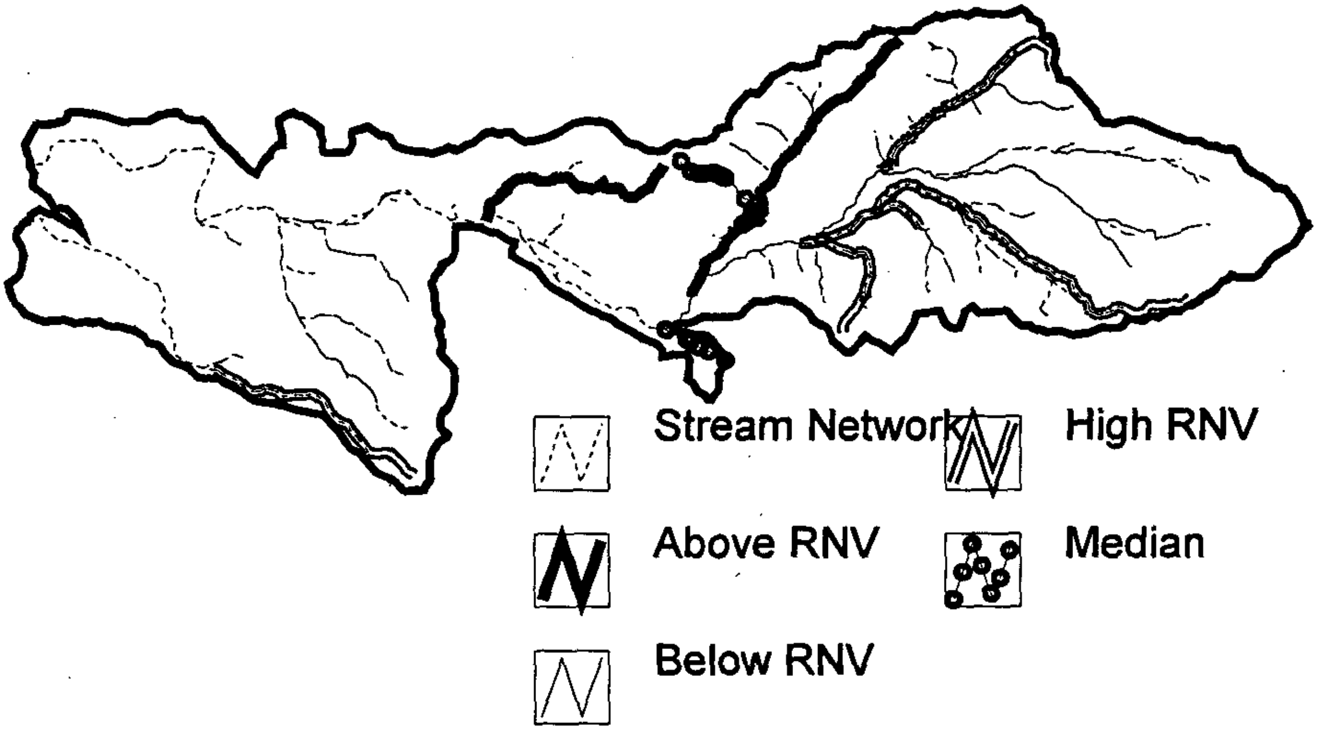


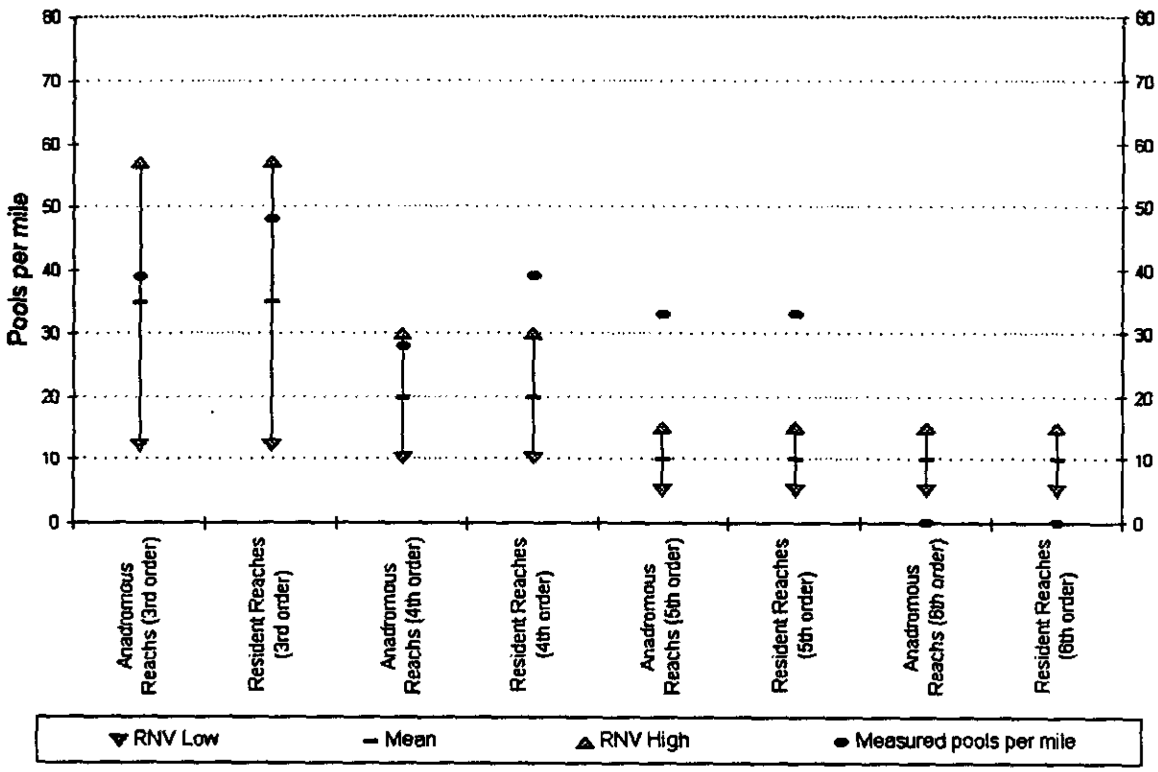
Figure 4-49 Pool Volumes



Comparison of pool levels and pool volume found high pool quality habitat (pool levels above the mid range of the RNV and pool volume above the mid range of the RNV) in: Bear Creek, Gowan Creek, Cast Creek, Cedar Creek, Clear Creek, Horeseshoe Creek, Little Clear Creek, North Boulder Creek, Clear Fork, and Lost Creek. Clear Creek and Clear Fork are outside and above the RNV for both pool numbers and pool volume. The Muddy Fork has pool numbers at the high end of the RNV and pool volume at the low end of the RNV indicating small lower quality pools.

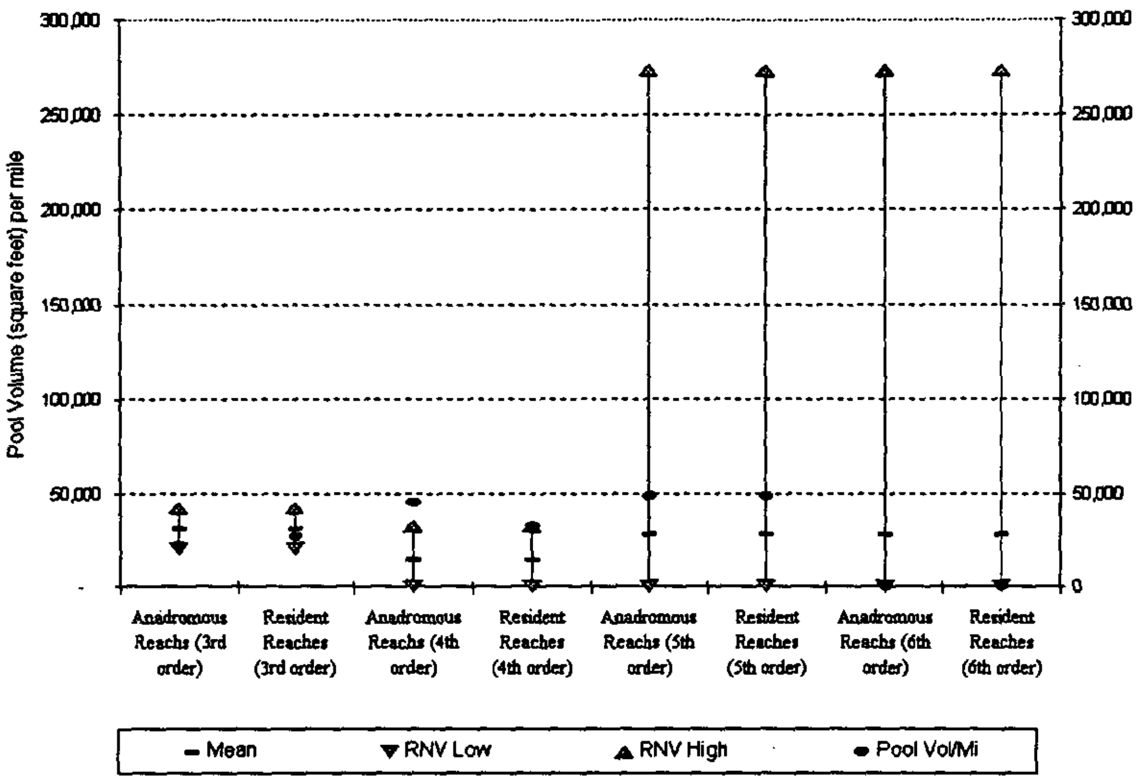
Pools and Fish Stocks

Chart 4-55 Pools and Fish Stocks



Pool levels in stream reaches that are utilized by anadromous and resident fish are at the upper end of the RNV for third, forth and fifth order streams. Sixth order streams are outside and below the RNV for pool levels.

Chart 4-56 Pool Volume and Fish Stocks



Pool volumes in stream reaches that are utilized by anadromous and resident fish are within the range of natural variation for all stream orders, however, third order streams are at the low end of the RNV and sixth order streams have no pool volume.

Both pool levels and pool volumes are indicating very limited pool habitat in sixth order streams (upper and lower Sandy River). As previously discussed this may be the natural condition of this area due to this being an area undisturbed by management activity. Low pool levels and pool volumes are attributed to the mudflow deposits that the stream is flowing through.

Pool levels and pool volumes are within and for the most part at the upper end of the RNV for third, forth, and fifth order streams in stream reaches utilized by both anadromous and resident fisheries.

This lack of pools in the larger streams indicates limited habitat for chinook salmon that utilize mainstem pools. The levels of pools in smaller streams would indicate good pool habitat for coho salmon, steelhead, rainbow trout, and cutthroat trout.

In-Channel Large Woody Debris

Large woody debris (LWD) provides: pool structure, sediment storage, substrate, partitioning of space, cover, nutrients, channel roughness, and velocity refuge for aquatic plants, fish, macroinvertebrates, and amphibians.

The current levels of large wood were queried from the SMART database. Large woody debris (LWD) has a diameter of 36 inches or greater, and length of 50 feet or greater. The RNV was established for the Sandy Basin by examining levels of LWD in unmanaged stream reaches stratified by stream order. In the same manner as pool counts and pool volume the RNV was established as the median plus and minus one standard deviation to eliminate outliers and keep the RNV from being too wide.

Chart 4-57 LWD Current Condition and RNV

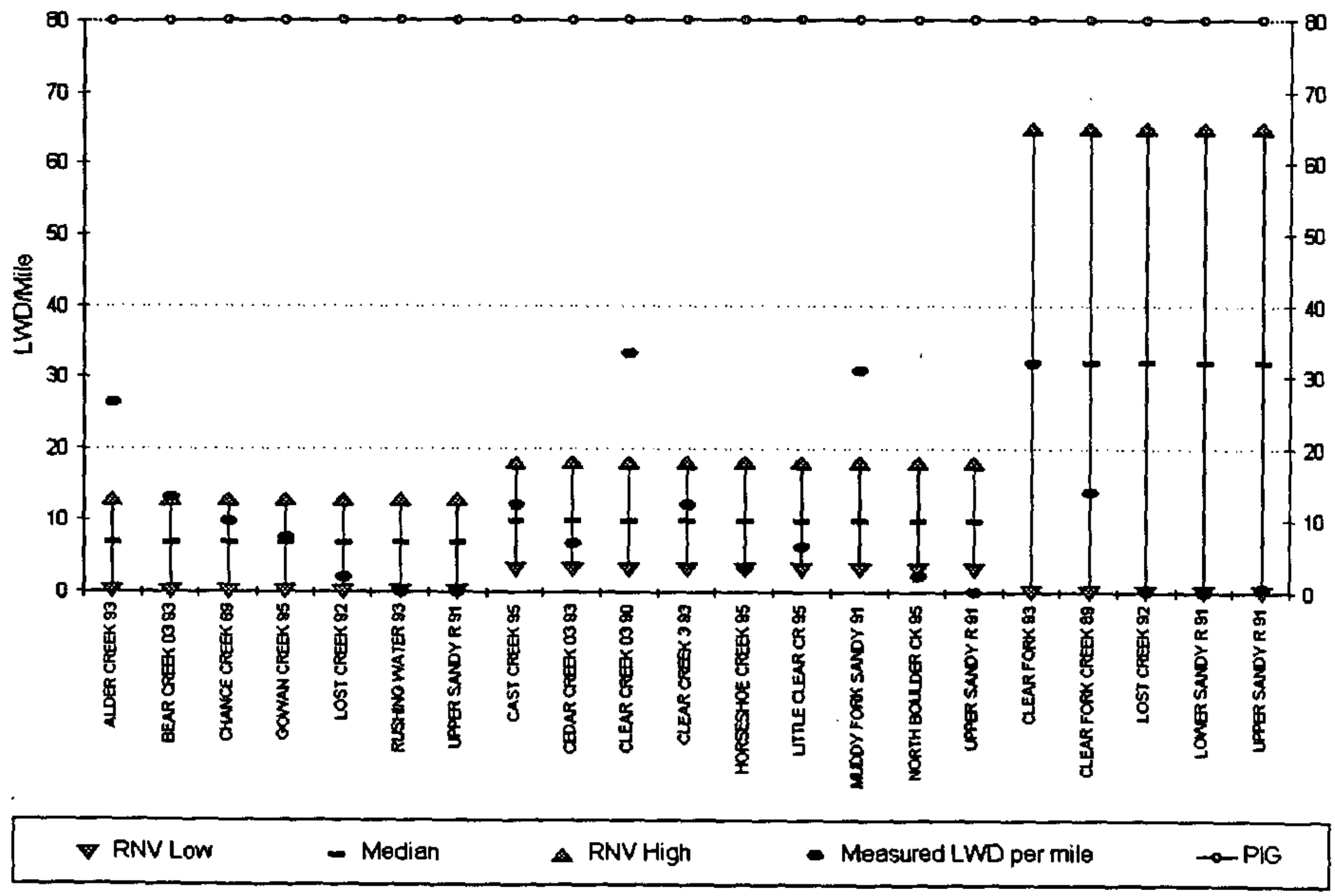


Figure 4-50 Large Woody Debris

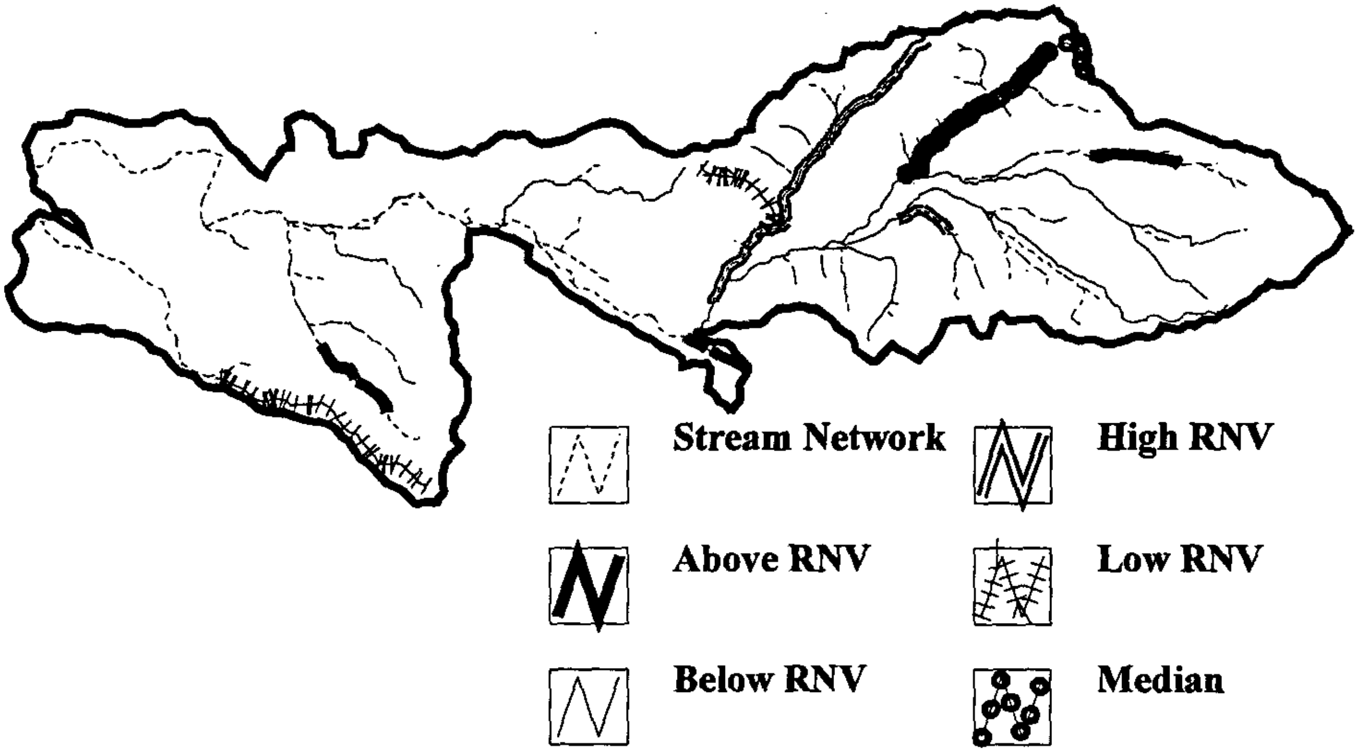


Chart 4-57 indicates none of the surveyed streams within the watershed meet the PIG standards. Alder Creek and the Muddy Fork are outside and above the RNV (Clear Creek was not included because the latest survey does not indicate LWD levels above the RNV). Most of the surveyed streams within the watershed are well within the RNV for similar stream orders, however, there are a number of streams at the low end of the RNV or below the RNV including Lost Creek, Rushing Water Creek, North Boulder, and Upper and Lower Sandy River.

Many of the streams at the low end of the RNV are within the Pacific Silver Fir Zone. When the PIG standard 80 pieces per mile was compared to Pacific Silver Fir Zone stands within the adjacent Zigzag Watershed, the average was determined to be approximately 1.5 pieces of large woody debris per mile (pers comm, Jeff Reis). Stands within the Pacific Silver Fir Zone of this watershed may not be able to generate trees with a diameter of 36 inches, so small woody debris (>=24" diameter and >=50' long) was added to large woody debris and compared to the RNV for unmanaged streams within the Sandy Basin. In the upper elevations of this watershed trees with a diameter of 36 inches may not have been available historically, so debris with a diameter of 24-36" may provide the same function as larger wood in this system.

Chart 4-58 LWD Current Condition and RNV

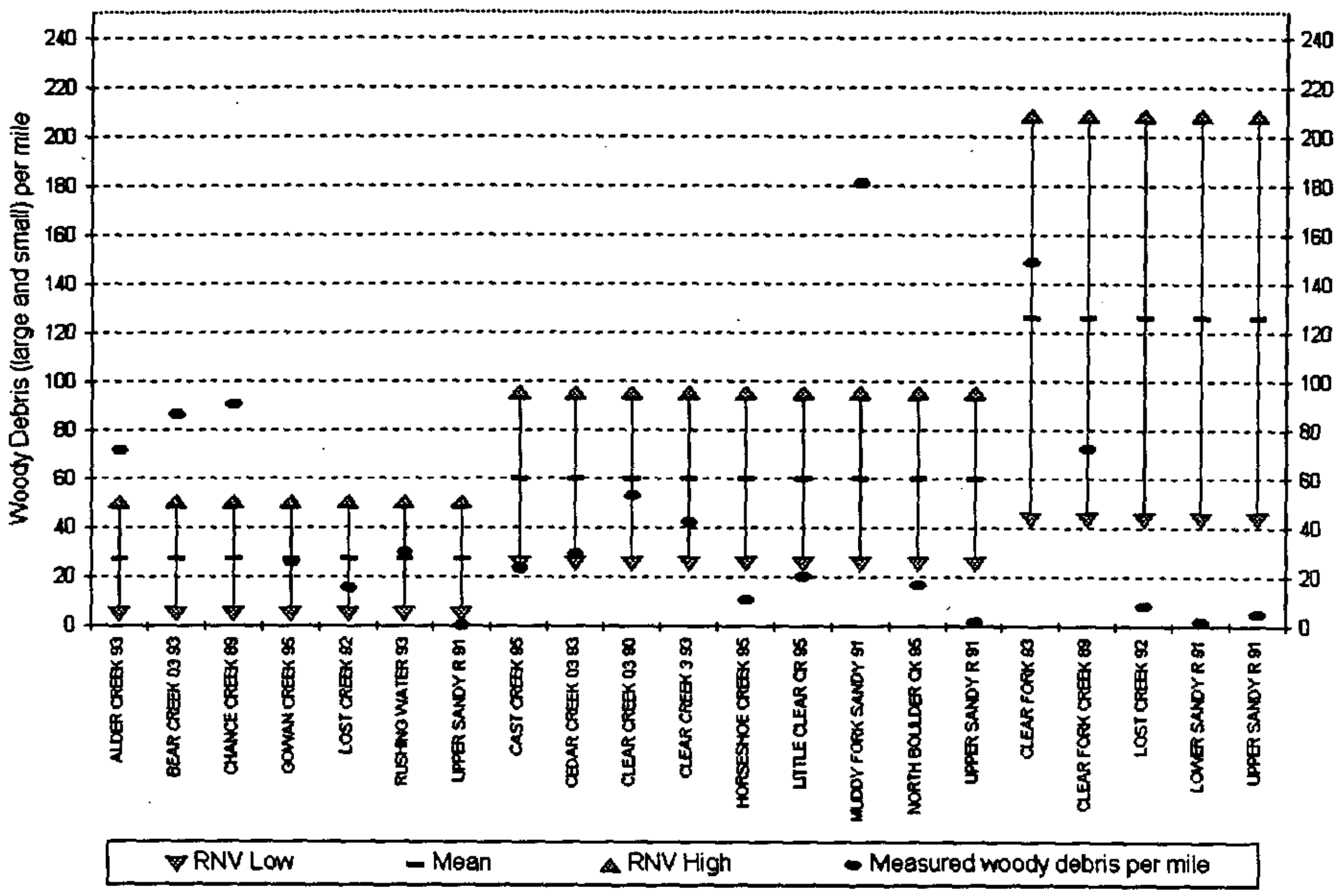
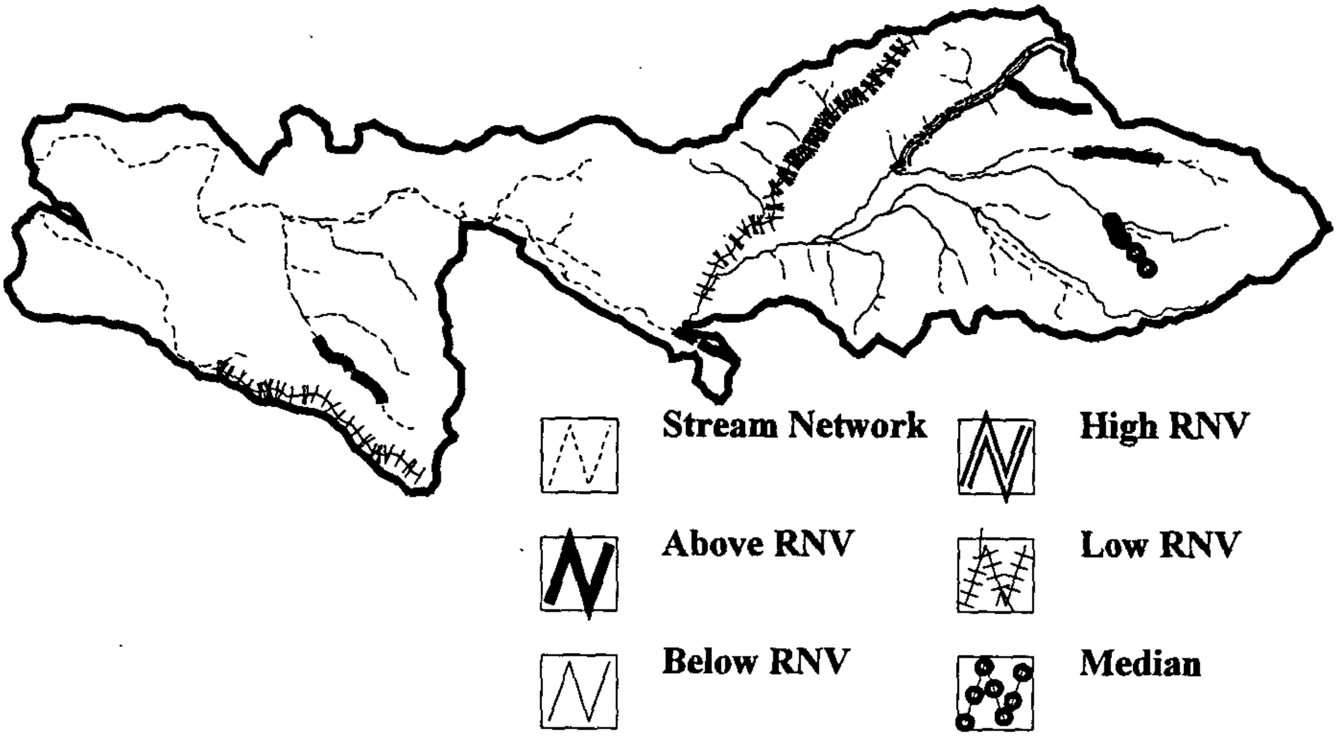


Figure 4-51 All Woody Debris



The addition of small woody debris to large woody debris moves woody debris levels within Lost Creek and Rushing Water Creek well into the RNV. North Boulder, and Upper and Lower Sandy River still have very low levels of woody debris. Again this may be the natural condition within the Sandy River due to the unmanaged conditions within this area and the stand conditions within the mudflow deposits (this will be assessed in the large woody debris recruitment section).

Fish Stock Concerns

Chart 4-59 LWD and Fish Stocks

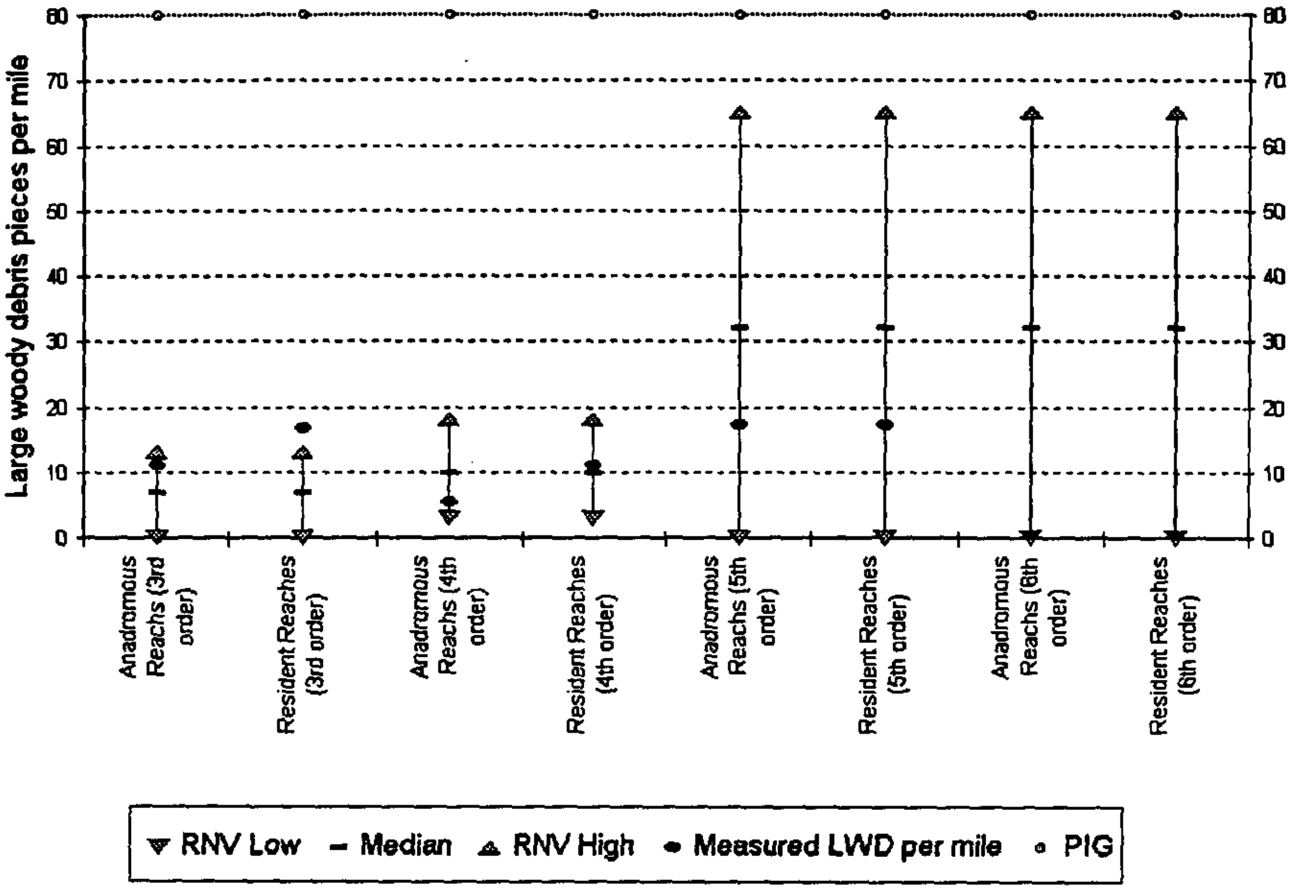
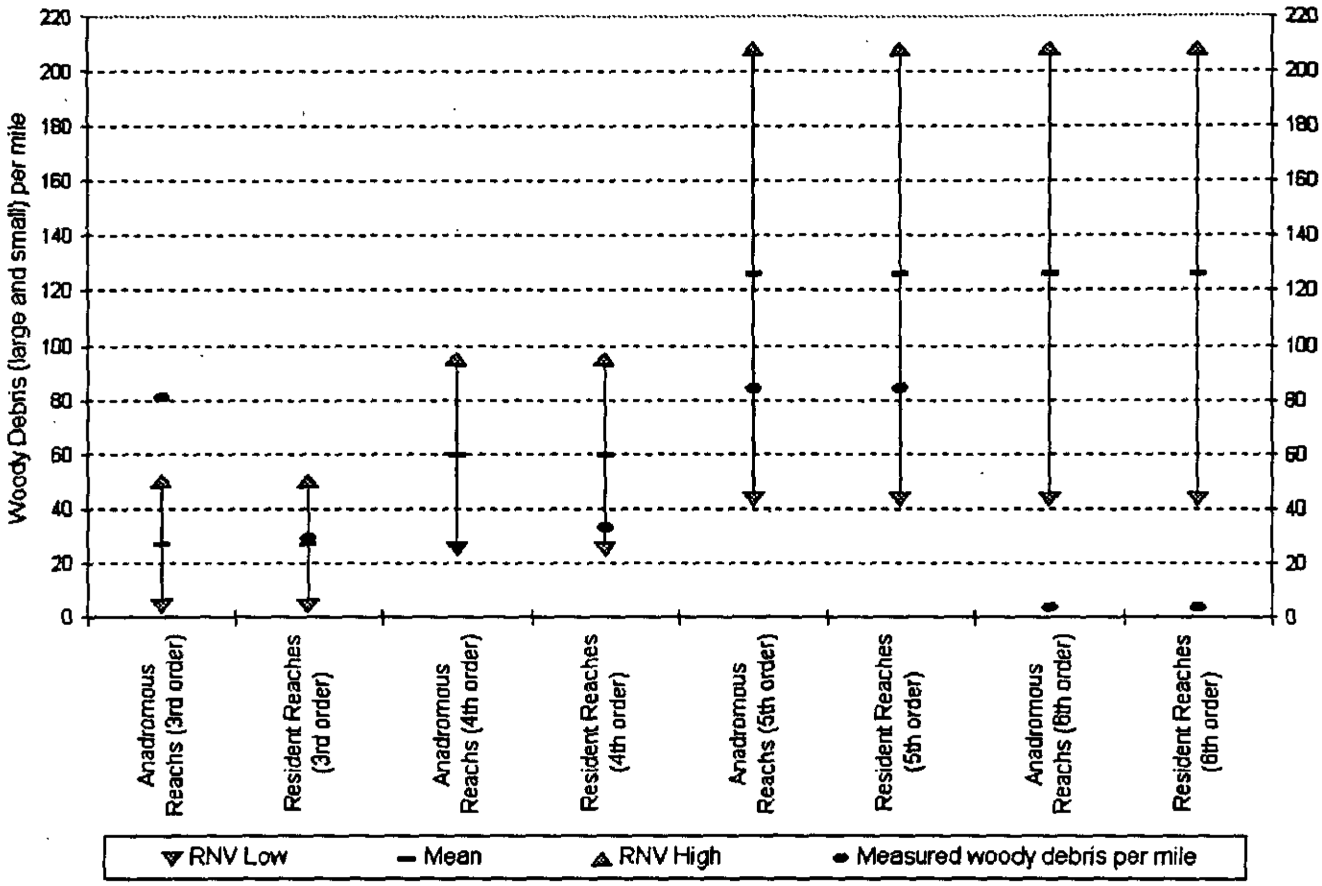


Chart 4-60 Large and Small Woody Debris and Fish Stocks



LWD and all woody debris levels in the stream reaches utilized by anadromous fish vary by stream order. Woody debris levels within third order streams are at the upper end if the RNV. Within forth order streams woody debris levels are at the mid to low range of the RNV. Fifth order stream have woody debris levels at the low end of the RNV, and sixth order streams have woody debris levels outside and below the RNV. The distribution of large woody debris by stream order would indicate limited habitat for chinook salmon that unitize mainstem pools. Habitat conditions appear within the RNV for coho salmon and steelhead which utilize the lower order streams.

Levels of LWD and all woody debris within resident reaches have a similar distribution to those for anadromous fish. The lower order streams are within or above the RNV and the sixth order streams are below the RNV. The cutthroat and rainbow trout within this watershed should be able to utilize the smaller order streams indicating woody debris levels within the RNV.

LWD Recruitment Potential

To assess the trend in in-channel LWD, the LWD recruitment potential of Riparian Reserves was assessed using the methodology from the DNR Standard Methodology for Watershed Analysis. LWD recruitment potential was rated as high, moderate, or low based on the following matrix:

Dominant Tree Type	Young/ Sparse	Young/Dense	Mature/ Sparse	Mature/ Dense	Old/Sparse	Old/Dense
Conifer	Low	Moderate	Moderate	Moderate	Moderate	High
Deciduous	Low	Low	Low	Moderate	Low	Moderate

"Young" is defined as seedlings, saplings and poles; "Mature" is closed small conifer, closed variable structure, open small conifer and open variable structure; and "Old" is open and closed large conifer. "Sparse" is less than 70% canopy closure.

Chart 4-61 – Distribution of LWD Recruitment Potential Classes

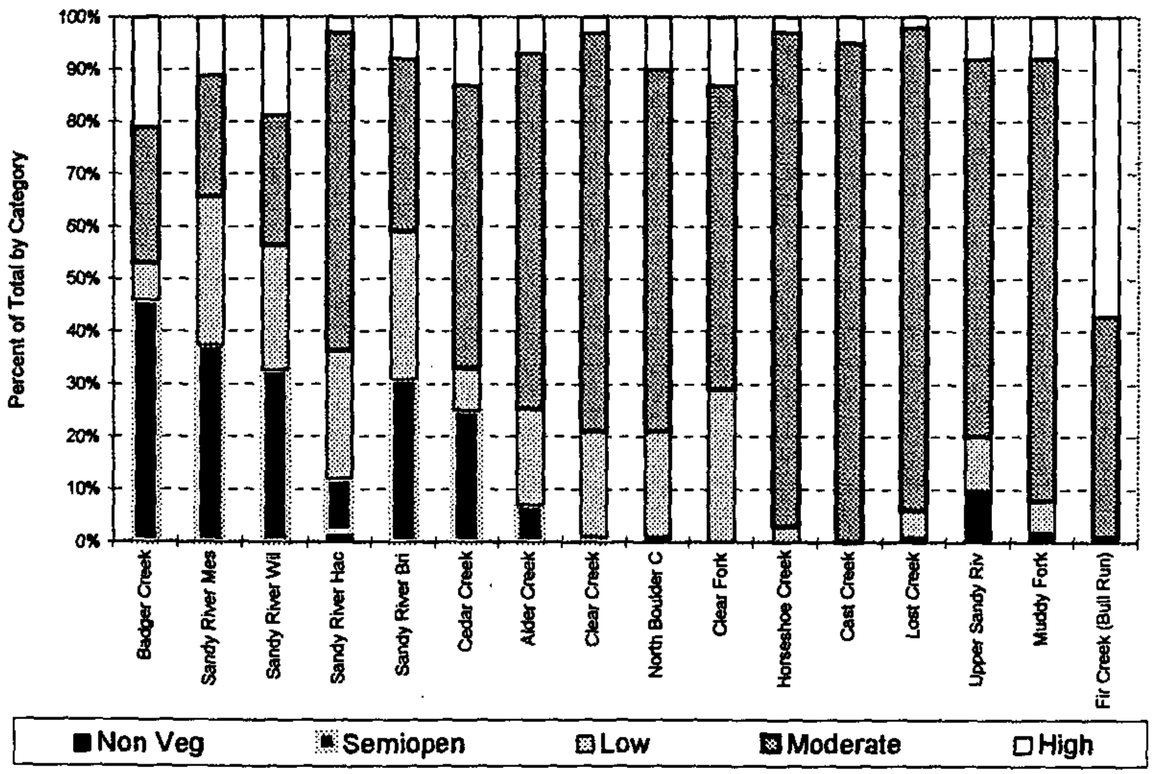
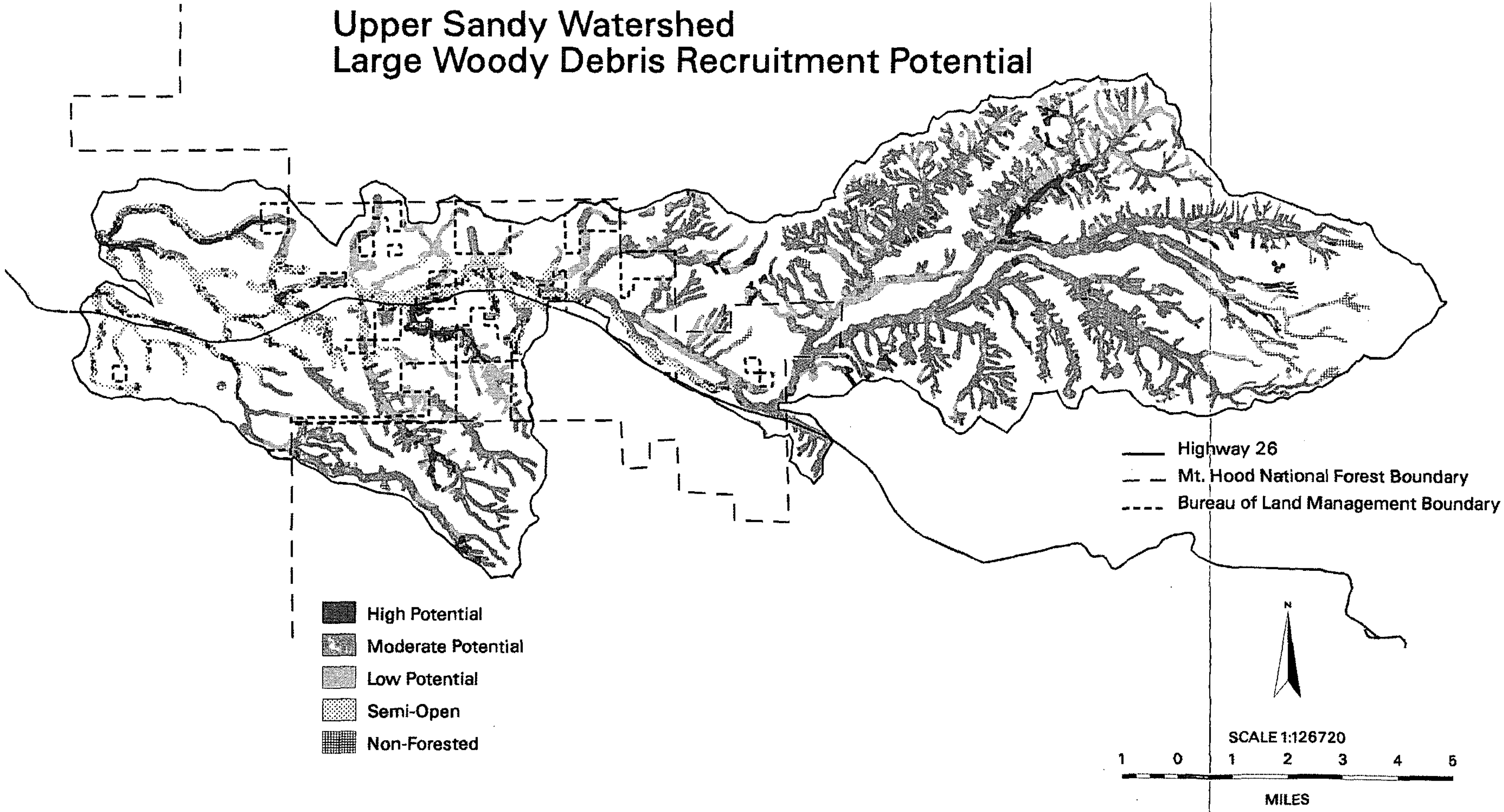


Table 4-44 Large Woody Debris Recruitment Potential (Percent of Area in Riparian Areas)

Subwatershed	Non Veg	Semiopen	Low	Moderate	High
Badger Creek	0	46	7	26	21
Sandy River Mensinger	0	37	28	23	11
Sandy River Wildcat	0	33	24	25	19
Sandy River Hackett	2	10	24	60	3
Sandy River Brightwood	0	31	28	33	8
Cedar Creek	0	25	8	54	13
Alder Creek	0	7	18	67	7
Clear Creek	0	1	20	76	3
North Boulder C	1	0	20	69	10
Clear Fork	0	0	29	58	13
Horseshoe Creek	0	0	3	94	3
Cast Creek	0	0	0	95	5
Lost Creek	1	0	5	91	2
Upper Sandy Riv	10	0	10	72	8
Muddy Fork	2	0	6	85	8
Fir Creek (Bull Run)	1	0	0	57	42


Upper Sandy Watershed
Large Woody Debris Recruitment Potential
High Potential
Moderate Potential
Low Potential
Semi-Open
Non-Forested
Highway 26
Mt. Hood National Forest Boundary
Bureau of Land Management Boundary
N
SCALE 1:126720
1 0 1 2 3 4 5
MILES

Classes used to classify large wood for the large woody debris recruitment potential are different than those for in-channel large woody debris. The high large woody debris recruitment potential class requires the stand to be over 21" diameter, -- while in-channel large woody debris requirement is 36" diameter and 50' long.

Fir Creek, the unmanaged control subwatershed in the Bull Run Watershed, has 57% of the riparian reserves in the high LWD recruitment class. This condition reflects the undisturbed or natural condition for an adjacent watershed in the Western Hemlock Zone. The majority of Alder Creek, Badger Creek, Cedar Creek, Clear Creek, Clear Fork, North Boulder and the lower Sandy river subwatersheds (Sandy River Brightwood, Sandy River Hackett, Sandy River Wildcat and Sandy River Mensinger) are in the western hemlock zone. The percentage of area in the high LWD recruitment class within these subwatersheds varies from 3 to 21%. This is considerably lower than the undisturbed condition reflected by Fir Creek subwatershed and indicates impacts associated with land management activities or natural disturbances in this area.

Subwatersheds within the upper portion of the watershed (Horeseshoe Creek, Cast Creek, Lost Creek, Upper Sandy, and Muddy Fork) are in areas that may not support stands that will grow trees over 21 inches and therefore may not have much area in the high large woody debris recruitment potential class. The majority of area in these subwatersheds are in land management allocations that preclude scheduled timber harvest (Wilderness and Wild and Scenic River) so conditions within these subwatersheds are most likely due to natural conditions.

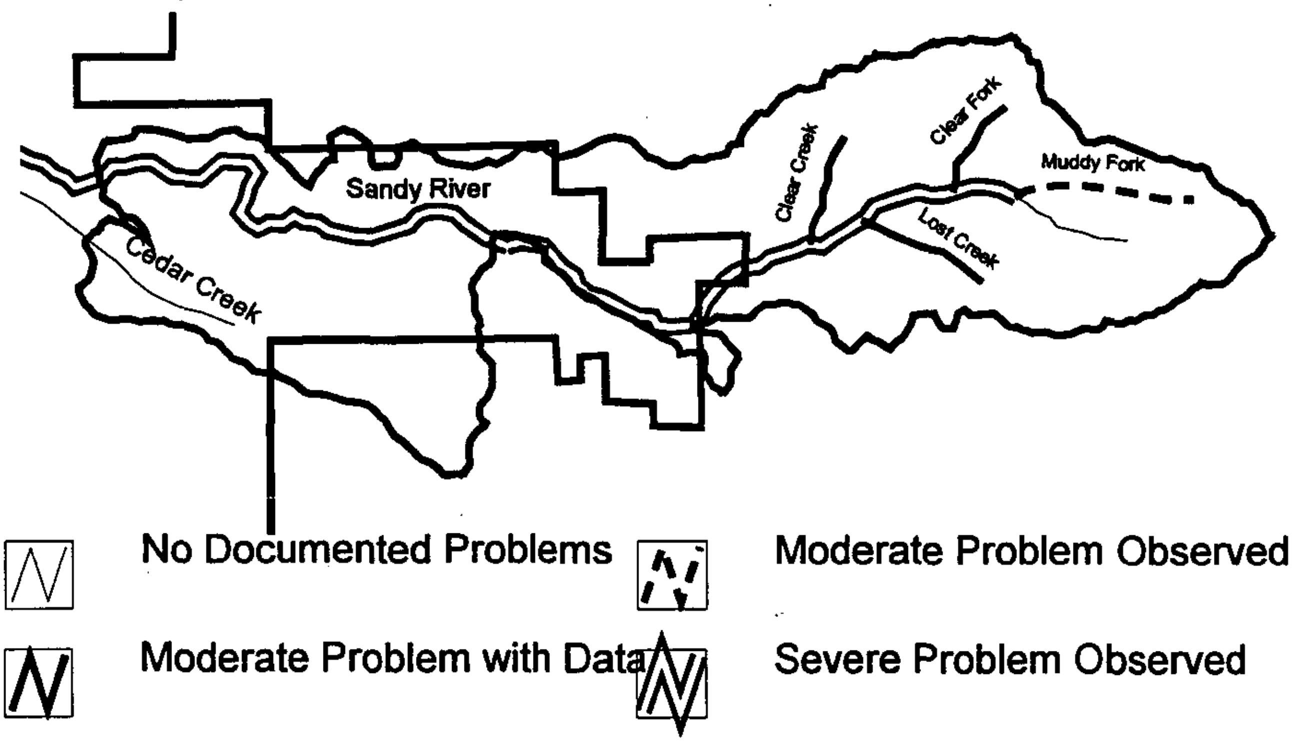
For the most part stream reaches within the western hemlock zone have levels of in-channel large woody debris that are within the range of natural variation. In the short term it appears there will be limited recruitment of additional large woody debris. In the upper watershed currently large woody debris levels are low and it appears that levels may stay that way due to limited opportunity for large woody debris recruitment.

Stream Structure 1988 DEQ Assessment

Stream structure was assessed as part of the 1988 DEQ nonpoint source assessment. Insufficient stream structure is defined as the inadequacy of one or more physical components of a stream (streambank, boulders, woody debris, pools, riffles, etc.) which reduces channel stability, habitat, or flow regulating characteristics of a stream. Insufficient stream structure can be detrimental to fish life and other beneficial uses of the water (1988 DEQ nonpoint source assessment).

Stream structure problems were identified as moderate or severe. Moderate problems interfere with the desired uses of the water body and with the life history or composition of aquatic populations. Severe problems cause substantial or nearly complete interference with the beneficial uses or opportunities to use the water (1988 DEQ nonpoint source assessment).

Figure 4-53 Stream Structure 1988 DEQ Nonpoint Assessment



In areas where stream survey data is available that data would be more reliable than the DEQ assessment because it quantifies critical habitat components and is more recent, however where no stream survey data is available the DEQ assessment gives and indication of habitat conditions. The Sandy River from the confluence with the Muddy Fork to the western extent of the watershed is classified with severe problems. This stream survey data from the Sandy River indicates similar habitat conditions. This would indicate limited pools and large debris within the Sandy River. These habitat conditions would indicate very limited habit for chinook salmon which utilize mainstem pools.

Seral Stage Distribution Riparian Reserves

Riparian vegetation serves an important function in a number of processes

- Riparian vegetation regulates the exchange of nutrients and material from upland forests to streams (Swanson et al. 1982b; Gregory et al. 1991).
- Riparian zone-stream interactions are a major determinant of large woody debris loading (House and Boehne 1987; Bisson et al. 1987; Sullivan et al. 1987).
- Stream temperatures and light levels that influence ecological processes are moderated by riparian vegetation (Agee 1988; Gregory et al. 1991).
- Root systems in streambanks of the active channel stabilize banks, allow development and maintenance of undercut banks, and protect banks during large storm flows (Sedell and Beschta 1991).
- Riparian vegetation contributes leaves, twigs, and other forms of fine litter that are an important component of the aquatic ecosystem food base (Vannote et al. 1980).
- Riparian areas are widely considered to be important wildlife habitat. A distinct microclimate is maintained along stream channels, created by cold air drainage and the presence of turbulent surface waters. Large wood on the ground is an important habitat component in riparian areas. Maintaining the integrity of the vegetation is particularly important for riparian-dependent organisms including amphibians, arthropods, mammals, birds, and bats (FEMAT).
- Riparian areas are used as part of the MW Forest Plan's strategy to provide for a functional and interconnected old-growth forest ecosystem. They provide for greater connectivity of late-successional forests within and among LSR's for dispersal of mobile species, and serve as refugia for species that disperse short distances (ROD 5, 7, B-13)

The seral stage of the riparian areas across the entire watershed (all ownership's) was assessed because of it's implications with respect to stand structure and it's importance in the processes listed above.

Chart 4-62 Seral Stage in Riparian Areas

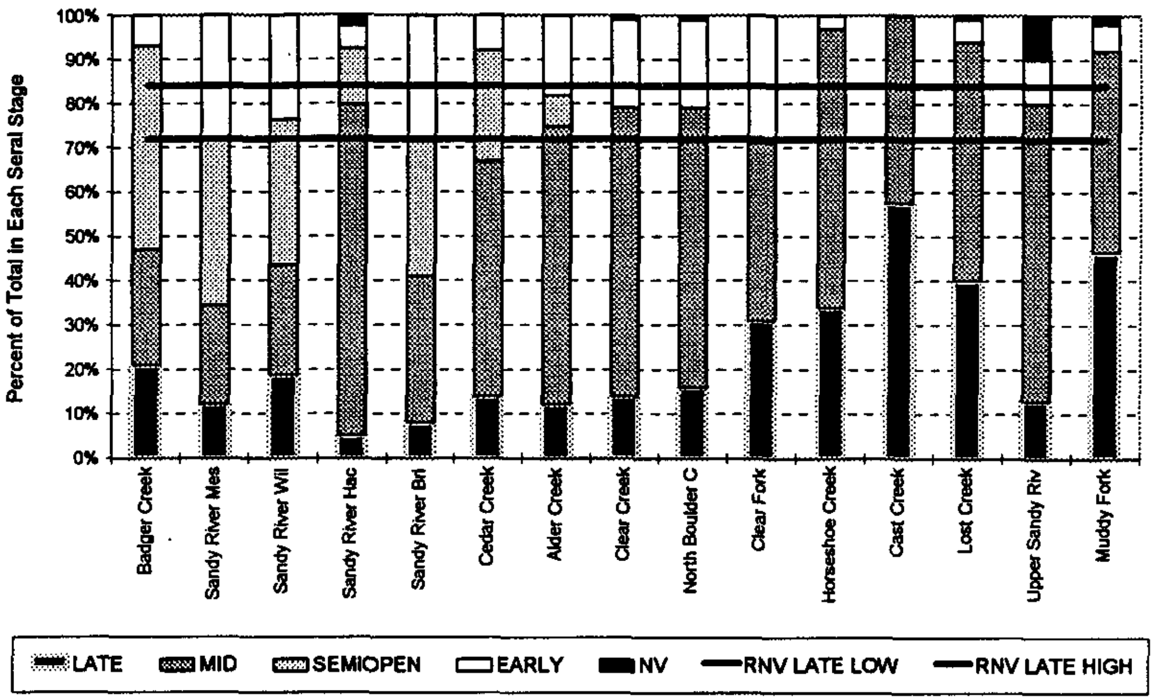


Table 4-45 Percent of Riparian Area in Late Seral Stands

Subwatershed	Percent of Late Seral[12]
Badger Creek	21
Sandy River Mensinger	12
Sandy River Wildcat	19
Sandy River Hackett	4
Sandy River Brightwood	8
Cedar Creek	14
Alder Creek	12
Clear Creek	14
North Boulder C	16
Clear Fork	31
Horseshoe Creek	34
Cast Creek	57
Lost Creek	40
Upper Sandy Riv	13
Muddy Fork	47
Entire Watershed	23

[12] RNV for late-seral stands is 72-84% of the area in the riparian reserves based on Bull Run data

Across the watershed riparian areas account for 36% of the land base. On federal lands, riparian areas are designated as Riparian Reserves. As Chart 4-62 and Table 4-45 detail none of the subwatersheds are within the RNV for late seral stand structure within the riparian areas. For the most part the Bull Run is in the Western Hemlock Zone so the RNV may not be appropriate for those subwatersheds outside that area (Horseshoe Creek, Cast Creek, Lost Creek, Upper Sandy, and Muddy Fork). These subwatersheds are in land management allocations that preclude scheduled timber harvest and appear not to have been influenced by management activities, so this may be the natural condition for these areas. Small stand size in these areas could be attributed to the small stands in the mudflow and recent fire history.

For fish bearing streams reaches on private lands that are subject to the State Forest Practices Act streamside vegetation would be expected to recover to approximate the natural condition. The goal of the streamside vegetation rule is to ensure that, over time, streamside areas within a watershed develop into mature age classes. Specifically, the goal is to grow and retain vegetation along streams so that, over time, average conditions across the landscape become similar to those of mature streamside stands.

Conclusions Fish Habitat

- In July there is a 69% reduction in flow (based on the monthly mean) in the Sandy River below Marmot Dam.
- Altered summer lowflows have the potential to dewater the lower section of Alder Creek
- Aquatic Habitat, pool levels, and large woody debris are within the RNV in 3-5 order streams. Sixth order streams lack any pool habitat and are very limited with respect to in-channel large woody debris
- The large woody debris recruitment potential is outside the undisturbed condition in the Western Hemlock Zone and limited due to stand size in the Pacific Silver Fir and Mt. Hemlock Zones.
- The 1988 DEQ nonpoint source assessment classifies the Sandy River with severe problems with stream structure.

Road Network

Road Construction History

Prior to the 1950's, the road network in the watershed was limited to what is now US Highway 26, and a few small secondary roads. Highway 26 serves the region as an important commercial and recreational travel route - connecting the Portland metropolitan area to central Oregon, as well as to recreational facilities around Mt. Hood. The highway currently receives extremely heavy use, particularly during summer and winter weekends.

Due to limited roads data for non-federal lands, the following section focuses on road construction on Forest Service lands within the watershed.

1950's

In the 1950's, Forest road 18 was built to facilitate construction of the Big Eddy / Troutdale transmission line from The Dalles dam. It also provided access to the Bull Run watershed. Forest road 18 is now a primary road within the watershed connecting Highway 26 to Hood River county. Currently, road 18 is one of the principle roads in the watershed carrying local watershed residents, and forest visitors to campgrounds, wilderness trailheads and other points of interest.

A great deal of road construction took place throughout the watershed in the 1950's, opening up road access to the Wildcat Creek / Wildcat Mountain, Alder Creek and other points in the watershed (see Figure 4-54). In the 1950's 48 miles of road were constructed in the watershed.

1960's

In the 1960's, the main road construction efforts were road 2609 up Cedar Creek, and secondary roads into Lost and Horseshoe creeks in the upper watershed. In all, there were 26 miles of Forest Service roads constructed in the Upper Sandy watershed in the 1960's.

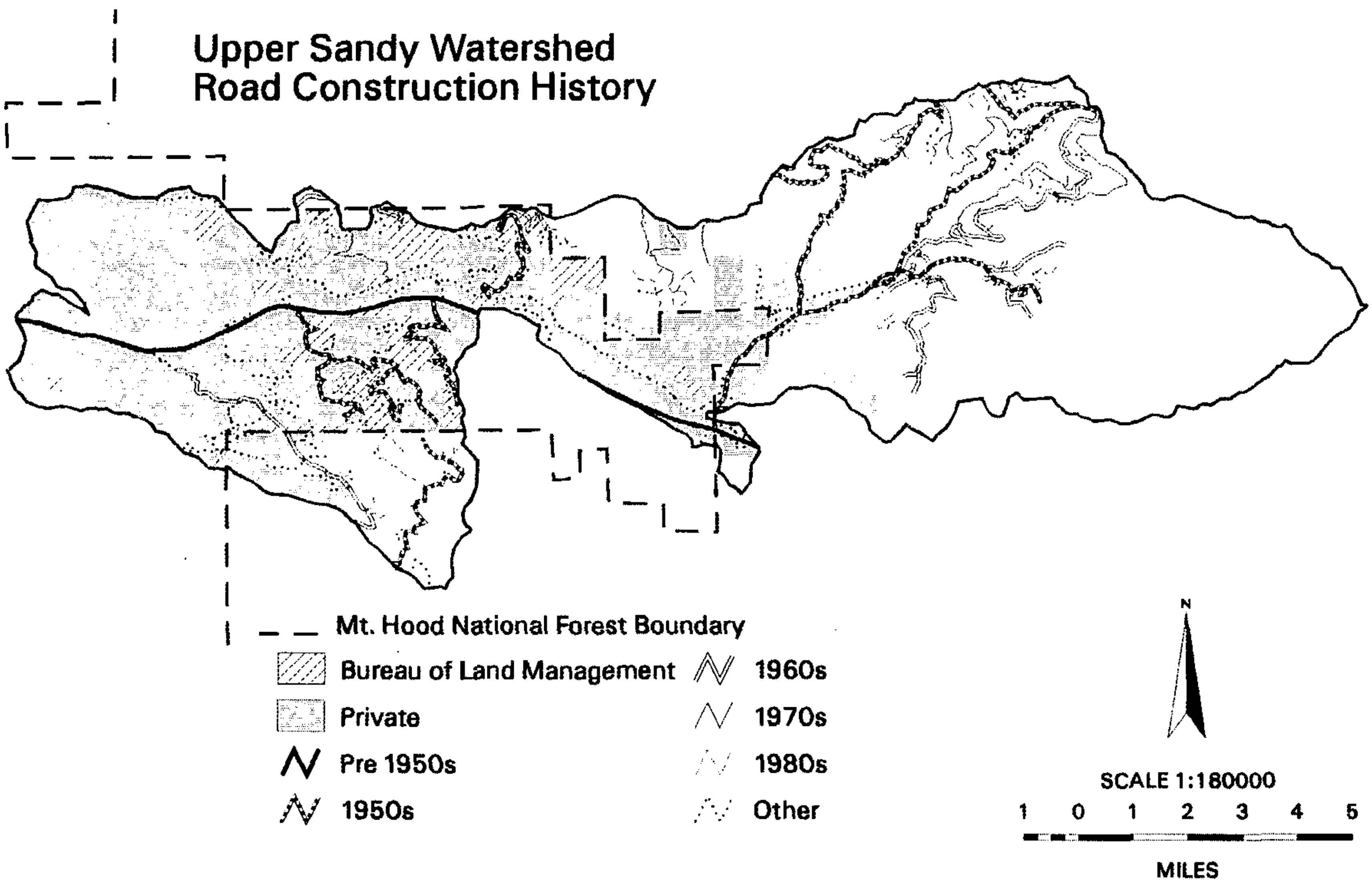
1970's

Road development in the 1970's continued with extensions of the previous network and expansion onto the midslopes of |the Clear Fork. By the end of the 1970's, an additional 25 miles of road were constructed in the watershed.

1980's

In the 1980's the road network was expanded into the North Mountain area, Cedar and Alder creeks, and Wildcat Mountain. Additional small spur roads were constructed during the 1980's throughout the watershed. In 1980 approximately 16 miles of road were constructed within the watershed.

Upper Sandy Watershed Road Construction History



Road Data Coverage

Data for the current road distribution within the watershed (see Figure 4-55) was taken from the USFS Transportation Management System (TMS) database and supplemented by BLM roads data. Roads in the TMS database include numbered Forest Service roads, roads inside of the forest boundary and roads outside of the forest boundary that provide access to forest lands.

The TMS data provides complete coverage in the eastern portion of the watershed where national forest lands predominate. Coverage is also fairly complete for the Alder and Wildcat areas within and adjacent to Forest Service lands.

BLM roads data was complete for most of the BLM ownership, with some apparent omissions in the northwest section of the watershed (T2S R5E sec 3 and T2S R6E sec 15).

Except for the areas covered by the TMS data, roads information on private lands in the watershed is extremely limited. In particular, the Cedar, Badger, and Sandy River Mensinger, Wildcat and Hackett subwatersheds lack complete road data.

Digital locations were not available for BPA powerline access roads in the watershed. These roads were installed during the 1950's for powerline maintenance and are steeply sloping, unsurfaced, poorly maintained and are scoured by surface erosion. Location information would facilitate restoration and maintenance planning.

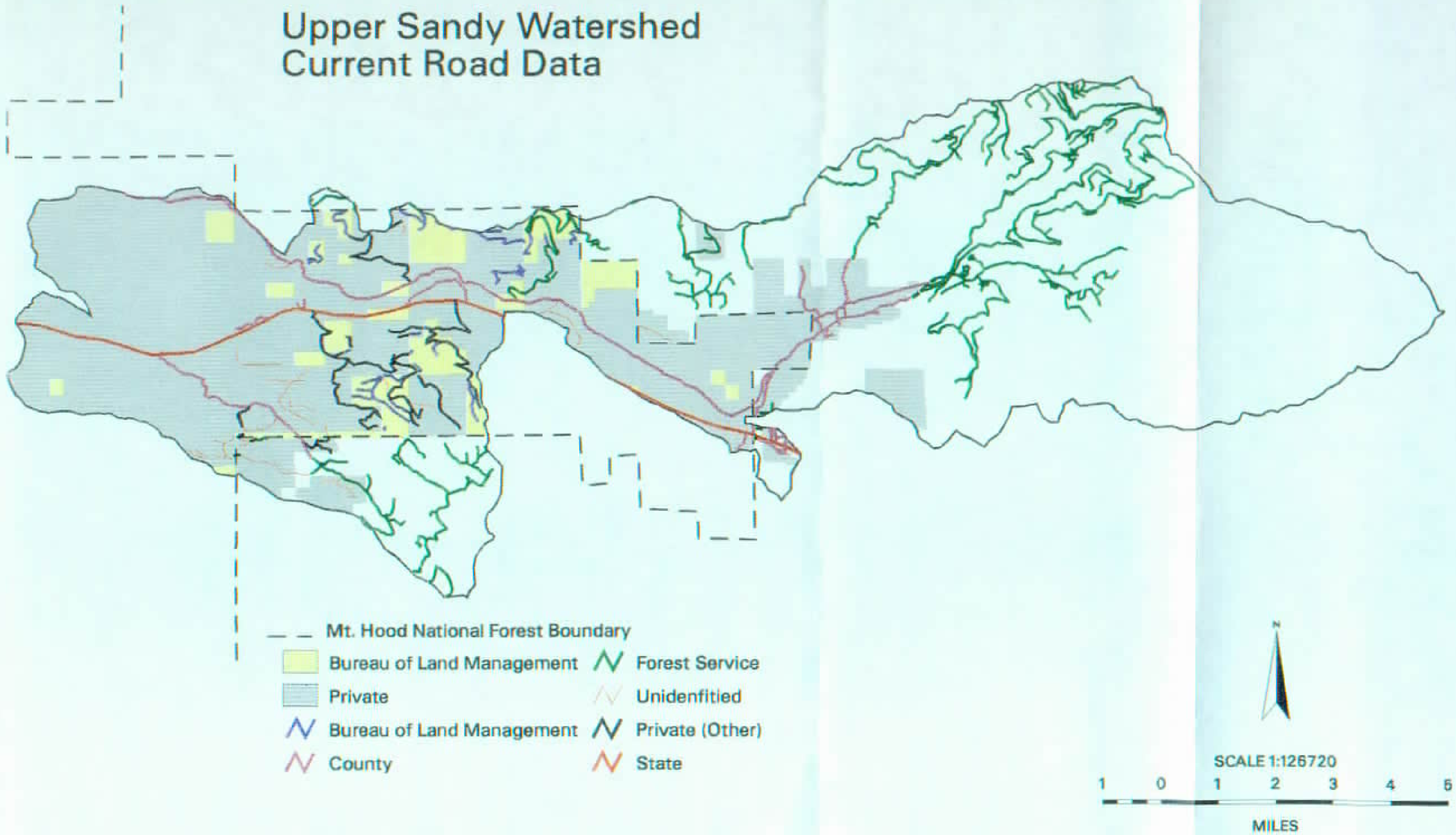
Throughout the Upper Sandy watershed analysis, evaluation of roads in the watershed was limited by the coverages described above. Road data was most complete for Federal lands (USFS and BLM) in the watershed. Some of the analysis modules utilizing road data include: calculating road densities, erosion rates, and stream drainage network expansion.

Current Road Network

From the existing coverages, there are over 190 miles of road within the watershed.

Table 4-46 Roads by Subwatershed -- Upper Sandy

SUBWATERSHED	TOTAL ROAD MILES	ROAD DENSITY (MILES / SQ. MILE)
Alder Creek	17.97	2.5
Badger Creek	6.11	0.8
Cast Creek	1.43	0.5
Cedar Creek	17.38	1.7
Clear Creek	22.02	1.9
Clear Fork	33.50	4.2
Horseshoe Creek	2.64	0.7
Lost Creek	8.21	0.9
Muddy Fork	.62	0.1
North Boulder Creek	6.06	1.9
Sandy River Brightwood	9.25	3.8
Sandy River Hackett	14.42	2.1
Sandy River Mensinger	13.63	1.9
Sandy River Wildcat	23.29	3.2
Upper Sandy River	15.38	1.4
ENTIRE WATERSHED	191.91	1.8


Upper Sandy Watershed
Current Road Data
Mt. Hood National Forest Boundary
Bureau of Land Management
Private
Bureau of Land Management
County
Forest Service
Unidenfitied
Private (Other)
State
N
SCALE 1:126720
1 0 1 2 3 4 5
MILES

Trends - Road Network

The federal budget for road maintenance has declined considerably in recent years. Currently, new road maintenance objectives are being considered for the watershed. Under these objectives, 48 miles of road in the watershed would be closed by gate, berm, signing or abandonment (operation maintenance level 1). These roads receive basic upkeep to prevent damage to other resources. Funding for total road decommissioning is uncertain. Additional discussion on the future road network is inlcuded in Chapter 5, Landscape Analysis and Design.

Recreation

Introduction

The Upper Sandy Watershed from the top of Mt. Hood to the National Forest Boundary (on Lolo Pass Road), is currently serving as a key area for providing year-round recreational opportunities within the Mt. Hood National Forest. Recreationists travel from around the region to recreate in the upper watershed. Much of the upper watershed was closed to public access from 1904 to 1959, due to its inclusion in the original Bull Run Reserve and strict interpretation of the 1904 Trespass Act. Until 1959 recreation in the area was limited to the upper reaches of Mt. Hood and trails that skirted the Bull Run Watershed reserves. Through efforts of a Portland newspaper editor, Fred McNeil, the area outside the actual Bull Run watershed was opened to the public in 1959. The area was temporarily closed again from November 1976 to mid 1977 due to a lawsuit. Since the opening of the Reserve in 1959, recreation use in the upper watershed has soared.

Recreational development on Federal forest lands in the western portion of the watershed is limited to the McIntyre Ridge Trail that borders the Salmon Huckleberry Wilderness. A limited number of recreationists enjoy the dispersed opportunities in the Alder and Cedar Creek drainage's and along Crutcher's Bench.

The beauty of Mt. Hood began luring recreationists around the turn of the century. Prior to European settlement, American Indians relied on the watershed for hunting, fishing, and gathering foods such as huckleberries. The establishment of the Mt. Hood Primitive Area, predecessor to the current Mt. Hood Wilderness shows the early recognition of the importance of preserving recreation related values on the upper portions of Mt. Hood. The Wilderness area was expanded to the west to include much of Zigzag Mountain in 1978.

As roads were constructed and access to the upper watershed increased, use of the area has been rising at rates at least as great as the rate of population growth for Portland and the entire state. Primary access to the Upper Sandy Watershed is provided via US Highway 26 (US 26), a major travel route between Portland and central Oregon. Lolo Pass Road 18 provides access to the upper watershed. The fact that the watershed is within an hour's drive to three quarters of the state's population is particularly significant.

The primary recreation activities that occur in the watershed are: Hiking, fishing, developed site and dispersed camping, cross country skiing, nature study, and sightseeing. In the publication Recreational Values on Oregon Rivers, developed by the Oregon State Parks and Recreation Division; canoeing, kayaking, drift boating, rafting, salmon and steelhead fishing, and other values such as hiking, camping and nature viewing are all listed as "outstanding recreation resources" for the Sandy River.

Of the watershed's total 67,800 acres, 25,873 acres are in private ownership, 3,786 acres BLM and 39,141 are under National Forest Management. Of the 39,141 acres of National Forest Lands, 14,951 acres are designated as Wilderness and 4600 acres is within the Bull Run buffer.

The private land along Highway 26 is comprised of several small communities; Zigzag, Welches/Wemme, Wildwood, Brightwood and Marmot. Services such as motels, grocery stores and restaurants are available in Welches/Wemme, Zigzag and Brightwood. The businesses derive much of their income due to recreation related use in the watershed.

Developed National Forest Campgrounds

The watershed contains three developed campgrounds, all are located within the Old Maid Flat Special Interest Area. The campgrounds are managed under permit by concessionaire and are generally open from May to October:

McNeil Campground: In use since the 1960's, named in memory of Fred H. McNeil, Newspaper editor, mountaineer, skier and passionate advocate of recreation on Mt. Hood. The campground has 34 campsites and two double vault type toilets. Water is currently not available at the campground due to many problems and failures of the original gravity system. The site has approximately 15,000 visits per year. The site is partially within the Sandy River Riparian Reserve with the closest campsites located 250 feet from the river. The campground is generally level and the sandy soils absorb water quickly. No runoff towards the river has been observed. The major attraction of this campground to campers is the open, dry nature. When the campground was dedicated, the trees were much smaller and views of Mt. Hood were outstanding. With the steady growth of the trees over the past 35 years, the views of the mountain are more difficult to obtain

Riley Horse Camp: Formerly called Lost Creek Camp, was changed to Riley in 1968 in memory of Frank Riley a local packer/guide and advocate of equestrian opportunities on the Forest. The campground was originally built for horse camping in 1963. Very few campgrounds on the Forest are designed to meet the needs of equestrians. Trails leading out of the campground and into wilderness from this site enhances the recreation experience. The campground has 14 campsites and two wells with hand pumps for water. There are two vault type toilet buildings. The site has approximately 8,800 visits per year. The site is within the Riparian Reserve created by Lost Creek and adjacent to the Riparian Reserve created by Cast Creek. The closest campsites to either stream are nearly 300 feet.

Lost Creek Campground: Located two miles beyond Riley and McNeil Campgrounds on Lost Creek, the campground was built over a number of years beginning in the 1970's as an informal picnic site and ending in 1989 as a fully accessible campground complete with accessible nature trails including special fishing platforms. The campground has 9 accessible sites and two vault type accessible toilet buildings. The facility was built by the Forest Service and several clubs and organizations and is designed to provide recreational opportunities for people who are physically challenged. The facility was recently recognized in a national contest for most effective use of "cost share" funds. The facility attracts recreationists from around the US, approximately 9000 visits per year. The site and associated trail system is located entirely within the Lost Creek Riparian Reserve with all sites within 300 feet of Lost Creek.

Clear Creek Picnic (abandoned): This site is located 2 miles up Lolo Pass Road from Highway 26, at the confluence of Lost Creek and the Sandy River. The site has been decommissioned since 1986 due to ongoing vandalism and expense to keep the site open. The site was originally constructed by the Civilian Conservation Corps (CCC) in the 1930's, and is entirely within the Clear Creek and Sandy River Riparian Reserves. Much of the original site was washed out during the 1964 Floods. The site was redesigned and reconstructed in the mid 1960's.

Dispersed Recreation

The watershed provides a variety of dispersed recreational opportunities. Some of these, such as camping, fishing, mushroom picking, mountaineering, and hiking, are activities which generally take place in or adjacent to riparian reserves. An extensive trail network provides access to the Mt. Hood Wilderness and alpine areas; links to "through" trails (PCT and the Timberline Trail); and popular destination camping areas such as Paradise Park, Burnt Lake, Cast Lake, and Ramona Falls.

Trails

Top Spur, Pacific Crest National Scenic Trail, Bald Mt., Ramona Falls, Yocum Ridge, Paradise Park Loop, Zigzag Mountain, Burnt Lake, Cast Creek Horseshoe, Sandy River, and McIntyre Ridge Trail., are all trails located in the Upper Sandy Watershed. The most popular trails are Ramona Falls, Top Spur and Burnt Lake. The Cast Creek trail has been closed for several years until it can be reconstructed to eliminate erosion and related safety problems due to the deep rutting of portions of the trail. All of the trails provide an important component of the transportation system on the Forest. The original intent of many of the trails was fire related access for lookouts, prevention patrols, and suppression. Prior to road building on the forest, trails provided the only access to the upper watershed.

Trails are currently designed and maintained to standards based on the type of trail user. The trails in the watershed are either horse or hiker trails. No trails have been constructed for mountain bikes and none are open to motorized use. In the winter months the bridge over the Sandy River at the Junction of forest road 1828 and 1825 is closed and the area behind the gate is used extensively by cross country skiers and snowshoers. No trails are marked as cross country ski routes. Most winter activity takes place on snow covered roads. Parking becomes a problem due to the lack of winter parking areas near the Forest Boundary.

Trails in the Upper Sandy Watershed that are open to horses are: Cast Creek (when reopened), Horseshoe, Zigzag Mountain, Pacific Crest, Sandy River, and the Sandy River side of the Ramona Falls Loop. The Ramona Creek side of the Ramona Falls Loop was recently relocated and closed to horses due to water and soils related resource concerns. Also, the Muddy Fork section of the Pacific Crest Trail was permanently closed to horse use and redesignated the Timberline Trail. The Bald Mountain Trail (which was once the Pacific Crest Trail) was redesignated the Pacific Crest Trail to take the place of the Muddy Fork PCT.

High use trailheads such as Top Spur and Ramona Falls create unsanitary conditions due to the absence of toilet facilities. Popular destination camp areas such as Burnt lake, Ramona Falls and Paradise Park, also have sanitation problems due to lack of toilets. Hikers tend not to bury human waste even though there has been much effort to educate them to the benefits. (The effects of the unburied human waste on water quality has not been quantified) Human waste is a problem in the areas that surround popular dispersed sites in the Old Maid Flat Area.

Other Dispersed Recreation

Target shooting: There is an area under the power lines on Lolo Pass Road (Road 18) that has been popular as a target practice range. The range is currently in the process of being closed for safety and resource reasons and another area is being developed for shooting further up Lolo Pass Road. Effects on water quality due to high quantities of lead in target areas is a concern but has not been quantified.

Viewing Scenery: The scenic nature of the upper watershed makes it a popular area for driving for pleasure ,viewing scenery and photography.

Fishing: Some fishing occurs for native cutthroat and hatchery rainbow trout in the watershed. The river and its tributaries are open for steelhead angling from the end of May to December 31 each year though actual use of the upper section of the river for steelhead angling is considered to be relatively low in comparison to the lower portions of the river. Lost Creek is probably the most heavily fished tributary on the river. Burnt Lake and Cast Lake are popular wilderness fishing destinations. Fishing occurs to a lesser degree at Dumbbell and Devils Lake since system trails do not lead to these lakes. Fishing access creates user trails along streams and around lakes. The amount of sedimentation produced by such trails has not been quantified and varies with the soil type.

Boating/Kayaking: The Sandy River provides a unique kayaking opportunity for experienced kayakers. The river is kayaked from McNeil Campground downstream to Wildcat Creek and sometimes beyond to Dodge Park. The section from McNeil Campground to the Sandy River bridge on Lolo Pass Road is described in Soggy Sneakers, Guide to Oregon Rivers, published by the Willamette Kayak and Canoe Club. The stretch is classified as class 4 to 4+, and is described as "among the steepest runable river sections anywhere in the state." Correspondence with Thom Powell of Oregon Kayak and Canoe Club confirmed that this section provides a unique experience by offering, a level of challenge and sustained intensity that is unmatched by any other river in the region. Use is estimated at approximately 100 user days annually in this uppermost section and twice that from the bridge to Wildcat Creek.

Rock Climbing: Is popular at Frenches Dome (an isolated basalt plug located under the power lines on Lolo Pass Road) but not widespread over the watershed. Approximately 1600 people visit the site annually.

Residential Camping: There are approximately 5 cases per year of residential camping. This activity is illegal and occurs mostly along the Sandy River near the Forest Boundary. This activity is monitored by Law Enforcement agents and stay limits are enforced.

Recreational and residential dispersed camping in the Old Maid Flat area is affecting areas through soil compaction and loss of vegetation, hacking on trees and cutting trees. There has been a slight increase of the number of sites due to increased camping pressure and strictly enforced fees in nearby campgrounds. Due to the fragile nature of the soils and vegetation areas subject to "off roading" or "pioneering" need to be regularly monitored to ensure adequacy and appropriate placement of barrier rocks or posts. The average car accessible dispersed site has an unvegetated and compacted area approximately 400 square feet. Some larger "group" (unofficial sites) sites cover an area of over 100 feet by 100 feet (10,000 square feet). Some of the larger sites located in Riparian Reserves have been rehabilitated and access roads closed such as the site on the lower Clear Fork of the Sandy. There are approximately 109 mapped dispersed sites in the Sandy River watershed. The sites were recorded and measured during 1995.

It is likely that use by humans has scared away beavers from traditional areas of habitation, i.e.: Burnt Lake, Cast Lake, Clear Creek, Lost Creek, and other riparian areas. Trapping has occurred in past years and it is not known to what degree this has contributed to the reduction in animal populations.

Wilderness

Approximately 14,951 acres (22%) of the watershed is located within the Mt. Hood Wilderness. Surprisingly, actual use for most of the wilderness areas within the Upper Sandy Watershed is low, except for day hiking use along access trails entering the wilderness, particularly the Ramona Falls Trail, Burnt Lake, and Top Spur Trail. These trail corridors experience very high use and exceed the LRMP standards and guidelines for social encounters. High use camping is experienced at Burnt Lake, Paradise Park and Ramona Falls. These areas exceed the LRMP A2 Wilderness standards and guidelines for social encounters and campsite percentage of exposed mineral soil per acre (A2-005 to A2-030).

The goal of Wilderness management on the Mt. Hood National Forest is to: *promote, perpetuate and preserve the wilderness character of the land; protect watersheds and wildlife habitat; preserve scenic and historic resources; and promote scientific research, primitive recreation, solitude, physical and mental challenge, and inspiration.*

Two actions have taken place since the LRMP was published to bring the high use areas of the Mt. Hood Wilderness in line with the stated goals. A Wilderness Implementation Schedule (WIS) was prepared in 1992 to identify and document the actions needed to achieve the overall goal, desired future condition, and standards and guidelines identified in the LRMP, the Wilderness Act, and the Northwest Forest Plan. The Mt. Hood WIS is intended to serve a 5 year schedule of activities. The WIS is interdisciplinary in scope and must integrate all resource values. The WIS summarizes the existing and desired conditions and the project list using an interdisciplinary approach. It is intended that the WIS be updated annually to reflect changes in conditions or new information. The Mt. Hood Wilderness WIS indicates a great need for data collection in all resource areas. Little funding is available to conduct data collection in wilderness.

The second action was to conduct a Limits of Acceptable Change inventory to determine if current Mt. Hood LRMP standards and guidelines are adequate to protect social standards and resource standards affected by people in wilderness. This study is currently in progress. The final results of this study will be in the form of an Environmental Assessment to determine the changes that would be necessary to bring the encounter and people affected resource standards in line with the Wilderness Act.

As part of the LAC process, a mandatory wilderness permit system was enacted in 1994 to inventory use levels. The results confirmed Mt. Hood LRMP statements in the Mt. Hood Wilderness Action Plan (Appendix B-13), that several areas of the wilderness exceeded social standards and soil compaction standards. A summary of the study indicated that campsites were distributed as follows:

Table 4-47 Campsite distribution, Mt. Hood Wilderness

Distance (feet) From:	water	trails
0-50	26%	39%
51-100	16%	18%
101-150	8%	11%
151-200	9%	8%
greater than 200	41%	12%

The summary shows that the majority of campsites are closer than the prescribed campsite distance of 200 feet from lakes and streams.

Campsites were inventoried in the entire wilderness. The following summarizes the number of sites in each of the higher use areas:

Table 4-48 High use backcountry campsites, Mt. Hood Wilderness

Wilderness Location	Number of campsites
Paradise Park	63
Ramona Falls	36
Burnt Lake	21
Cast Lake	13
Rushing Water	6

Use comparison from 1994 to 1995 showed similar use with 1995 being 3.8 % less than 1994. It is likely that the weather contributed to this change. Weather has been observed to change use up to 20 percent in other areas over a year. 1995 was quite rainy for much of the early summer especially on weekends. 1994 use was 35019 in the entire Mt. Hood Wilderness and 33,704 for 1995.

Fisheries, botany and ecology specialists have conducted some surveys in wilderness as part of large scale analysis. Lake surveys, Threatened and Endangered plant surveys and Lichen surveys are ongoing. Established ecology plots are monitored. Other projects are identified in the WIS project list and will be accomplished as funding becomes available.

Non-Federal Lands

A 1988 survey shows that 1/3 of the businesses in the Mt. Hood Corridor derive 80% of their business from tourism. In 1987, tourism accounted for more than 70% of the gross revenue for Mt. Hood Corridor-area businesses. Growth in the area is limited due to the ownership and zoning of the lands on the slopes above the valley bottom of the watershed.

Recreation Opportunities

Opportunities for off road mountain bike riding (trail riding) are very limited in the watershed. Trails in wilderness are closed to mountain bikes and the few trails that exist outside of wilderness are not suitable for mountain bikes. Reconstruction of the Sandy River Trail could be done in such a way that it would be suitable for mountain bikes.

Trail links/corridors from private lands to Forest Service Lands do not exist except for a couple of unofficial abandoned roads along the Sandy River upstream from Zigzag Village subdivision. There may be a way to create a link trail from Road 19 at the west end of Zigzag Mountain, to the Old Maid Flat area. This would require private landowners in the valley floor to allow for an easement.

Interpretation: No interpretation exists for the Old Maid Flat Special Interest Area. An interpretive kiosk has been proposed to be part of other facilities in the Old Maid Flat Special Interest Area.

An area suitable for winter parking such as a snowpark facility, is not provided. Lolo Pass road is plowed to the Forest Boundary and recreationists block private landowners driveways with their cars creating access and safety problems.

Developed areas designed to accommodate group camping is not provided. Sites of this type are rare on the Forest as well.

Future Recreation Trends

Local and Portland metropolitan area population growth serves as the driving factor influencing recreation-use trends within the Upper Sandy Watershed. As an "urban forest" within a one to two-hour drive from the Portland metropolitan area, population growth affects both demand for recreation resources as well as the condition of those resources. Oregon's population grew 8% from 1980 to 1989, the majority in metropolitan areas and nearby "bedroom" communities. Distant rural populations during this period declined. Based on population estimates from

Metro, the economy of the Portland metropolitan region's four-county area (Clackamas, Multnomah, and Washington counties in Oregon; and Clark County in Washington) is expected to add more than one million new residents and a half-million new jobs during the next 50 years.

Information from the State Comprehensive Outdoor Recreation Plan (SCORP) shows a projected 57% increase in Recreational Visitor Day demand for the Mt. Hood National Forest from 1987 to 2000. No studies are available to show how much of this increase would take place within the watershed, but it is assumed that the demand could be even greater due to its current high-use level and close proximity to the Portland Metropolitan area.

The following SCORP information summarizes potential growth projections for the 1987-2000 period for activities which take place within the watershed. This information is for the Portland metropolitan region which includes Clackamas, Columbia, Multnomah, and Washington counties. It is based on a demand survey conducted in 1987.

Table 4-49 -- Recreational Activity Projected Growth from 1986-2000

Recreational Activity	Percent projected growth 1986-2000
Bicycling on designated trails	93%
Day hiking	67%
Recreational vehicle camping	55%
Nature/wildlife observation	52%
Sledding/snowplay/snowboarding	51%
Off-road bicycling	38%
Downhill skiing	37%
Tent camping with a motorized vehicle	35%
Picnicking	35%
Cross country skiing	33%
Overnight hiking on trails	29%
Climbing/mountaineering	23%
Freshwater fishing from banks	21%

In addition to user demand, the SCORP study also indicated a shortage -- both regionally and within the Mt. Hood National Forest -- of the semi-primitive Recreational Opportunity Spectrum (ROS) setting. All of the semi-primitive acreage found in the watershed is within the Mt. Hood Wilderness. Its presence in the watershed helps to meet some of the demand for that type of recreation setting. Management actions which could further limit access to dispersed camping sites, and wilderness could further limit supply.

Water offers a preferred setting for many recreational activities. As a result, most recreation activities are located in or adjacent to Riparian Reserves. These areas can be expected to be under even greater pressure as the Portland metropolitan area grows along with the demand for additional recreation opportunities. Because existing water oriented landscape features (rivers, lakes, and vistas) are in limited supply, the recreational use in these areas is expected to increase.

A high rate of increased residential development is being experienced in the local Hoodland communities and Sandy, with both vacation and primary residences being developed for those seeking less crowded conditions than Portland's metropolitan area offers. Associated future infrastructure such as roads, stores, and other services is therefore also expected to satisfy this projected increase in local population. These individuals, in turn, will be relying on areas within and adjacent to the watershed to meet many of their recreational needs and desires.

Increased use in the watershed can also increase the number of social encounters and user-conflicts, which can increase the need for additional law enforcement personnel as violence and crime increases. In summary, the increased population growth of the metropolitan area can be expected to lead to an increase within the existing pattern of recreation use in the Upper Sandy Watershed.

Barring any large-scale changes in the forest cover from natural events such as fires and insect epidemics, changes in scenic quality will primarily be a function of tree growth and future timber harvest. The progression of early-seral stands, particularly those created by timber harvest, to mid-seral would serve to improve scenic quality over time as the forest canopy closes and blends in with adjoining stands.

Since the concessionaire and reservation systems have been implemented, all of the developed campgrounds in the watershed are mostly full during the managed season of May to October. Prior to the change to concessionaire operated system, the campgrounds would rarely fill to capacity and overall use was moderate to low. With the increasing Portland population and more people reaching retirement age, the demand for developed campsites will soar over the next 10 years. The demand will outpace the availability of sites due to downward trends in Forest Service funding of developed recreation improvements. It is expected that as the demand increases beyond what the developed sites can handle that there will be an increase in dispersed site use and increased impacts to sensitive areas as a result.

Chapter 5:

Landscape Analysis and Design

Chapter 5 -- Landscape Analysis and Design

Introduction

The Forest Landscape Analysis and Design (LAD) Process (Diaz and Apostol, 1992), joins forest planning with the principles of landscape ecology. This process assists forest managers in addressing landscapes as ecosystems. It presents basic ecological information about landscapes and proposes a strategy for designing landscape patterns that provide a synthesis of ecological functions. In doing so, the LAD process emphasizes the conscious design of patterns in the landscape.

LAD's objective in the Watershed Analysis process is to synthesize current management direction into a spatial plan of vegetative patterns and forest structures; and to assist in synthesizing information about physical, biological, and social processes. Thus, through the LAD process, future ecological patterns and potential landscape vegetation patterns are mapped, based on current land allocations, standards and guidelines, and the inherent potential of the land.

This conceptual landscape design becomes an integral and essential step in answering the Watershed Analysis's Key Questions, especially regarding future trends.

LAD is an ongoing, iterative process. After completion of the Watershed Analysis, additional Landscape Analysis and Design steps should be conducted to:

- Develop an interim landscape design to manage for the desired future condition.
- Graphically display where future management activities could occur to serve as a bridge between analysis and site-specific project development.
- Identify the future road network required to maintain the desired future condition

Conceptual Landscape Design

The Watershed Analysis Team, together with an interdisciplinary group of resource specialists (including aquatic and terrestrial biologists, foresters, road engineers, and representatives of the U.S. Fish and Wildlife Service and U.S. Bureau of Land Management) translated current management direction and landscape potential into a Conceptual Landscape Design Map. Through a spatial plan of vegetative patterns and forest structures, this map projects and depicts how the watershed's landscape may appear and function 50-200 years into the future.

Eleven different "Design Cells" were created and mapped that illustrate these potential future vegetation patterns within the Upper Sandy Watershed. These proposed Design Cells are based on Forest Plan *(The Mt. Hood Forest Land and Resource Management Plan)* Allocations and Standards and Guidelines, Salem District BLM Resource Management Plan, and direction from the Northwest Forest Plan *(The Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl).*

In addition, information concerning physical and biotic characteristics of the landscape, social desires, and ecological processes and functions attained through the Watershed Analysis process also helped create the Design Cells.

Design Cells are descriptions of likely future stand structure and vegetative patterns that could occur across the watershed as a result of landscape potential and current management direction.

The following criteria were used to determine individual Design Cells:

- Areas where structure and function of vegetation appear to be different at the landscape scale.
- Areas where structure or pattern of vegetation may differ as a result of forest management.
- Areas with different landscape potential (including variations in stand stability over time).
- Areas that can be recognized and mapped at the landscape scale.

Design Cell Descriptions

Table 5-1 -- Landscape Design Cells for Upper Sandy River Watershed Analysis Area presents an overview of each Design Cell using the following descriptive categories.

- **Name** -- Describes the Cell's future condition.
- **Ecological Unit** -- *Predominant ecosystem elements.*
- **Landscape Pattern** -- *General appearance of the Cell on the land.*
- **Stand Structure** -- *Detailed appearance within the Cell.*
- **Land Allocations** -- *List of allocations occurring in the Cell.*
- **Management Objective** -- *General objectives for land mgmt. within the Cell.*

Figure 5-1 -- Conceptual Landscape Design, displays the arrangement of Design Cells in the Upper Sandy Watershed.

Upper Sandy Watershed
Conceptual Landscape Design

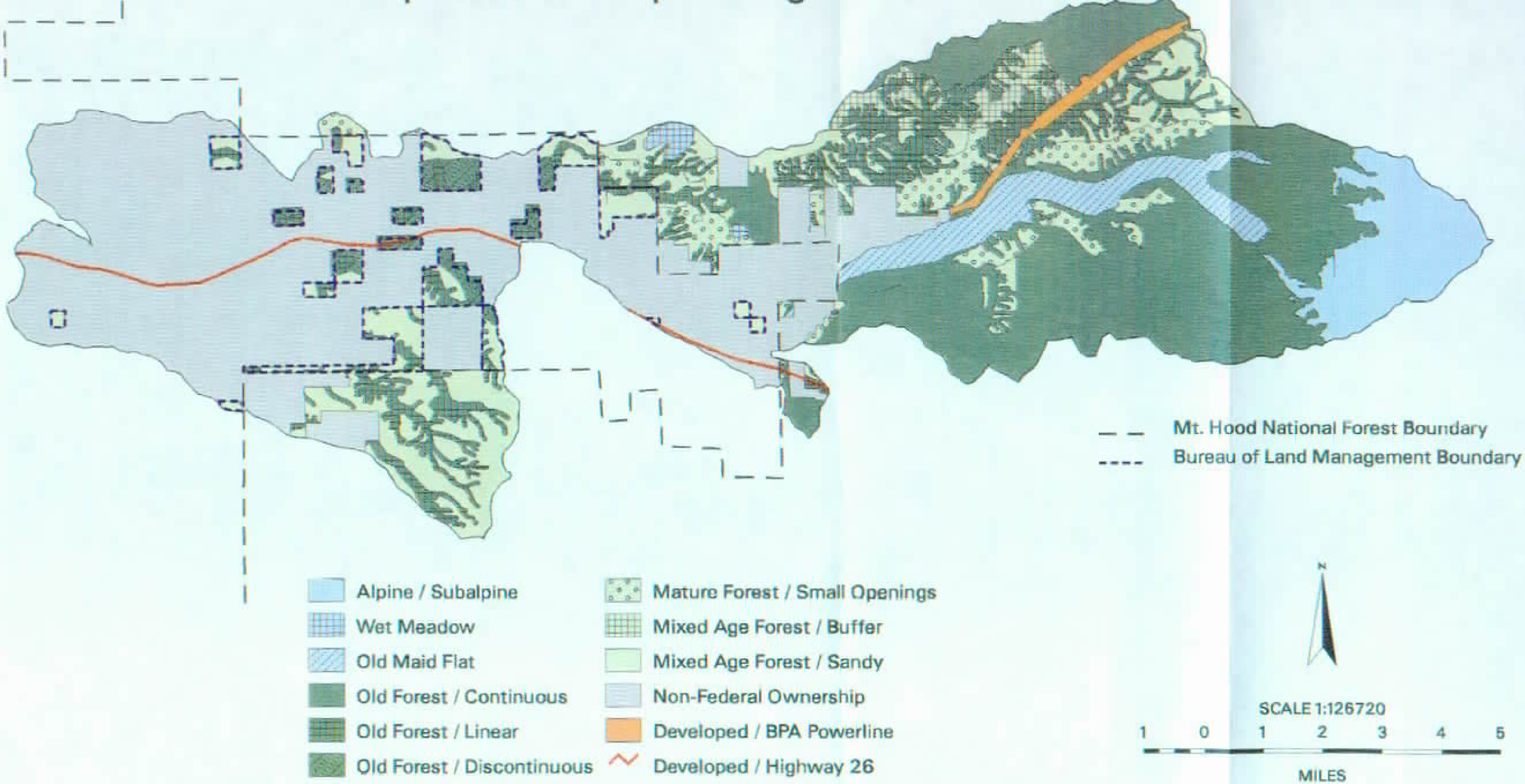


Table 5-1 -- Landscape Design Cells for Upper Sandy River Watershed Analysis Area

DESIGN CELL NAME	ACRES	ECOLOGICAL UNIT	LANDSCAPE PATTERN	STAND STRUCTURE	LAND ALLOCATIONS	MANAGEMENT OBJECTIVE
Old Forest / Continuous	15,922	late successional forest (upland / riparian) Mt. Hemlock, Pacific Silver Fir, Western Hemlock zones	continuous forest cover with small natural openings (rock outcrops, wetlands, fire scars, etc.)	large, old trees; multistoried; standing dead and fallen trees; shrubs and small trees in the understory	A2 Wilderness Late Successional Reserve Riparian Reserve A1 Wild and Scenic River B2 Scenic Viewshed A4 Special Interest Area B5 Pileated / Pine Marten	• preserve wilderness characteristics • maintain and promote late successional forest habitat • maintain and promote riparian resource values • protect and enhance outstandingly remarkable values • provide forest products within a naturally appearing forest setting • preserve and provide protection of unique geologic features • provide old growth forest habitat for pileated woodpecker populations

DESIGN CELL NAME	ACRES	ECOLOGICAL UNIT	LANDSCAPE PATTERN	STAND STRUCTURE	LAND ALLOCATIONS	MANAGEMENT OBJECTIVE
Old Forest / Linear	6,881	late successional forest (riparian) Mt. Hemlock, Pacific Silver Fir, Western Hemlock Zones	linear arrangement of continuous forest canopy along streams	large, old trees; multistoried; standing dead and fallen trees; shrubs and small trees in the understory; with a hardwood component	Riparian Reserve A9 Key Site Riparian	• maintain and promote *riparian resource* values • maintain wetland biodiversity and function
Mixed Age Forest / Sandy	6,854	mid/early successional Mt. Hemlock, Pacific Silver Fir, Western Hemlock Zones	a discontinuous forest canopy with multi-aged trees	a mosaic of managed forest stands of varying ages in even-aged size classes opening sizes range from 5-60 acres a maximum of 33% of area in early-seral stand conditions.	C1 Timber Emphasis BLM GFMA B6 Special Emphasis Watershed BLM Connectivity	• timber production • maintain or improve watershed, riparian and aquatic habitat conditions and water quality; timber management • timber management will retain 25-30% of the area in an old growth forest condition to provide connectivity and biodiversity
Alpine / Subalpine	3,586	alpine and subalpine zone	upper elevation forest/meadow mosaic; with rocky areas snowfields and glaciers	forbs, grasses, shrubs and small trees; non vegetated areas	A2 Wilderness	• preserve wilderness characteristics

DESIGN CELL NAME	ACRES	ECOLOGICAL UNIT	LANDSCAPE PATTERN	STAND STRUCTURE	LAND ALLOCATIONS	MANAGEMENT OBJECTIVE
Mature Forest / Small Openings	3,226	mid successional forest (upland) Pacific Silver Fir, Western Hemlock Zones	continuous canopy forest with irregularly dispersed small openings	managed stands of: mature trees; some large trees; snags and fallen trees; small openings with young trees openings <5 acres on not more than 20% of area	B2 Scenic Viewshed B5 Pileated / Pine Martin B10 Deer and Elk Winter Range	• provide forest products within a naturally appearing forest setting • provide old growth forest habitat for pileated woodpecker populations
Old Maid Flat	2,606	volcanic mudflow deposits Western Hemlock Zone	sparse, open canopy forest	mid successional conifer forest; sparse shrub understory; moss and lichen ground cover	A1 Wild and Scenic River A2 Wilderness Riparian Reserve	• protect and enhance outstandingly remarkable values • preserve wilderness characteristics • maintain and promote riparian resource values
Mixed Age Forest / Buffer	1,047	mid/early successional Mt. Hemlock, Pacific Silver Fir, Western Hemlock Zones	a discontinuous forest canopy with multi-aged and multistoried trees	a mosaic of managed forest stands of varying ages and sizes openings <10 acres in size	DC1 Bull Run / Timber Emphasis	• maintain and protect water quality and quantity • timber production

DESIGN CELL NAME	ACRES	ECOLOGICAL UNIT	LANDSCAPE PATTERN	STAND STRUCTURE	LAND ALLOCATIONS	MANAGEMENT OBJECTIVE
Old Forest / Discontinuous	968	late successional forest (upland) Mt. Hemlock, Pacific Silver Fir, Western Hemlock Zones	patchy arrangement of continuos forest cover in isolated sections of federal ownership	large, old trees; multistoried; standing dead and fallen trees; shrubs and small trees in the understory	BLM Viewshed	• timber management will retain 25-30% of the area in an old growth forest condition to provide connectivity and biodiversity
Developed / BPA Power lines	585	human infrastructure all zones	linear openings with mostly non-forested vegetation	young trees, shrubs forbs and grasses occasional taller trees in topographic depressions	transects many allocations Primary Allocations: Riparian Reserve Late Successional Reserve	• power line safety and tower access • maintain and promote riparian resource values • maintain and promote late successional habitat
Wet Meadows	252	wetlands Pacific Silver Fir Zone	wetland openings within forest	emergent forbs and shrubs; grasses and sedges	A9 Key Site Riparian DA9 Bull Run / Key Site Riparian	• maintain wetland biodiversity and function • maintain and protect water quality and quantity
Developed / Hwy 26 Corridor		human infrastructure all zones	open, non-forested highway arterial	road surface, grasses, forbs, and shrub plantings of cut and fill slopes	transects many allocations	• maintain highway safety and cross-state access

Implementation / Interim LAD

As previously noted, the conceptual landscape design is an approximation of the vegetation pattern 50-200 years in the future given current land management objectives and landscape potential. In order to move the current landscape condition toward the conceptual landscape, an interim operating plan would need to be developed. The objectives of the interim plan would be to develop a short term strategy to grow and develop the desired stand characterstics identified by the design cells. During implementation of the interim plan, field validation of assumptions behind the design cells can be conducted. Unmapped Riparian Reserves for example, will need to be mapped as they are identified on site.

Identification of a future road network consistent with the landscape design is also needed. Design of the future road network is intended to:

- provide access to meet the objectives of the conceptual landscape
- assist in the prioritization of road restoration and maintenance
- promote achievement of the Aquatic Conservation Strategy objectives.

Comparison of Proposed Network to Conceptual Landscape

The proposed future road network was taken from Mt. Hood National Forest access and travel management planning efforts completed prior to watershed analysis and landscape design. The proposed road network, Figure 5-2 Access and Travel Management-- Upper Sandy Watershed, identified roads to close, roads to keep open and primary and secondary priorities for maintenance. These road miles are also summarized in Table 5-2 Proposed Road Network.

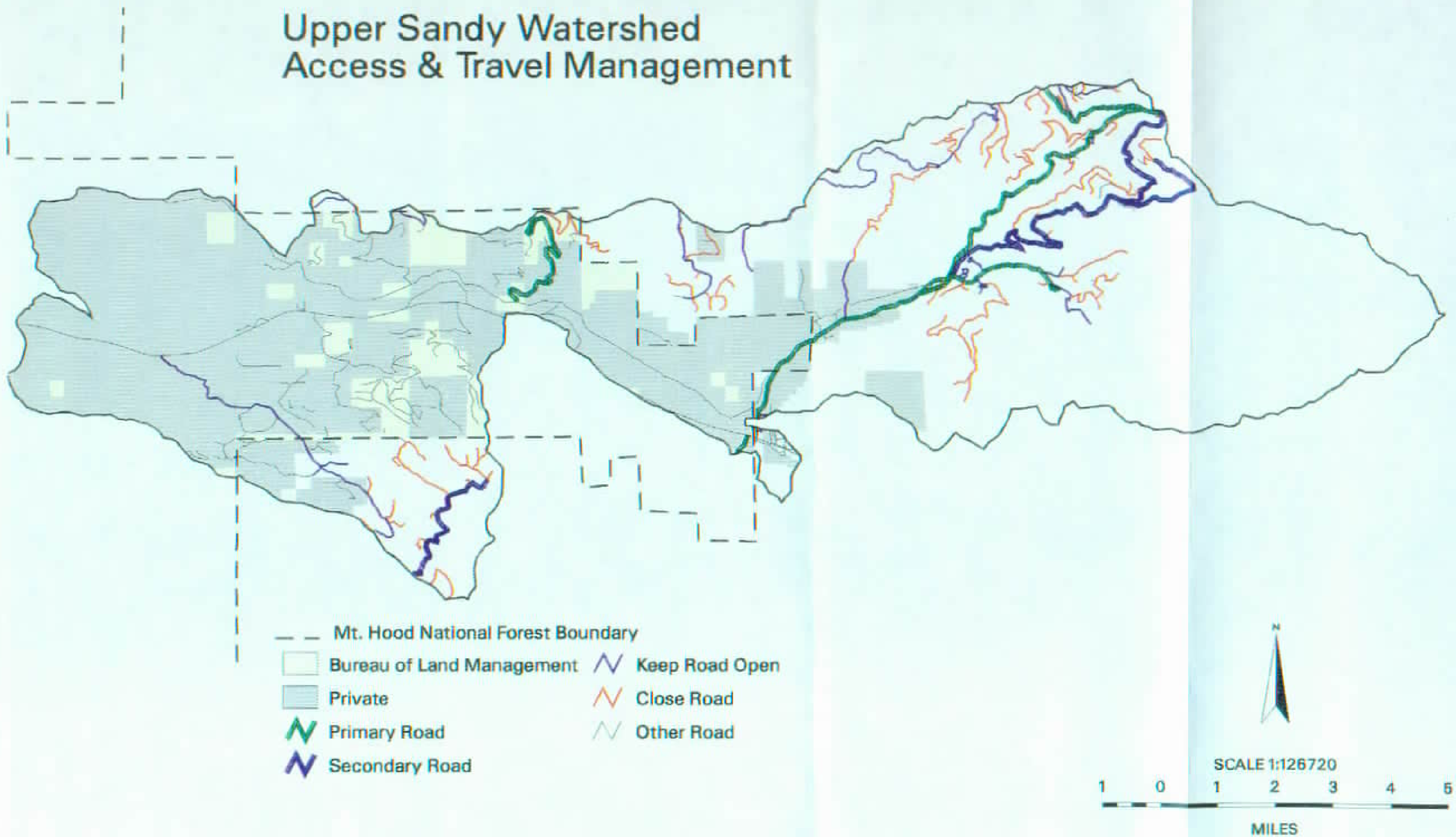
Table 5-2 Proposed Road Network

FUTURE ROAD CONDITION National Forest System	MILES
Abandon	1.21
Close	47.88
Primary Maintenance (open)	19.80
Secondary Maintenance (open)	14.09
Keep Open	24.86

In comparing the proposed road network to the landscape design cells, discrepancies between future access needs and proposed road access were noted.

In some cases, road closures were proposed in design cells where access would be needed for future activities such as timber management and recreational use. Additionally, road users were asked which roads were essential to the continued management of their resource. Identifying number of user groups can assist in further prioritization and allocation of limited road maintenance funds. User groups may be asked to share the cost of future road maintenance.

Following watershed analysis, interim landscape design could be used to review the proposed road network and, if necessary, to make adjustments consistent with the landscape design.


Upper Sandy Watershed
Access & Travel Management
Mt. Hood National Forest Boundary
Bureau of Land Management
Private
Primary Road
Secondary Road
Keep Road Open
Close Road
Other Road
N
SCALE 1:126720
1 0 1 2 3 4 5
MILES

Seral Stage: Future Trend

The Conceptual Landscape Design was used to project the future condition of the Upper Sandy Watershed in terms of seral stage and landscape pattern. Seral stage affects a variety of ecosystem functions, including: wildlife species use, hydrologic function, production of snags and coarse woody debris, nutrient cycling, and disturbance processes such as fire and windthrow. The conceptual future condition for seral stage is used in addressing many of the Key Questions in Chapter 6.

Projected Seral Stage by Design Cell

Conceptual Landscape Design Cells were projected into the following seral stages:

Late-seral

- Old Forest/Continuous
- Old Forest/Linear
- Old Forest/Discontinous
- A small portion of the Mudflow *(current late-seral inclusions)*
- Some Private lands

Mid-seral

- Mixed-Age Forest/Buffer *(approximately 90% mid/10% early)*
- Mixed-Age Forest/Sandy *(approximately 67% mid/33% early)*
- Mature Forest/Small Openings
- Most portions of the Mudflow
- Some Private lands

Early-seral

- Developed/BPA Power lines

- Mixed-Age Forest/Sandy *(approximately 67% mid/33% early)*
- Mixed-Age Forest/Buffer *(approximately 90% mid/10% early)*
- Some Private lands

Non-Forest

- Alpine/ Subalpine
- Wet Meadows
- Lakes
- Other areas currently classed as non-vegetated in vegetation layer

Assumptions: Seral stage projections

- The Mixed Age Forest/Sandy Design Cell, although dominated by mid-seral, will -- at various points in time -- have portions present in early seral openings from harvest that include remnant old trees. For landscape analysis purposes this mix is projected to be 33% early-seral. (This is an approximation of the maximum allowed for hydrologic concerns) and 67% mid-seral.
- The Mixed Age Forest/Buffer Design Cell, although dominated by mid-seral, will -- at various points in time -- have small portions present in early-seral, generally in small, open patches with remnant old trees. For landscape analysis purposes this mix is projected to be 10% early-seral (This is an approximation of the amount allowed to meet water quality and quantity objectives of the Bull Run Buffer) and 90% mid-seral.
- The future trends of many private lands are unknown, but may include a variety of seral stages similar to current amounts. For this analysis, the existing Clackamas County Zoning map was used as a proxy for projecting dominant land uses and thus, predominant forest stand types on private lands in the future.
- Natural, unplanned disturbances are not accounted for and will, to some extent through time, alter projections.
- Areas currently mapped as non-vegetated will remain as such in the future (no net increase or decrease).

- Adjustments for the proposed land exchanges between Longview Fibre and the BLM are not included here, but effects to future seral stage are footnoted below Table 5-3. New BLM Lands in the Highway 26 corridor are projected to be predominantly late-seral in the conceptual future condition.

Range of Natural Variability: Future Trends

The future trend for all three seral stages on federal lands appears to be within or near the range of natural variability.

Table 5-3 -- Seral Stage: Future Trend on Federal Lands, displays current (1996) and future amounts of the three seral stages on federal lands as compared to the range of natural variability (RNV). Amounts are presented by forest zone and as a total.

Table 5-3 -- Seral Stage: Future Trend on Federal Lands

Zone	Seral Stage	RNV* %	1996 %	Future** %
WH	Late	47-59	8	51***
PSF	Late	38-55	52	66
MH	Late	n/d	66	89
Total	**Late**	**n/d**	**29**	**58**
WH	Mid	n/d	77	38
PSF	Mid	n/d	33	25
MH	Mid	n/d	23	1
Total	**Mid**	**n/d**	**50**	**26**
WH	Early	8-28	15	11
PSF	Early	9-35	14	6
MH	Early	n/d	9	1
Total	**Early**	**n/d**	**14**	**7**

"n/d" = no data or unknown. The 1993 REAP data included natural ranges only for late and early-seral forests and did not include the Mountain Hemlock Zone for the Sandy River Basin.

* RNV is based on the Sandy River Basin adapted from REAP (1993) as presented in Chapter 4.

** Future, as used here, implies full implementation of the Northwest Forest Plan and sufficient time for successional processes to progress from early through late, approximately 120 years.

*** Upon completion of the BLM/Longview Fibre land transfer as currently proposed, the conceptual future amount of WH late-seral forest could increase to 57 %.

The future amount of late-seral on federal lands will be double the current amount. Conversely, the amount of both mid and early-seral will be half as much as presently exists.

The future trend for all seral stages across all zones appears to be within or near the RNV. The amount of late-seral will increase across all zones with the most significant trend being a dramatic increase within the Western Hemlock Zone to move it within the Range of Natural Variability. The amount of late-seral will be slightly above the RNV in the Pacific Silver Fir and Mountain Hemlock Zones and conversly the amount of early-seral is slightly below RNV in these two zones. Small areas of low site productivity or periodic, unplanned disturbance events through time, however, will temper this projected deviation from RNV.

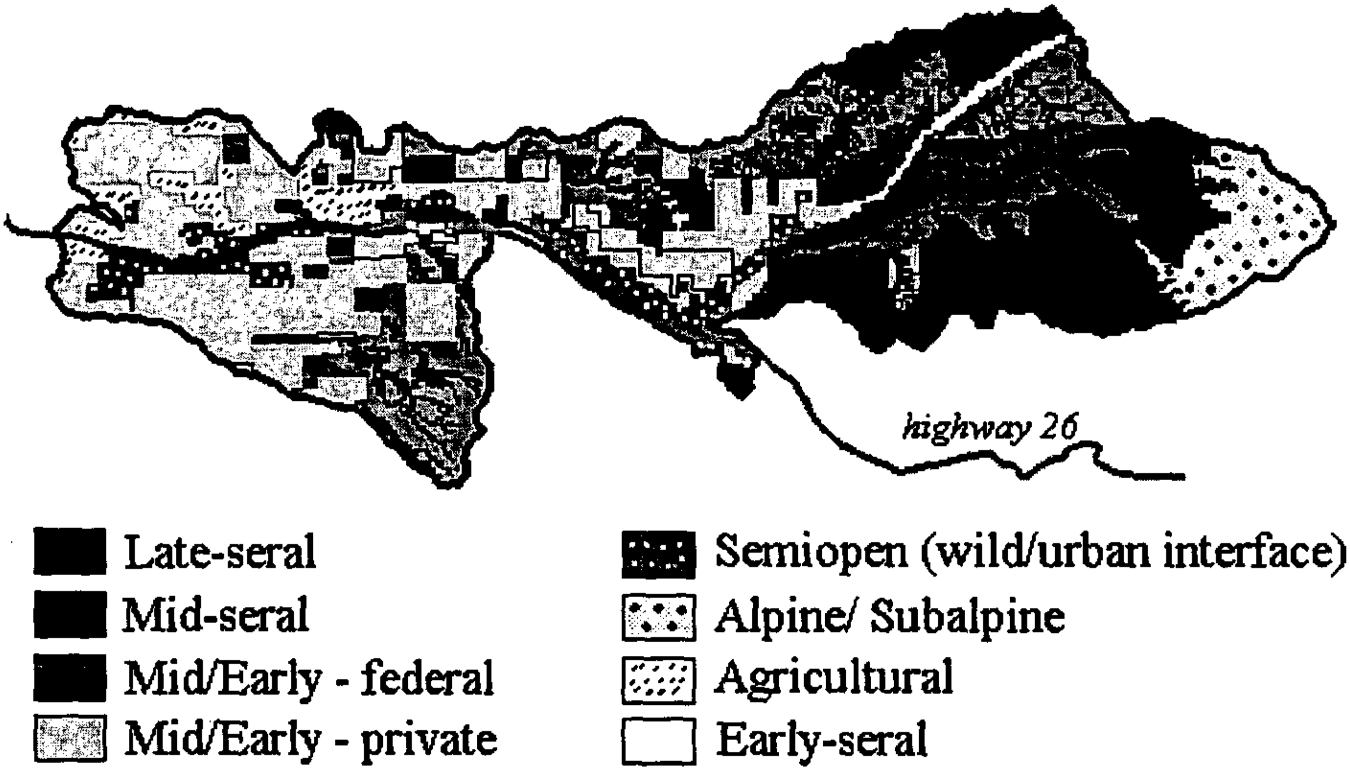
Future Landscape Pattern

As forest succession progresses and edge effects diminish, the amount of interior habitat will greatly increase within the Upper Sandy Watershed.

The future landscape on federal lands in the Upper Sandy Watershed will be less fragmented, including less openings in the northeast portion of the watershed. Patterns in the wilderness and LSR will be dominated by unfragmented landscapes of late-seral forest with scattered natural openings (talus/rocky areas, lakes, wetlands). Growth of early-seral stands to mid-seral will reduce the edge effects to any adjacent late-seral stands in the short term future. Growth of early and mid-seral stands to late-seral in past timber harvest units combined with the subsequent loss of edge effect will substantially increase both the amount and patch size of interior habitat within the LSR area over the long term. In the near future, the continued growth of mid-seral stands towards late-seral in the wilderness will also increase the amount and patch size of late-seral forest in the watershed.

Landscape patterns outside reserve areas will be dominated by various sized patches of mid-seral forests connected by linear corridors of late-seral forests within the Riparian Reserves as well as some scattered early and late-seral patches. Landscape connectivity for many late-seral species will improve within the watershed (*see also Key Question #2, Connectivity*). While the future pattern of private lands is not known, it is suspected to be some arrangement of aggregated openings and fragmented forest lands -- similar to current patterns. Figure 5-1 -- Conceptual Landscape Design (previous) and Figure 5-3 -- Future Seral Stage: Location and Pattern, visually display future landscape patterns within the Upper Sandy Watershed.

Figure 5-3 -- Future Seral Stage: Location and Pattern



Assumptions: Seral Stage Mapping:

1. Seral stage projections for federal lands are projected from Design Cells as discussed earlier in this section.
2. Future seral stage for non-federal lands is not known. For this map Clackamas County Zoning designations were combined and shown as follows:
   - Agricultural = Agricultural related uses
   - Semi-open = Areas of various rural/residential zoning. Tax lot sizes are generally small. This area approximates the wildland/urban interface portion of the watershed.
   - Mid/Early - private = A generalization of all commercial forest lands. Future stand types and uses are assumed to be similar to present.
3. Exchange lands are displayed based on current ownership. Boundaries *(thin black lines)* denote these areas in Figure 5-3.

Chapter 6:

Key Questions/Synthesis

Chapter 6 -- Key Questions/Synthesis

Introduction

In this chapter, Key Questions are answered and provide synthesized, interpreted results based on the analyses described in previous chapters. Changes in ecological conditions and their probable causes are examined and explained, including implications for watershed management objectives.

The Key Questions were investigated in terms of past, present, and future. For example, *condition* in the statement "*conditions of the watershed*" – used with many Key Questions – refers to any of the following that exert influence:

- Historic events, both natural and human-caused.
- Current status or practices.
- Trends, or land allocations that may have future implications.

The results provide a basis for identifying and prioritizing management recommendations.

Key Question #1: What are the influences and relationships between human development and ecosystem processes in the watershed?

The first European influences in the Upper Sandy Watershed began with the Oregon Trail which was used by early pioneer emigrants. The watershed has a relatively long history of human development stemming primarily from its location along the Oregon Trail and its proximity to a major metropolitan urban area. Development of the transportation corridor may be the single most influential trend of human development in the watershed.

Wildland/Urban Interface

The term "wildland/urban interface" is commonly used in context with wildland fire prevention and suppression. In addition to the relationships between human development and natural fire processes, other ecosystem processes have been influenced by human development in the ecosystem. These processes and attributes that have been influenced by their direct interface with human development include vegetation patterns, natural fire regime, biodiversity, water quality and channel morphology.

The issues related to the wildland/urban interface could be considered to be compounded due to relatively high degree of human development contiguous with designated wilderness. This has created a noticeable contrast of attributes and processes between wilderness and non-wilderness lands in the watershed.

Water Quality

The wildland/urban interface has the potential to impact water quality in the watershed. Specific wildland/urban interface processes that could directly affect water quality include small domestic system water withdrawal, removal of riparian vegetation, introduction of chemical pollutants, and sewerage. Though each of the above processes have the potential to affect water quality, they have not been specifically analyzed nor have their specific effects on the watershed been quantified.

The 1988 DEQ nonpoint assessment did not identify problems associated with the wild/land urban interface for chemical pollutants or sewage. Water withdrawals were listed as a factor influencing water quality in the assessment.

Channel Morphology

Development within the wildland/urban interface has resulted in altered channel morphology in the watershed. Streams in the watershed with headwaters on Mt. Hood, including the mainstem of the Sandy, experience periodic violent channel altering flood events. The flood plain ,if natural processes are allowed to occur, continually changes with new channel braids created annually. Many of the lands in the watershed that have been developed for residential purposes are within flood plains that are subject to these naturally occurring flood events. In addition, transportation infrastructure including roads, trails, and bridges can be found in proximity to stream channels. The desire and economic realities to protect these investments have led to the willingness to manipulate the natural channel morphology of the Sandy River and its tributaries. Bridge abutments and approaches encroach into the flood plain. Riprap is placed to protect investments, including homes. Existing wetlands have been filled in, and side channels closed. Perhaps more importantly, the potential for creation of new naturally occurring wetlands, side channels, and new natural stream braiding has been reduced. The natural evolution of the river geomorphology has been altered.

Fire Regime

It is estimated that the natural fire rotation in the watershed is 250-300 years with fires of moderate severity. Actual fire history indicates that three-fourths of the watershed was subject to stand replacement fire between 1873 and 1920 (Chapter Four, Fire). The presence of a relatively high human population and development directly affects the natural fire regime.

There is an increased potential for human caused fire starts in the watershed which is a result of the wildland/urban interface process. A high road density and a large human population increases the potential for accidental as well as deliberate fire starts.

In addition, the first priority for fire suppression strategies is firefighter and public safety. Protection of property and natural/cultural resources, based on their relative values is the next priority. People living within the watershed and the presence of homes and other developed property of high economic value has and will affect fire suppression emphasis and alter the natural fire regime. Fire suppression response will be quick and deliberate in order to save lives, homes, farms, and businesses within the watershed. It may be politically untenable to implement suppression strategies that would protect and/or enhance natural processes and attributes at the cost of developed property with high economic value or threat to human lives.

The relatively large human population may also contribute to the earlier detection and suppression of wildfire including larger suppression forces and available equipment. The developed road network can contribute to quick suppression efforts.

The Mt. Hood Wilderness Area requires different suppression methods and strategies than what may be found on non-wilderness lands (Chapter Four, Fire). A prescribed natural wilderness fire plan has yet to be developed for the Mt. Hood Wilderness. In its absence it could be expected that strategies and tactics will be used that have the least effect on wilderness values. The fact that the Mt. Hood Wilderness has such a high recreation value and of its location within greater Portland's airshed may result in fire suppression that may not mimic natural fire processes. It may be more likely to see fires suppressed in the wilderness as opposed to allow fire to perform its natural process so as not to impact air quality or scenic views

In conclusion, there is an increased potential for fire starts yet these will be quickly suppressed. Continued control tends to perpetuate overstocking; changing species composition and increasing the risk of more severe fires. The interaction of human development and natural ecosystem processes has and will continue to alter the natural fire regime and vegetative patterns within the watershed.

Biodiversity

The natural biodiversity of the watershed has been altered directly by the wildland/urban interface by human introduction of exotic plants and animals, and domestic pets. Residents in the watershed often introduce exotic plants to use in landscaping applications or in the form of agricultural crops. They also introduce exotic animal species in the form of domesticated farm animals or pets. Non-native species tend to compete for habitat with native species (see also Chapter Four, Botany) and with assistance from their human attendants will displace natives. This displacement will adversely affect the viability of native species.

Vegetation Patterns

Patterns of vegetation types in this watershed (as compared to other watersheds) are due in part to diverse private land holdings and intense timber harvest. This occurs primarily across the Western Hemlock Zone. Open patches, created primarily by human activities, dominate the structure and function of the landscape across a large portion of this watershed. Simplification of riparian structure and reduced riparian function have occurred due to human activities. Forest connectivity and interior habitat is severely reduced or absent. This condition is prevalent on non-federal lands in the western half of the watershed as well as along the Lolo Pass Road and power line corridor area in the mid to northeast portion of the watershed. This west to east band dissects the connected forest landscape areas of the Bull Run to the north from the extensive unfragmented forests of the Salmon-Huckleberry Wilderness to the south.

An examination of tax lots graphically illustrates certain areas in the watershed with extremely small lot sizes in context to naturally occurring vegetation patterns. Each tax lot has the potential to display differing vegetation patterns dependent largely upon the desire and objective of the landowner. In addition to the size of these patches, their shape and arrangement on the landscape is also outside the range of natural conditions since they tend to follow legal boundaries as opposed to natural topographic boundaries. These alterations of the vegetation patterns reduce connectivity and may even alter vegetation potential in portions of the watershed.

Amounts of late seral forest are far below the expected range of natural variability for the Western Hemlock Zone. Although fire history and the mudflow contribute to this deviation, human development and management activities account for the majority. Altered conditions and ecological processes may exist in subwatersheds that are low in late-seral forests. *(See Chapter Four/ Vegetation for detailed discussions on Structure, Seral Stage and Pattern; Chapter Five for future conditions; and Chapter Six, Key Question #2 for further connectivity discussions).*

Urban Proximity

The proximity of the watershed to a large human population has magnified the influences of human impacts on natural ecosystem processes. Easy access on well maintained road systems has encouraged heavy recreation use patterns and increased human visits. The recreational opportunities sought within the watershed are as diverse as the population seeking them. The fact that many of the areas sought out for these diverse recreation opportunities are ecologically sensitive only compounds the problem. Portions of the wilderness environment are being trammeled by overuse: naturally unstable stream channel banks are eroded, alpine environments are impacted and special ecosystems are altered. Many wildlife species that would naturally occur in this watershed do so in limited numbers or not at all due in part to their high sensitivity to human presence or destruction of critical habitat.

An example of these human influences on the natural ecosystems is the Paradise Park area within the Mt. Hood Wilderness. This area has long been the destination of recreationists seeking an alpine experience on Mt. Hood. One of the first recreation/administrative trails accessing the timberline was the Paradise Park Trail along the north side of Zigzag Canyon. Paradise Park was one of the attributes of the mountain that led to the creation of the Mt. Hood Primitive Area and eventually the designation of the Mt. Hood Wilderness Area. The Timberline

Trail, constructed in the 1930s, provided yet another route to Paradise Park and the number of visitors continued to increase. A recent survey recorded 63 campsites at Paradise Park. Paradise Park is one area of the Sandy River Watershed within the Mt. Hood Wilderness (others are Burnt Lake and Ramona Falls) that exceed Wilderness standards and guidelines for social encounters and soil compaction (Chapter 4, Recreation). Other human impacts at Paradise Park include improper disposition of human waste and depletion of natural vegetation.

Another example where human influences may have the potential to impact natural ecosystem processes is the Old Maid Flat area of the watershed. Old Maid Flat is designated a Geologic Special Interest Area in the Mt. Hood Forest Plan (Chapter 4, Special Habitats). The heavy recreational use currently experienced in the area threatens the very attributes that contribute to its attractiveness. Dispersed camping, off-road vehicle use, and mushroom picking particularly have the potential to adversely affect the natural ecosystem processes. Old Maid Flat is a classic example of primary vegetation successional stages associated with volcanic activity. A management threat to the natural successional evolution of the area is the desire to retain the currently existing vegetation patterns and retard natural succession. The objective would be to preserve the unique vegetation patterns that exist today in which lodgepole pine, lichens and mosses seem to dominate (The Upper Sandy Wild and Scenic River Environmental Assessment and Management Plan, USDA, 1994).

The dependency of the recreation service based economy on natural ecosystem attributes has resulted in an economic conflict in this watershed that may not be as evident in other watersheds. Commodity extraction in the form of timber harvest or water diversions are often in direct conflict with the high recreation values fostered by the close proximity of an urban population seeking quality recreation opportunities.

Water Rights

The Bull Run Hydroelectric Project allows for the diversion of up to 800 cfs from the Sandy and Little Sandy Rivers in any combination. There is a minimum flow requirement below Marmot Dam of 200 cfs (June 16 through October 15), 400 cfs (October 16 through October 31), and 460 cfs (November 1 through June 15).

Alder Creek is one of the supply sources of water for the City of Sandy. In Alder Creek water rights exceed the available supply for the summer low flow period.

Cedar Creek has water rights totaling 29.5 cfs with only 8.0 cfs available during the summer low flow period. The majority of the water rights on Cedar Creek are for the fish hatchery near the confluence with the Sandy River and this water may not be removed from the stream.

Fish Stocks

The lower Sandy River is nationally renowned for its summer steelhead fishery and is very popular with anglers. The current stock of summer steelhead in the Sandy River is an introduced stock that was developed from eggs taken from the Washougal River in southwestern Washington. In order to meet the demand for recreational fishing the Oregon Department of Fish and Wildlife regularly releases the hatchery stock of summer steelhead below Marmot Dam.

Dominant Infrastructure

There are a number of human infrastructures of dominant stature in the watershed. Among these are the Bonneville Power Administration power transmission line and accompanying right-of-way, US Highway 26, and the Marmot Dam.

The influences of both the highway and the powerline right-of-way are compounded by their east/west orientation running the length of the watershed. The linear nature of the highway and powerline severs natural connectivity corridors and limits opportunities to restore connectivity. Natural flow patterns are disrupted between key natural ecosystems within the Bull Run Watershed to the north and both the Mt. Hood and Salmon-Huckleberry Wilderness areas to the south. (see Key Question #2 - Connectivity). The highway and powerline corridors are both landscape patterns that do not occur naturally on this landscape. This contributes to their effectiveness in severing natural connectivity and also adversely affects scenic qualities.

The Lolo Pass powerline right-of-way was cleared by the early 1950s. Both the initial clearing and the periodic maintenance of the right-of-way has created a vegetation composition and fire fuel type that is outside the range of natural condition. How exactly this has altered the natural fire regime is not quantified. It may be that the corridor would act as a firebreak in the instance of a wildland fire or, it may have increased the fire hazard by introducing a larger percentage of more combustible fuel types. In addition, it has been a pathway for noxious weeds. The high road density of primitive access roads used to access powerline towers and the lack of adequate maintenance of these roads has led to a concern that water quality has been compromised. The very nature of this primitive road system is attractive to recreationists pursuing off-road vehicle opportunities. This use has compounded the soil erosion problems.

Highway 26 acts as a flow corridor introducing a variety of human influences into a natural landscape. The highway provides access to a variety of recreationists which bring with them the potential of use patterns that the landscape cannot support. In addition, much of the commercial traffic on the highway is hauling hazardous wastes and an accident involving one of these haulers could have grave consequences to the natural environment of the watershed. Vehicles tend to be proficient carriers of noxious weeds from one area to another and a constant vigil is required along the highway corridor to ensure that non-native plant species do not become established. The road prism of Highway 26, as with any highway of this size, is an effective connectivity barrier to ground based organisms. The physical effects of the highway are compounded by the high volume of traffic which also acts as a barrier. Standards for this class of roadway require vertical and horizontal alignments, and grades that force the roadway to be constructed in ecologically sensitive areas such as wetlands or floodplains that might be avoided in a lower standard of road. Road location and design is often driven by economic and safety concerns over values of the natural ecosystem. Another highway related impact is the introduction of sediment levels outside the range of natural condition into Bear Creek, a tributary of the Sandy River.

The Marmot Dam was constructed in 1912 on the Sandy River as part of the Bull Run Hydroelectric Project. The dam diverts water from the Sandy River and delivers it to Roslyn Lake (outside of the watershed study area) via a series of canals, flumes, and pipelines. The lake serves as a reservoir and forebay for the Bull Run hydroelectric plant.

The Marmot Dam has affected the natural ecosystem process of the Sandy River (Chapter 4, Fisheries and Hydrology). Though fish passage facilities were associated with the dam since its construction, the operation of these facilities was not historically the most effective. Egg take operations for hatchery purposes were common at the dam from 1913 to 1946 and it appears that few if any fish were allowed to proceed upstream to spawn naturally for an extended number of years. In addition, smolt production was diverted and killed by the Bull Run power generating facilities. A 1970 study (Basin Investigations Special Report #2, Oregon State Game Commission, 1970) identified that adequate fish passage did not exist at Marmot Dam and that there was not adequate sustained streamflow below the dam. A screen was added to the diversion canal in 1951 to reduce smolt mortality and the fish passage was reconstructed in the early 1980s. In 1974 minimum flows were established on the Sandy River below the dam to improve fish passage and provide for fish rearing areas.

Even with minimum flow requirements below the Dam summer streamflows are reduced from by 53-69% for the period June-August based on monthly mean streamflows. This limits the systems ability to buffer in stream temperature in a stream reach that is listed as Water Quality Limited for summer stream temperatures. Reductions in summer streamflows also limits habitat availability for aquatic species below Marmot Dam.

Air Quality

Two programs are currently in place to assess air quality and possible effects to vegetation.

One is the Assessment of Air Quality Related Values. As a provision of the Clean Air Act, this assessment looks at three indicators of air quality: lichens, lake chemistry, and visibility. Of these three components, lichen monitoring is currently occurring in the Mt. Hood Wilderness. The ability of lichens to concentrate elements that may be present in low concentrations in the ambient air make them useful as bio-indicators of air quality. A series of lichen monitoring plots was installed in the early 1990's. Monitoring, assessment, and reporting will be ongoing with the first report expected in late fall, 1996.

Preliminary results have shown elevated lead levels in tissues of lichens in the Mt. Hood Wilderness.

The second air quality monitoring program is part of the Continuous Vegetation Survey and assessed every four years. The purpose of the lichen monitoring is to look through time at the possibilities of air quality influence on lichen species presence and abundance.

Preliminary analysis suggests that there have been effects to lichens from air pollution. The most likely cause of this air pollution is from motor vehicles - both from adjacent Highway 26 and the nearby Portland metropolitan area.

Key Question #2: How do conditions of the watershed affect terrestrial connectivity within the Upper Sandy Watershed and between adjacent watersheds?

Large areas of Late Successional Reserve/Wilderness are located to the north and south of the Upper Sandy Watershed. Within the Upper Sandy Watershed, ownership and land use patterns are quite variable and discontinuous. As presented in Chapter Four, Vegetation/Landscape Pattern, a pattern dominated by openings forms a west to east band across the watershed that divides the large continuous forest landscape areas of the north from those to the south. This dramatic landscape-scale separation of forest connectivity may have implications to species linked to late-successional forests. This key question will examine the condition and effectiveness of vegetative connectivity within the Upper Sandy Watershed and its role between watersheds.

Northwest Forest Plan Connectivity Strategies

Connectivity of habitat helps to fulfill the life requirements of some species by: providing travel and migration routes; providing for reproduction and genetic interchange; allowing movement to respond to environmental changes and natural disasters; and allowing recolonization of areas where populations may have been locally extirpated. A primary goal of the Northwest Forest Plan (NWFP) is to provide for a functional and interconnected old-growth forest ecosystem. The Plan's strategy to meet the needs of late-successional forest species includes:

- **Late Successional Reserves (LSR)** large habitat blocks intended to maintain a functional, interacting, late-successional and old-growth forest ecosystem (ROD p. C-11).
- **Riparian Reserves** to provide for greater connectivity of late-successional forests within watersheds and among LSR's for dispersal of mobile species such as the northern spotted owl, and serve as refugia for species that disperse only short distances (ROD pp. 7 & 2).
- **Isolated Patches** of late-successional habitat and green tree retention in matrix lands for species to move between LSR's and for refugia for sessile species (ROD p. B-1, C-44).

The Upper Sandy Watershed by itself does not (and is not intended to) provide a functional and interconnected old-growth forest ecosystem. It does, however, play a role within the Sandy River Basin in providing this.

An analysis process to assess connectivity of the LSR network on the Mt. Hood Forest was proposed in July 1996 (Mellen et al.). Concepts from this process were used to address whether or not current conditions of the watershed allow for these approaches to connectivity (as discussed above) to occur.

Given current conditions of LSR's and Riparian Reserves, the connectivity envisioned by the NWFP may not currently exist in some areas. Gaps in habitat connectivity exist inside and between LSR's due to past timber management and natural disturbances. Most of these "gaps" are expected to fill in as the NWFP is implemented and young stands mature. In the meantime, however, connectivity may be a concern over parts of the Upper Sandy Watershed. The following summarizes current conditions of areas intended to contribute to the interconnected late-successional/old-growth forest ecosystem in the Sandy River Basin.

Late-Successional Reserves

Salmon-Huckleberry Wilderness/LSR complex:
This large reserve area is dominated by a large expanse of continuous canopy forest. Much of the forest is currently 80-100 years-old and transitional to late-successional with old-growth forests in draws and canyon bottoms. (Refer to the Salmon Watershed Analysis (1995), Vegetation section for specifics on this area).

Bull Run LSR:
The extensive Bull Run LSR to the north has a large amount of late-successional habitat including interior habitat which will also increase in the future. It does, however, presently contain local areas of poor connectivity. (Refer to the Bull Run Watershed Analysis, Key Question #3/late-seral (in press, 1996) for specifics on LSR conditions.) This large LSR is generally isolated from other large areas of habitat by the Columbia River and highways to the north, agricultural and developed lands of Hood River Valley to the east, developed land/metropolitan areas to the west, and somewhat by developed lands and highway 26 to the south. This "isolation" intensifies the role the Upper Sandy Watershed serves in landscape connectivity.

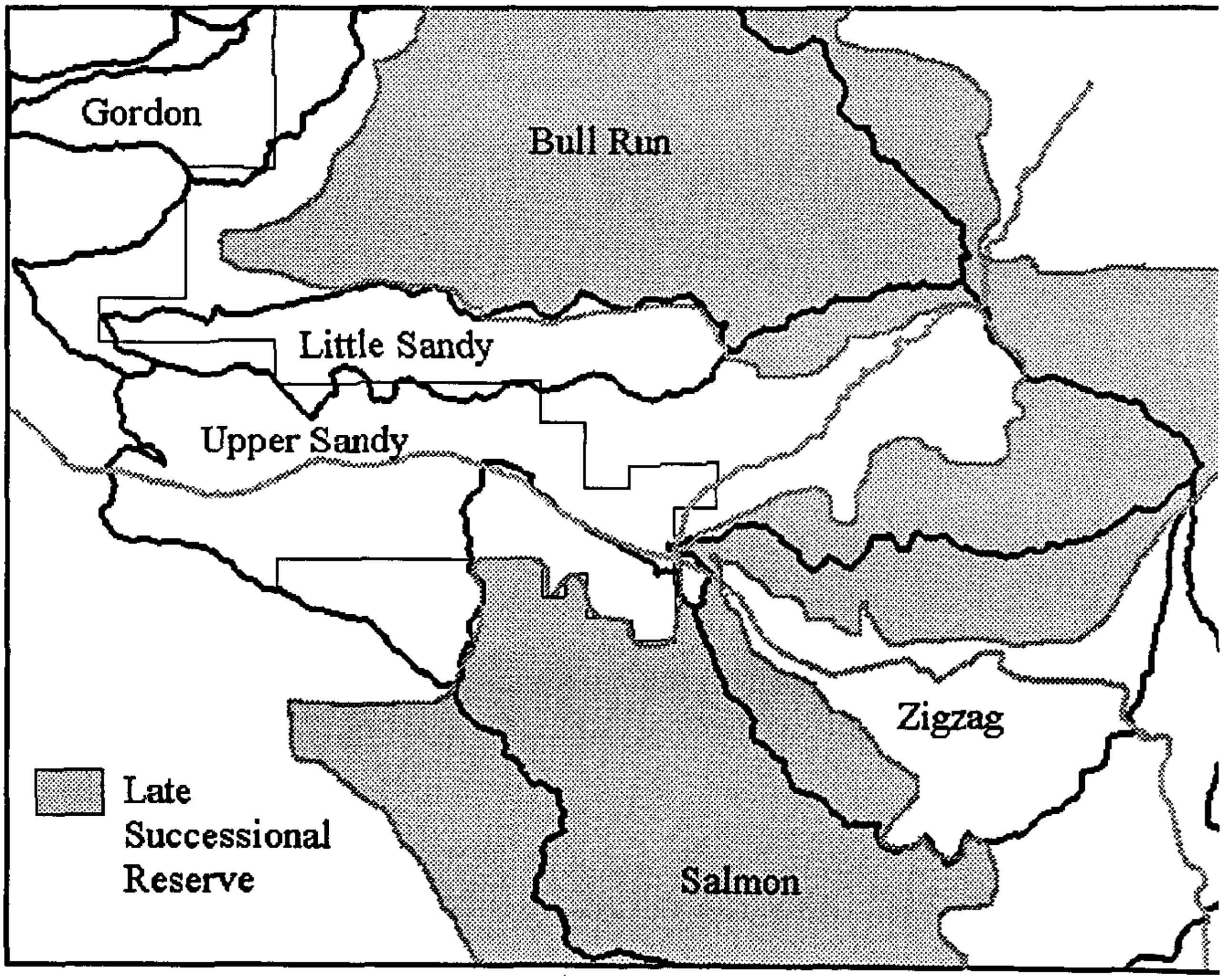
The portion of the Bull Run LSR (2460 acres) that is in the Upper Sandy Watershed (NE corner) is currently fragmented and contains little contiguous late-seral habitat. This area could develop into an important landscape link from the Bull Run LSR to the Mt. Hood Wilderness and LSR areas to the south as forests mature.

Mt. Hood Wilderness
The forested portion of the Mt. Hood Wilderness along with portions of the Sandy Wild and Scenic River and Special Interest Area contains large well connected

blocks of continuous forest cover including good interior habitat. Much of this forest cover is presently in transition to late-seral (many stands are 80 to 120 years in age).

Figure 6-1 displays the large reserve areas made up by LSRs and Wilderness areas in the Sandy River Basin and their location with respect to the Upper Sandy Watershed.

Figure 6-1 -- LSR/Wilderness Complex in the Sandy River Basin



Riparian Reserves

Riparian Reserves of the Upper Sandy Watershed are projected to be corridors of late-seral forest with occasional natural openings that lie between the large blocks of continuous forest mentioned above. Currently, however, only 21% of the Riparian Reserves are in a late-seral state.

Isolated Patches

Additional scattered patches of late-seral forest may provide important "stepping stone" habitat between LSR's to the north and south for mobile species. They also provide refugia areas on the landscape for sessile or poor dispersal species which will serve as a source to populate future stands. While portions of these stands may be carried into future stands as part of Forest Plan prescriptions that require 15% green tree retention, other portions may be harvested. Private lands contain 2228 acres of late-seral forest. Most of these stands are scattered small patches and contain no interior habitat. While portions of these stands may be maintained through State Forest Practices Act provisions such as riparian area protection, the greater portion is zoned as timber land or residential and may not be maintained as late-seral over time.

Approximately 2000 acres in the watershed have management objectives that will result in isolated patches of late-seral habitat in the future. At present, most of these areas are not in a late-seral condition. It is important to determine if any of the existing stands mentioned above currently play critical roles in connectivity in the short term while other reserve areas recover.

Table 6-1 -- Late-Seral Forest Amounts by NWFP Connectivity Strategy, shows current and future amounts of late-successional forest within areas that are to be managed to promote late-successional forest under the Mt. Hood and Northwest Forest Plan.

Table 6-1 -- Late-Seral Forest Amounts by NWFP Connectivity Strategy

Federal lands only

(Amounts expressed as percentages of reserve area)

Connectivity Strategy	Current Condition (1996)	Future Condition* (Short-term, 30-50 yrs)	Future Condition** (Long-term, 120+ years)
LSR/ Wilderness (15,922 ac)	51%	68%	100%
Riparian Reserves (6,881 ac)	21%	42%	100%
Isolated Patches (968 ac)	10%	29%	100%

* Future, short term, includes late-seral stands plus closed small conifer stands with remnants.
** Future, long term, implies full implementation of the Northwest Forest Plan, absence of large scale natural disturbances and sufficient time for successional processes to progress from early through late, approximately 120 years (or longer in MH Zone).

Effects of Land Exchanges on Connectivity

As of October 1996 the Oregon Resource Conservation Act was passed and a land exchange is in progress between Longview Fibre and the US Bureau of Land Management (BLM). Land currently owned by Longview Fibre in the Highway 26 corridor is proposed for exchange to the BLM (2929 acres). Most of these areas will be managed by the BLM for protection of important scenic values, resulting in late-seral forest over time. Although only a small amount of late-seral currently exists in this area (Table 6-2), the location of these blocks should increase the level of connectivity in the long term, both within the watershed and between reserve areas to the north and south of the Upper Sandy Watershed. *(Note: This exchange includes transferring a small portion of BLM lands in the watershed (168 ac) to Longview Fibre. The amount and location of these lands appear to be insignificant in regards to connectivity in this watershed.)*

Table 6-2 -- Late-Seral Amounts in Longview Fibre Offered Lands

(Estimates based upon proposals as of Oct. 1996)

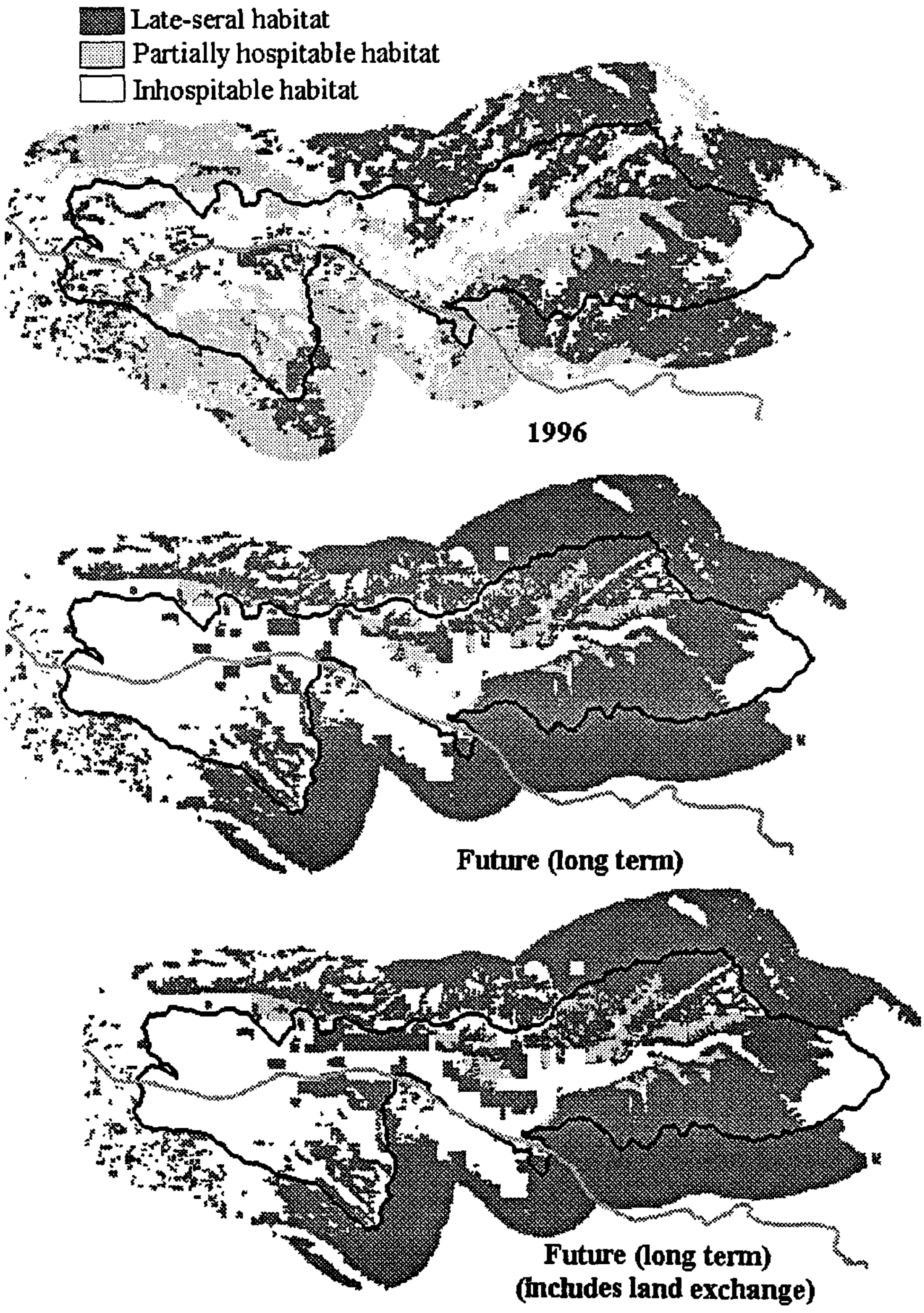
Isolated Patches	Current Condition (1996)	Future Condition* (Short-term, 30-50 yrs)	Future Condition** (Long-term, 120+ years)
Longview to BLM (2,929 ac)	11%	15%	80-100%

Partially Hospitable Habitat

While the stand types between areas of late-seral habitat may be less than optimal habitat, some areas may be usable for dispersal, resting, or seasonal/annual migrations between optimal habitat patches (Morrison et al. 1992). These areas, in effect, function as *partially hospitable habitat*. Late-seral blocks surrounded by partially hospitable habitat can be smaller and further apart than islands surrounded by inhospitable habitat (Harris 1984: 156). In this analysis closed small conifer stands that have some large remnants (trees over 21" in diameter) present are considered to be partially hospitable habitat. For assessing future conditions, partially hospitable habitat was determined from the projected stand structures of the Landscape Design Cells *(presented in Chapter Five)*. The Mature Forest/Small Opening and Mixed Age/Buffer Design Cells were determined to best approximate this. The Mixed Age/Sandy Design Cell could also provide shifting areas of partially hospitable habitat, but as openings may be larger or more common in this area it was not included in the landscape diagrams presented below. *(Refer to Chapter Five, Landscape Analysis and Design for detailed maps of Design Cell locations.)*

Figure 6-2 -- Habitat for Late-Seral Species: Current and Future, displays the location and arrangement of late-seral habitat in the Upper Sandy Watershed as well as habitat that is considered to be *partially hospitable*. Figure 6-2 also displays the projected future location of late-seral forest, both without and with the proposed land exchanges in the Highway 26 corridor.

Figure 6-2 -- Habitat for Late-Seral Species: Current and Future



Barriers to Movement

Highway 26, the Lolo Pass Road (Rd #18) and the BPA power lines are major barriers to movement of species with poor or very poor dispersal capabilities. Mobile species with larger home ranges are less affected as long as they have some patches of acceptable habitat within a reasonable distance (approx. 3-12 miles depending on species). Culverts help to mitigate the barrier from roads for riparian/aquatic species. Few opportunities exist in relation to mitigating the direct barriers imposed by major roads. Some opportunities to mitigate the effect on movement imposed by the BPA power lines, however, do exist. These include: managing for larger trees and intact forests in the deeper draws and canyons particularly those adjacent to late-seral forest; topping trees in some locations to provide structure while meeting power line management requirements; and providing habitat with down wood across the power line corridor between areas of adjacent habitat when possible.

Effects of NWFP Connectivity Strategies on Key Species

To focus on whether the habitat conditions and barriers described above present specific connectivity concerns, a list of late-successional species known to be associated with the LSR areas to the north and south of the Upper Sandy Watershed was explored. These species were then grouped into general habitat guilds.

TLMLT Guild: Mobile late-successional species that have large home ranges (>1000 acres).

Spotted Owl; Goshawk; Pileated Woodpecker; Fisher; Pine Marten; Wolverine.

Species in this guild are quite mobile and able to disperse across distances ranging from five miles (pileated woodpecker), twelve miles (spotted owl) or further (wolverine). In the Upper Sandy Watershed, distances range from 2 1/2 to 4 1/2 miles between blocks of habitat suitable for the spotted owl. *(Suitable owl habitat is displayed in Key Question #4 in this Chapter.)* The actual distances between large blocks of late-seral habitat are less than three miles in the upper half of the watershed but over eight miles in the lower half. These distances will decrease over time in the future landscape. The high human presence in the watershed most likely results in a disturbance barrier to north/south wolverine dispersal and also creates a barrier to potential fisher/pine martin movement. Availability of partially hospitable habitat and in particular ample snag habitat will strengthen connectivity for pileated woodpeckers.

TSPLT Guild: Late-successional species that have limited dispersal capabilities and small home ranges (<60 acres). These species need mostly continuous habitat for dispersal. Even smaller breaks in habitat can affect the dispersal of these species. Downed wood is very important for dispersal with many of the shrews and voles.

Red Tree Vole; Northern Flying Squirrel; Shrew Mole; Trowbridge's Shrew

Small rodents in this guild also serve a role in helping certain sessile plant species such as lichens disperse.

Very Poor Dispersers Group: Late-successional species that are very poor dispesers or sessile.

Malone Jumping Slug; Certain species of lichens; Krushea (STST)

Species in this guild are generally not capable of crossing areas of non-habitat. Some plant species, however, in particular species of lichens may be dispersed across short distances by small rodents. Species in this guild basically remain in the same location during their lifetime. Since they do not travel, isolated patches of late-seral forest and/or remnant portions from old stands provide refugia for these species to populate future stands (in essence, providing connectivity through time). Because of past fire history as well as land management activities, the Upper Sandy Watershed has few remaining remnant patches of old forest. Only seven percent of the watershed contains large, old forests. These remnant patches are particularly scarce in the lower half of the watershed.

Riparian Guild: Generally need contiguous riparian connections.

Cope's Salamander; Cascade Torrent Salamander; Pacific Giant Salamander; Harlequin Duck; Cold water Corydalis

Specific concerns relating to habitat gaps that may interfere with connectivity for any group of species are summarized in Conclusions below. Strategies to mitigate or improve areas of concern are presented below under Recommendations.

Conclusions:

- Late-seral forest within and adjacent to the watershed will substantially increase over the future.
- Blocks of late-seral forest will be better connected in the future, especially in the eastern end of the watershed.
- Late-seral habitat patch size will increase in the future and contain more interior habitat.
- North/south dispersal opportunities will be enhanced for mobile and limited dispersal species across the mid portion of the watershed.

- Connectivity will be further enhanced in the long term if the Highway 26 Corridor land exchange proceeds as currently proposed. These areas will provide stepping stone habitat for mobile species and increase scattered refugia areas for less mobile species.
- Land use in the watershed will continue to present dispersal barriers (albeit less than present) to late-seral species that have limited dispersal capabilities.
- There was little late-seral habitat along the southern portion of the watershed and adjacent areas in 1948. There is more in 1996 and thus dispersal distances across the watershed have been shortened. This trend will continue under current management plans especially in the upper portion of the watershed.
- Old forest patches of large trees are rare, especially outside of reserve areas. Forest legacies from these stands provide a local source of propagules of certain species including lichens that take centuries to become established.

Recommendations:

Note: Silvicultural techniques to enhance or accelerate late-seral conditions may include: density management of overstocked conifer plantations; reintroduction of conifers into alder dominated riparian areas; thinning in some natural stands; creation of snags or down wood.

- Use silvicultural techniques to enhance late-seral conditions in Riparian Reserves where it is lacking (specifically Clear Creek, North Boulder and Alder Creek subwatersheds of the Upper Sandy Watershed, and also in the upper end of the Lower Little Sandy subwatershed *(refer to Bull Run Watershed Analysis)*.
- Maintain structural components in the short term on upland areas adjacent to Riparian Reserves that currently lack late-seral, especially within the subwatersheds mentioned above.
- Strengthen forest connectivity across the BPA power line right-of-way in the northeast portion of the watershed by managing forest patches in draws and canyons to have large trees and structural diversity, including down wood.
- Maintain or increase down wood in additional areas across BPA power line right-of-way where possible.
- Maintain areas or components of isolated late-seral patches in subwatersheds on federal lands that are low in late-seral habitat in the short term. (Clear Creek, North Boulder, Alder) Give higher priority to those of unique diversity (especially patches of old, large trees) or known to have populations of sensitive species. (For example, Krusehea populations near North Mountain, see Chapter Four Botany and Key Question #4.)
- Maintain and/or increase down wood amounts in subwatersheds or large areas that lack late-seral forest and down wood to help create partially hospitable habitat for some species.

- Use silvicultural techniques in plantations in the LSR area of the Upper Sandy Watershed to promote late-seral forest or components. Prioritize treatment areas by those that will best respond to treatment combined with those that will most benefit landscape connectivity (for example plantations that sever potential late-seral corridors, or create a high proportion of edge in areas where interior habitat is scarce).

- Evaluate future trends and contribution of riparian habitat on private lands to connectivity under the updated Oregon Department of Forestry Water Protection Rules (1994).

Key question #3: What is the relationship between conditions of the watershed and recreation uses on federal lands?

Conditions of the Upper Sandy Watershed which affect recreational opportunities and management are tied to watershed features and standards and guidelines from the Mount Hood Land and Resource Management Plan (LRMP) and the Northwest Forest Plan (NWFP). The NWFP lists additional standards for management of all federal lands (ROD p. C-1 through C-5) and in Riparian Reserves (ROD p. C-30 through C-38) and matrix lands (ROD p. C-39 through C-61). The specific reference to management of recreation sites within Riparian Reserves is found in the ROD page C-34 (RM-1, RM-2, RM-3). The specific Aquatic Conservation Strategy Objectives that all proposed projects are reviewed against are found in the Basis for Standards (ROD page B-11).

The current level of recreation use in the watershed is expected to increase in the future. The State Comprehensive Outdoor Recreation Plan (SCORP), projects a 57% increase in recreation use between 1987 and 2000 in the Portland metropolitan region, which includes the Upper Sandy Watershed. This will cause an increased demand for additional recreation facilities both on public and private lands in the watershed. This increased demand will also likely cause additional resource impacts at existing and planned facilities. The potential for conflicts between the various recreation uses and resource management objectives will also occur. An example of a conflict that is already occurring is the increase in dispersed camping use due to developed campgrounds being filled to capacity. This tends to expand the traditional dispersed camping areas and creates additional compacted and unvegetated sites as well as problems with litter and vandalism. Dispersed campsites are often associated with Riparian Reserves in the watershed.

Each fall, thousands of mushroom hunters visit the Old Maid Flat area seeking several varieties of fall mushrooms. This activity in conjunction with an increase of dispersed camping, is a threat to the unique bio-diversity of the area. Data needs to be gathered to determine trends of impacts and plan for management created.

Proposed Recreation Projects (next 5 years)

McNeil and Riley campground power and water: This project will install a water system at Riley with pressure piping to McNeil. Funding for the project has not been secured. A power line would be buried from Lolo pass road to Riley campground to power the pump in the existing well. This project would be designed to be consistent with Aquatic Conservation Strategy objectives (ROD B-11).

Sandy River Trail Reconstruction: This project would reconstruct the trail from Riley Campground to the old upper Ramona Falls Trailhead, construct a hiker bridge over Lost Creek and improve the horse ford (near Riley Campground). The possibility of making the trail a mountain bike trail in addition to a horse trail will be investigated. This project would be designed to meet the Aquatic Conservation Strategy (ROD B-11).

Shooting Pit: This project would close old shooting area under the Lolo Pass power lines and create a new site. This project is in progress and was designed to meet the ACS objectives.

Cast Creek Trail Reconstruction: This project realigns and reconstructs the trail to horse standards. The current location and design do not meet the standard and the trail has experienced severe erosion. The project would solve the problems associated with poor initial trail layout. The lower mile of trail would be relocated out of the wilderness, and other sections would be relocated to solve erosion problems. The existing trail is currently closed due to safety concerns caused by the excessive erosion in portions of the trail. The project has been designed to be consistent with ACS objectives.

Horseshoe Trail Reconstruction: The project reconstructs the existing trail to horse standards. It relocates two short sections to avoid wet areas and relocates the beginning of the trail to avoid the Three Creeks Cascade Streamwatch site. It eliminates one stream crossing over Lost Creek. The project has been designed to be consistent with ACS objectives.

Close Ramona Falls Road. This was accomplished in 1996 due to portions of the road washing out earlier in the year. Closing this one mile section of road had been identified in the Upper Sandy Wild and Scenic River plan and other land management planning documents as far back as 1976 as a potential way to reduce impacts to wilderness. The project meets the objectives of the ACS in riparian areas.

Wilderness Limits of Acceptable Change Implementation: This project is to develop an EA revising LRMP Standards and Guidelines (A2). The project will be designed to be consistent with ACS objectives and the Wilderness Act.

Wilderness Implementation Schedule Update. This project is not funded but and update is needed to reflect completed work and revised priorities based on ACS objectives, new A2 - Wilderness standards and guidelines, and projects already completed.

Removal of Ramona Falls Trail Bridge: This project would remove the concrete and steel bridge over the Sandy River near the old upper trailhead. The bridge is condemned and two log stringer seasonal bridges are taking its place. Access to the wilderness from late fall to early spring now requires fording the stream. This will undoubtedly reduce wilderness use during this time period. Removal of the old bridge is not currently funded. The project would be designed to be consistnet with ACS objectives and LRMP scenic objectives. Some short term impacts may be experienced depending on the type of equipment used to remove the bridge.

Frenches Dome Trail: This project proposes to complete trail stabilization and access. It would requires special funding, which is currently not available. This is a popular rock climbing area adjacent to the Lolo Pass Power lines. Rock Climbing popularity has exploded over the past 5 years due to the advent of "rock gyms" in the Portland area. This project would be designed to be consistent with the ACS objectives.

Cascade Streamwatch Three Creeks Site. This project would create interpretive trail and viewing areas near Riley Campground. (Funding is uncertain.) The design of this project would need to meet the ACS objectives as well as scenic objectives for the area (roaded recreation).

Upper Sandy Guard Station: Built as a guard station for the original Bull Run Reserve, this building is rapidly deteriorating and either needs to be rehabilitated or torn down for public safety. The building is located within wilderness and is considered a non-conforming structure. The building is eligible to be placed on the National Historic Register. Removal of the building would reduce impacts to the surrounding area from overuse.

Old Maid Flat Snowpark: (funding uncertain) This project would develop a site that would be a combination snowpark and group camp site with interpretive kiosk with seasonal panels. A major feature of the site would be an outstanding view of Mt. Hood. The site would need to be designed in accordance with ACS objectives and LRMP scenic objectives.

McIntyre Ridge Trail: This trail accesses the Salmon Huckleberry Wilderness near Wildcat Mountain. The trail is a ridgetop trail and swings in and out of the wilderness along its length. Planning is in progress that would relocate all of the trail outside of wilderness and open the trail to mountain biking since that opportunity is very rare on the district. The project would be designed to be consistent with ACS objectives and the LRMP.

Conclusions

The future recreation projects proposed in the Upper Sandy watershed do not appear to conflict with the objectives of the Northwest Forest Plan, LRMP, Wild and Scenic River Plan, or the Mt. Hood Wilderness plan. The projects are proposed to enhance or improve conditions of the Upper Sandy Watershed. Projects that include additional development such as the Three Creeks Cascade Streamwatch site can be designed to be consistent with Aquatic Conservation Strategy objectives.

Key Question # 4 – How do conditions of the watershed contribute to habitat needs for species of concern associated with aquatic, riparian, terrestrial and special habitats?

Terrestrial Habitats - Late-seral

Table 6-3 – Documented Late-Seral Species of Concern

Species (Documented in the watershed)	Concern
Krushea *Streptopus streptopoides*	Forest Service sensitive
Noble polypore *Bridgeoporus nobilissmus*	ROD survey and manage species
Hypogymnia duplicata	ROD survey and manage lichen species
Loxosporopsis coralifera	ROD survey and manage lichen species
Pseudocyphellaria rainierensis	ROD survey and manage lichen species
Thorluna dissimilis	ROD survey and manage lichen species
Northern Spotted Owl *Strix occidentalis caurina*	USFWS listed as threatened

Krushea

Small old-growth forest patches on North Mountain represent a significant habitat in the Upper Sandy Watershed. For, it is here -- within these patches' thick duff and rotting wood in cool, moist forest -- that North America's southern-most population of **krushea** is found.

Krushea is more common in Washington and northwards in undisturbed old-growth forests. In Oregon, the majority of populations reside in the Bull Run Watershed. In fact, North Mountain is krushea's only location outside the Bull Run. This North Mountain forest habitat appears to be an extension of Bull Run Watershed forest types -- with cool, moist plant associations such as western hemlock/Alaskan huckleberry-oxalis (TSHE/VAAL-OXOR) and a long period of fire exclusion (at least 200-300 years). (In depth discussion of the Bull Run habitat is available in the *Bull Run Watershed Analysis* [In preparation, Lankford et al, 1996].) Krushea habitat is not expected elsewhere in the Upper Sandy Watershed.

North Mountain was selected as one of five major population sites for protection in the draft *Species Management Guide for Streptopus streptopoides* (Kagan and Vrilakas 1993). The Northwest Forest Plan also suggests protecting this type of rare plant site as a mitigation measure (ROD, p 33). The North Mountain krushea population and adjacent habitat encompass approximately 500 acres. Much of this patch is located within the B5 Pine Marten/Pileated Woodpecker Management

Area that is recommended for retention. The Mt. Hood National Forest's standards and guidelines for B5 include keeping at least 300 acres of contiguous late seral forest within the 600-acre allocation at all times while allowing timber harvest on the other 300 acres. The majority of krushea on North Mountain grows in the oldest forest which is fragmented, *not* contiguous and thus may not be protected from disturbance by the B5 allocation. Protection for existing krushea plants and habitat equates to retaining all old-growth fragments on North Mountain in an undisturbed state. Any timber harvest in this stand type may be deterimental to krushea's microclimate and substrate requirements. Additional no-timber harvest acres including krushea sites need to be designated on North Mountain. While plantations can be thinned as needed to encourage tree growth, to encourage a thick duff layer, disturbance to the forest floor should always be minimal.

The habitat needs of krushea are compatible with direction for B5 Pine Marten/Pileated Woodpecker Management Area lands if fragmented old-growth patches with krushea are added to the contiguous 300 acre late-seral block. Krushea's viabiltiy in the Upper Sandy Watershed and the protection of this unique portion of its gene pool is dependent on establishing: a B5 land allocation and a botanical reserve, or a similar restricted land allocation on North Mountain.

Noble polypore

Large-diameter true fir snags and stumps are substrate for the very rare **noble polypore**, a Survey and Manage fungus. This habitat is most often found within the Pacific Silver Fir Zone. Past fires and logging have probably reduced the amount of substrate for this conk from historic levels. Currently, only 1,065 acres of large conifer stands occupy the Pacific Silver Fir Zone within the Upper Sandy Watershed.

One noble polypore conk was collected on BLM lands on North Mountain in the 1980's during a timber sale layout. Despite intensive post-harvest surveys, no other conks were found nearby. This BLM discovery site is currently (1996) in a five-year-old plantation.

Management of North Mountain Forest Service lands for krushea or a B5 allocation may also assure substrate habitat for noble polypore.

On Wildcat Mountain a noble polypore conk grows 1000 feet south of the watershed boundary in the Eagle Creek watershed. Large diameter true fir snags and stumps are present in the Upper Sandy portion of Wildcat Mountain. Grid surveys are recommended to locate additional sites in this watershed. The

Northwest Forest Plan's guidelines for snags and green tree retention should help provide future substrate within the watershed's federal lands.

Lichens

Three survey and manage lichens are associated with cool, moist old-growth forest: ***Hypogymnia duplicata*** (2 sites), ***Loxosporopsis coralifera***, and ***Pseudocyphellaria rainierensis***. The following land allocations currently protect most of these sites: Riparian Reserve, Wild and Scenic River, and wilderness. No sites are yet known in Late-Successional Reserves, however, this land allocation does provide some of the best habitat in the watershed for these lichens and other Survey and Manage lichens. Generally the highest biomass and diversity of lichens is found in the oldest forests. Many of the nitrogen-fixing and forage species will not colonize stands until they are at least 100-200 years old.

Isolated old-growth stands outside LSR's, such as those on North Mountain, are an important source of lichen propagules for the colonization of younger stands.

Generally cool, moist old-growth forest stands should increase within the watershed over the long term under direction from the Northwest Forest Plan.

Thorluna dissimilis, which is known from a subalpine site at Paradise Park, also has habitat in old-growth Douglas fir canopies on foggy ridgetops. Northwest Forest Plan direction should protect this type of habitat.

All four of these survey and manage lichen species may be sensitive to air pollution. Preliminary data from a Mt. Hood Wilderness air quality study suggests that the concentration of some elements -- including lead -- may be higher than expected at some sites in the Upper Sandy Watershed (Geisier and Boyll 1994). Car exhaust at trailheads or from Highway 26 or pollutants carried with Columbia Gorge winds are likely sources.

Northern Spotted Owl

The northern spotted owl is closely associated with old-growth stand conditions. Multi-layered old-growth forests are the preferred nesting habitat of spotted owls in Oregon, although suitable nesting sites are provided by both mature and second-growth stands with scattered old-growth and broken-topped trees.

Five active owl pairs are known within the watershed and one additional pair resides on the border with the Bull Run Watershed. There are substantially more owl pairs located to the north in the Bull Run Watershed and to the south in the Salmon River Watershed, areas that have large contiguous patches of habitat.

The HABSCAPES program was run by Mt. Hood Wildlife Ecologist, Kim Mellen, to model spotted owl habitat for the Upper Sandy Watershed. The model was run for three points in time to reflect past, current and future conditions, and trends.

The following three maps in Figure 6-3, depict suitable, marginal, and non-habitat for the spotted owl. Acres are summarized in the accompanying table. Suitable habitat includes large conifer and closed small conifer stands with remnants and a minimum patch size of forty acres. It also includes a percentage of home range in habitat. Marginal habitat often meets the stand structure requirements for owl habitat, yet the patch size is too small or isolated to be considered suitable habitat. Non-habitat would include areas that do not have suitable vegetative structure for spotted owls. These would include agricultural fields, high elevation rock, snow and ice, and small size forested stands. (The categories suitable and marginal from this model both are considered nesting, roosting, and foraging habitat which is used for consultation.)

Figure 6-3 -- Historic, Current, and Future Spotted Owl Habitat

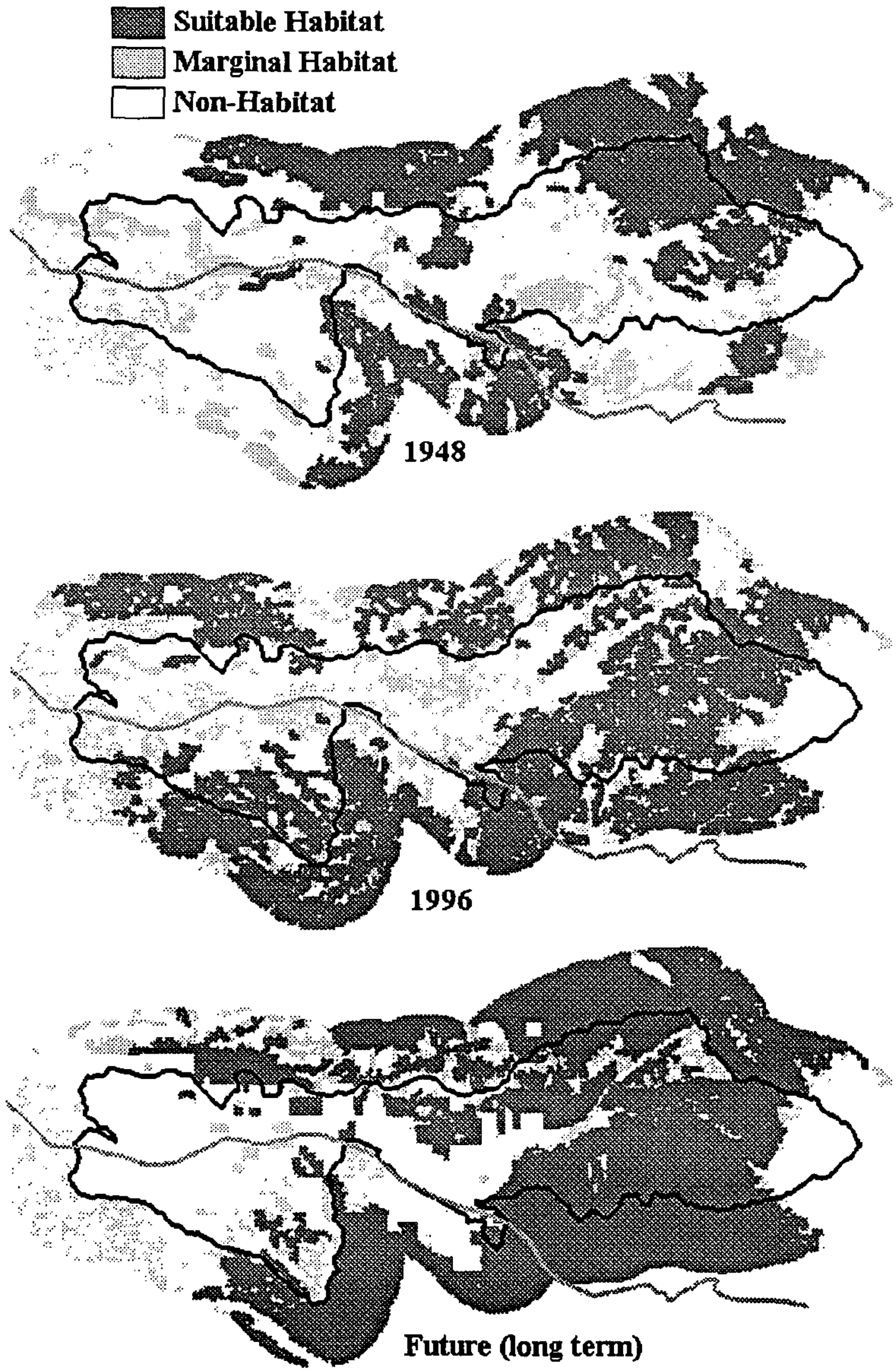


Table 6-4 Historic, Current, and Future Acres of Spotted Owl Habitat

Habitat	Historic Acres	Current Acres	Future Acres
Suitable	12,580	20,005	26,372
Marginal	5,283	4,836	2,058
Non-Habitat	49,946	42,963	39,377

The historic acres were determined from a 1948 vegetation database. This map reflects the influence of fires from the turn of the century which is strongly evident in the stand structure as well as human development in the lower watershed. At that point in time, suitable owl habitat was limited. The largest area occurred in the Clear Creek, Clear Fork, and Muddy Fork subwatersheds. Additionally, a smaller area of suitable habitat in the North Mountain area was present in 1948.

Current owl habitat shows a maturing of stands in the Mt. Hood Wilderness and Wildcat Mountain area, which contribute to a large increase in acres of suitable habitat. However, timber harvest has fragmented portions of the Clear Fork and North Mountain areas, reducing habitat. Scattered patches of marginal habitat, and smaller patches of suitable habitat occur throughout the watershed.

Future habitat is based on the Conceptual Landscape Design and Future Seral Stage maps which depict conceptual vegetative structure (see Chapter Five). There is another large increase in suitable owl habitat as stands on federal lands mature, especially in the Clear Fork subwatershed, which is currently fragmented. This area is the southern end of the Bull Run/Columbia Gorge LSR.

Overall, there is an increasing trend in acres suitable for spotted owls, and a decreasing trend in marginal habitat and non-habitat. However, there is still a large percentage of the watershed, 58%, that is projected to remain predominantly in non-habitat. This is due in part to the large amounts of developed, semi-open or agricultural lands in the lower watershed and Highway 26 Corridor. Above 5,000 feet elevation will also remain non-habitat, as most is rock, snow or ice.

In addition to suitable owl habitat, dispersal habitat is used for both foraging and as a crucial link for owls to travel between blocks of suitable habitat. Dispersal habitat is defined as a stand of trees with an average DBH of 11 inches, and average canopy closure of 40%. Currently dispersal habitat within the Upper Sandy Watershed is approximately 39,224 acres, or 58% of the watershed. Connectivity/dispersal is discussed in Key Question #2.

Of the five pairs of owls in the watershed, one is within the LSR, one within the Mt. Hood Wilderness, and three are within matrix lands. Each of the three pairs in matrix received 100 acre LSR designation in which the best one hundred acres of spotted owl habitat will be retained as close to the nest site or owl activity center as possible.

The owl pair in the Wildcat Mountain area is at risk because of poor habitat and potential harvest in the area.

Most of this area is composed of mid-seral stands as well as recent clearcut harvest units adjacent to the 100 acre LSR. There is not enough habitat to maintain and improve in the near future. This area is designated Critical Habitat Unit by the USFWS and Special Emphasis Watershed by the LRMP. Potentially, this pair is in a take situation in the future, (<40% habitat in home range circle), and therefore consultation with the USFWS will be needed on proposed projects.

Two other owl centers are located in lesser quality habitat. However, adjacent land allocations to the 100 acre LSRs will help to maintain additional suitable habitat. These allocations include Riparian Reserve, Wild and Scenic River, and Wilderness. Land allocations that allow timber harvest, however, are also in the immediate area of these owl centers and could be an impact.

Terrestrial Habitats - Early Seral

Ground cedar

The sensitive clubmoss, **ground cedar**, grows in shrubby areas with a hot fire history at upper mid-elevations within the Forest (primarily Pacific Silver Fir Zone). Sites near Little Clear Creek and the old Burnt Lake Trail were burned in the late 1800s and early 1900s. The former Burnt Lake Trail ground cedar site has disappeared -- perhaps from overstory competition. The large ground cedar population in the Zigzag Watershed (see Zigzag Watershed Analysis, 1995) at Government Camp's Ski Bowl ski area is being maintained as an indirect effect of ski slope brushing.

The small ground cedar population in the Little Clear Creek headwaters may be lost as overstory competition increases. Cutting vegetation to maintain a low shrub community may be contradictory to the desired late-seral future condition of Riparian Reserves. The importance of this site relative to other sites on the Mt. Hood National Forest and in Oregon needs to be assessed before habitat manipulation is started.

At this time, early-seral forest is within the RNV for the Pacific Silver Fir Zone. Further surveys for potential habitat could locate more populations. The amount of future shrubby fire-derived habitat will dependent on the Upper Sandy Watershed's fire suppression plans and strategies.

Noxious Weeds and Invasive Non-native Plants

Disturbed, bare ground provides ideal habitat for **noxious weeds** and **invasive non-native plants**. Chapter Four discusses these species known to occur within the watershed. Presently, non-federal lands provide the most disturbed habitat for weeds within the watershed.

The potential for noxious weeds and invasive non-native species on non-federal lands will probably remain similar or increase into the future. The trend on federal lands to maintain and improve natural biodiversity should provide less habitat for weeds in the future, and contribute to a decline in existing weed sites.

Terrestrial Habitats - Contrast

Elk

Elk, although not a listed "species of concern", are an important recreational and economic resource. There are two main herds in the watershed with isolated, smaller herds throughout the drainage. The higher concentrations are in the Marmot and Wildcat Mountain areas. The herds are distinct but individual animals will wander and join neighboring herds. The private lands and fringe areas also have healthy herds.

Elk are classified as a contrast species and therefore need both openings/early seral stands for forage and forested areas for cover. The HABSCAPES program was used to model elk habitat for the Upper Sandy Watershed. The vegetation database, developed for the watershed, was used to query specific parameters for elk. The specific parameters for the model are included in the analysis file and include the following: foraging habitat = grass/forb/shrub and some semi-open habitats, cover = large conifer and closed small conifer forests, home range size = 3,000 acres.

The outputs of the map are:

- Foraging contrast habitat - forage within 400 meters of cover
- Cover contrast habitat - cover within 400 meters of forage
- Contributing forage
- Contributing cover

Contributing habitat is usually at the edge of blocks of habitat, and contributes to an adjacent home range, but not enough to support an individual animal.

Figure 6-4 and Table 6-5 display elk habitat in 1948 and currently. A future estimation was not made since it is difficult to predict the size and arrangement of openings in the future that would determine contrast habitat, and since most of the current habitat is on private lands.

Figure 6-4 -- Elk Habitat - Past and Current

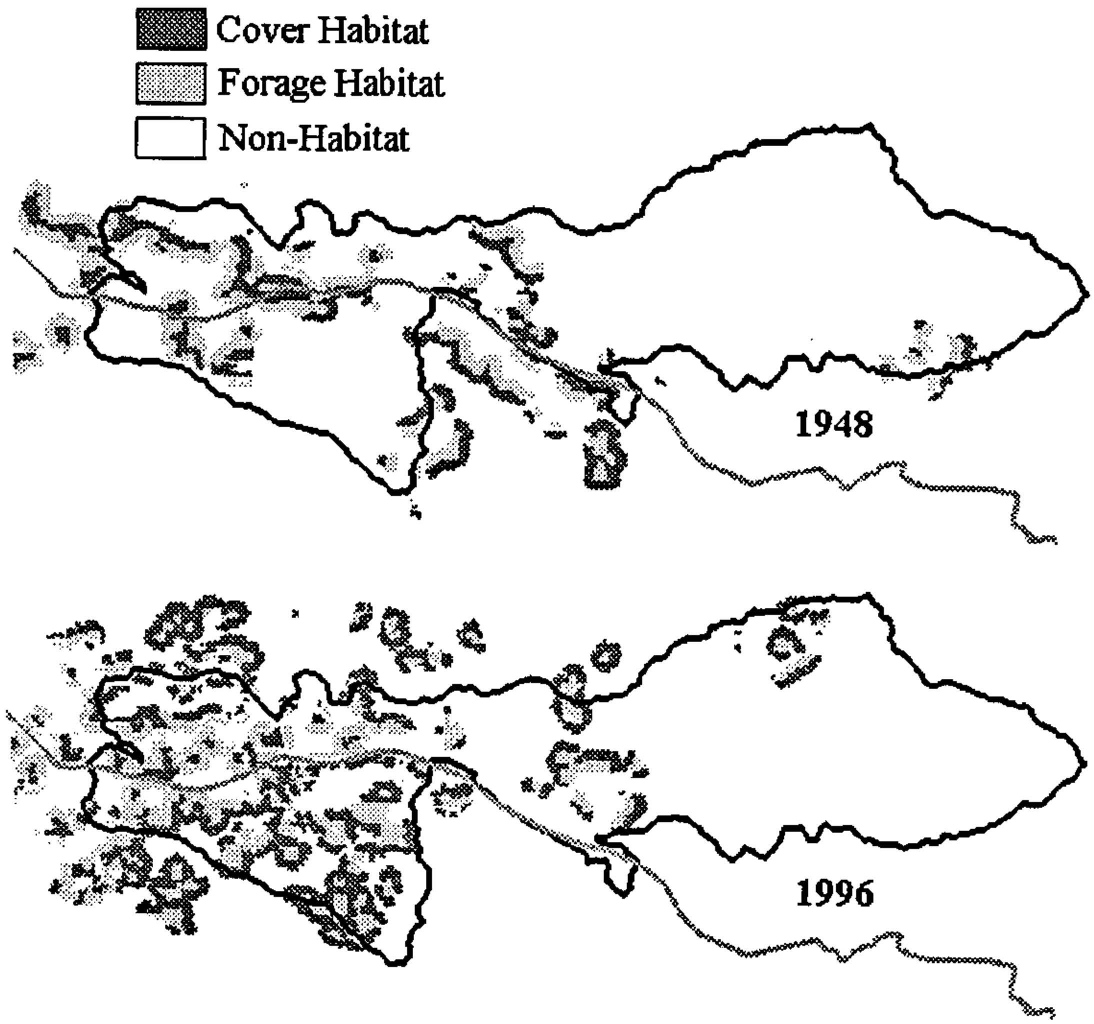


Table 6-5 Elk Habitat - Past and Current Acres

Habitat	Historic Acres	Current Acres
Cover habitat	3,033	6,051
Forage habitat	3,572	5,140
Contributing cover	603	986
Contributing forage	662	430
Non-habitat	59,935	55,200

Historically and currently, the majority of contrast habitat for elk occurs within the lower half of the Upper Sandy Watershed. Within this lower half, overall habitat has almost doubled from 1948 to 1996.

As stands matured from fires at the turn of the century, cover habitat improved in areas such as Wildcat Mountain. In addition, timber harvesting within this same area created the needed forage openings. Harvesting at the headwaters of Clear Creek also created forage openings and therefore contrast habitats. Agricultural lands in the lower watershed are frequently used as well.

Although it is difficult to predict size and arrangement of openings in the lower watershed in the future, it is likely that contrast habitat will remain at similar levels. The upper half of the watershed is not likely to provide much elk habitat due to steeper terrain and land allocations favoring late-seral stands. Natural openings will provide some forage, however, and some design cells allow for small openings.

Terrestrial Habitats - Other

Wolverine

A sighting of the wolverine, a sensitive species, occurred within the watershed at the foot of Crutcher's Bench in 1988. A 1996 sighting occurred at the Bear Creek house in the Bull Run Watershed to the north. In 1990 tracks were confirmed southeast of the watershed in the West Fork of the Salmon River.

Wolverine denning habitat was mapped for the Mt. Hood National Forest using a study in central Idaho as a starting point. For the Upper Sandy Watershed, potential denning habitat exists in higher elevation portions of the Mt. Hood Wilderness. The high level of recreation use in the watershed may limit wolverine use.

Special Habitats

Subalpine/Alpine

Three Species of Concern grow in subalpine/alpine habitats: ***Gastroboletus ruber***, a mushroom; ***Thorluna dissimilis***, a lichen (both are Survey and Manage species); and ***Brewer's reedgrass***, a Sensitive grass. All grow in the Mt. Hood Wilderness. Except for *T. dissimilis*, all should be well-protected into the future. *T. dissimilis*, however, grows on exposed trees and may therefore be sensitive to air pollution. There is an indication of air pollution within the Mt. Hood Wilderness (Geisier and Boyll, 1994) which suggests air quality may decline with increased human population growth.

Wetlands

Wetlands in the Upper Sandy Watershed are homes to: two sensitive plants, **pale sedge** and **fir clubmoss;** and two inventory plants, **cotton grass** and **wild cranberry**. In addition, seven other sensitive plants are also suspected to occur within the watershed's wetlands.

The North Mountain wetland complexes provide the largest and highest quality habitat in the watershed. Present land allocations (Riparian Reserve and Key Site Riparian Area) should maintain and, in some cases, even improve wetland habitat for species of concern.

All of the Upper Sandy Watershed's wetlands are in need of additional plant species inventories. These surveys will most likely discover additional species of concern.

Bridges

Caves, mines, bridges and abandoned buildings are often used as bat habitat. A survey of bridges and other potential bat habitat occurred on the Zigzag Ranger District in 1995. Several myotis were located although identification could not be narrowed beyond the genus level. Myotis were found in the Muddy Fork and Clear Fork subwatersheds. Several bats of unknown species were found in the Wildcat Mountain area.

Aquatic/Riparian Habitats

Table 6-6 – Documented Aquatic/Riparian Species of Concern

Species (Documented)	Concern
Coho salmon	Forest Service and State sensitive species; high risk of extinction; under review for Federal T & E listing.
Spring chinook salmon	High risk of extinction; status under review by State.
Winter steelhead	Moderate risk of extinction; proposed as threatened
Sea-run cutthroat trout	Forest Service and State sensitive species; moderate risk of extinction.
Pacific lamprey	State sensitive species
Resident cutthroat trout	Public interest; Mt. Hood National Forest management indicator species
Corydalis aqua-gelida Cold water corydalis	Forest Service sensitive species, ROD survey and manage species, Fish and Wildlife category 2
Hydrothyria venosa	ROD survey and manage species
Bald eagle	Federally listed as threatened
Harlequin duck	Oregon State and Forest Service sensitive species, USFWS species of concern

Anadromous Fish

All anadromous fish within the watershed were grouped in this assessment due to similar habitat requirements and range of distribution within the watershed.

Coho salmon is listed by the State of Oregon and the Forest Service as a sensitive species. The National Marine Fisheries Service is currently reviewing status of the stock for possible listing as a threatened and endangered species.

The spring chinook salmon run in the upper Sandy Basin is composed of two stocks, a native "early-run" and a later run derived from and supplemented with Willamette stock. The native run is presently very small and may be extinct. Natural reproduction of the introduced run is increasing over time in the watershed.

The existing stock of native winter steelhead is composed primarily of late-run upper Sandy stocks. Prior to 1964, early-run stocks were released throughout the upper Sandy Basin. Hatchery release of early run stocks continue in the Sandy River below Marmot Dam. Adult returns to the upper Sandy Basin have been fairly stable averaging approximately 3,000 fish the past 30 years. Returning numbers, however, have declined during the last several years. It is currently proposed as threatened by the National Marine Fisheries Service (NMFS).

The sea-run cutthroat is a native stock and is listed as a sensitive species by the State of Oregon. The American Fisheries Society (AFS) report lists the stock in moderate danger of extinction; very few are detected passing over Marmot Dam.

Pacific lamprey are State Sensitive Species based on significantly depressed populations throughout their range (Weeks, ODFW 1993; Downey et al., 1993).

Individual Species Habitat Requirements

Coho salmon prefer areas with low water velocities such as low gradient small to medium sized streams, side channels, and the margins of mainstem rivers (Meehan and Born 1991; Groot and Margolis 1991). Large woody debris frequently acts as the roughness element creating the protected low velocity margins of the river that coho prefer to utilize.

Chinook salmon utilize larger streams and river systems. Chinook prefer large pools with large woody debris in low gradient areas along the mainstem and do not usually venture into tributaries or side channels.

Juvenile steelhead trout typically prefer faster water areas than coho or chinook salmon (Groot and Margolis 1991; Meehan 1991). Older steelhead juveniles prefer the heads of pools, and riffles with large boulder substrate and woody cover in the summer. During winter, older steelhead juveniles are found in pools, near streamside cover and under debris, logs or boulders.

The historic range of the Pacific lamprey in the Columbia River Basin was coincident with anadromous salmonids. Pacific lamprey use the same spawning substrate as anadromous salmonids. Larval lamprey (ammocetes) spend 5-6 years in slow water, fine substrate, freshwater habitats before migrating to the ocean. Rapid or prolonged water withdrawals that dry out edgewater stream habitat is the greatest risk to larval lamprey (Dick Beemish pers. comm.). High water temperatures, degraded water quality, and extremely high barriers are additional risk factors. The habitat requirements of Pacific lamprey are similar to those of coho and chinook salmon

Based on the habitat requirements for individual species key habitat components were identified for anadromous fisheries within the Upper Sandy Watershed.

- In-channel large woody debris
- Pools
- Side channels
- Flow Regime within Range of Natural Variation
- Sediment Regime within Range of Natural Variation
- Habitat Access (availability to historical range of distribution)
- Stream temperatures within the appropriate range to meet life cycle requirements for anadromous fish

The following section will summarize conclusions for each habitat component. For more details on individual habitat components see the Fish Habitat section in Chapter 4.

In-channel large woody debris

- Third order streams are outside and above the RNV.
- Forth and fifth order streams are in the low range of the RNV.
- Sixth order streams have no LWD.
- The mainstem Sandy River has severe problems with stream structure identified in the DEQ 1988 nonpoint source assessment.

Large Woody Debris Recruitment Potential

- Subwatersheds in the Western Hemlock Zone are below the undisturbed condition for LWD recruitment potential.
- Subwatersheds in the upper watershed (above the Western Hemlock Zone) have little area in the high large woody debris recruitment potential class due to undisturbed stands with small diameters (less than 21" DBH).

Pools

- Third, forth, and fifth order streams are at the upper end or outside and above the RNV for pool levels.
- Sixth order streams have no pool habitat.
- The mainstem Sandy River has severe problems with stream structure identified in the 1988 DEQ nonpoint source assessment.

Side Channels

- Within anadromous reaches across the watersheds the percent of side channel habitat appears to approximate that of an undisturbed area.

Flow Regime

- Summer lowflows have been significantly reduced in the Sandy River below Marmot Dam and in Alder Creek below the City of Sandy's intake.
- Based on the DNR Hydrologic Change Module it appears that peakflow magnitudes have been increased with the potential to cause channel destabilization and increased sediment yields associated with streambank and inner gorge failures from both created openings and roads in the lower Sandy subwatersheds (Sandy River Brightwood, Sandy River Hackett, Sandy River Wildwood, and Sandy River Mensinger), Cedar Creek, Alder Creek, North Boulder Creek, and Clear Fork subwatersheds.

Sediment Regime

- Glacial Silt within the Sandy River and the Muddy Fork is a natural occurrence in this watershed and all the sixth and seventh order channels are affected.
- Clear Creek and Little Clear Creek were affected by debris torrents associated with the February 1996 flood. The debris torrent in Clear Creek was not management related but the debris torrent in Little Clear Creek was.

Habitat Access

- There are no artificial barriers limiting access to habitat within this watershed.

Stream Temperatures

- The Sandy River below Marmot Dam is identified as Water Quality Limited for summer stream temperatures

- Alder Creek, Clear Fork, and Clear Creek have concerns with summer stream temperatures
- Stream shade levels are well below the undisturbed condition in all the subwatersheds. The lower Sandy River subwatersheds, Badger Creek, and Clear Creek have less than 50% of the area in the riparian reserves with canopy closures over 70% (the undisturbed condition is 90% of the area with canopy closure over 70%).

Conclusions Anadromous Fish

Sixth and greater order streams have limited pool habitat, limited large woody debris, glacial silt, an altered lowflow regime in the lower watershed, an altered peakflow regime with the potential to increase sediment yields across the watershed, and problems with summer stream temperatures. This would indicate poor habitat conditions for chinook salmon, that utilize larger stream systems, in this watershed. The presence of glacial silt, an altered lowflow regime, and increased water temperatures in the mainstem Sandy may adversely effect lamprey due to prolonged water withdrawal, high stream temperatures and lack of fine substrate.

Third, forth, and fifth order streams within the National Forest are within the RNV and approximate the undisturbed condition for large woody debris, pools and side channel habitat. This would indicate habitat conditions that would meet the requirements of steelhead trout, coho salmon, and sea-run cutthroat. However, there are some concerns with habitat condition in 3-5 order streams: Clear Creek and Little Clear Creek had large sediment inputs associated with the February 1996 flood; Alder Creek may be dewatered in the lower reaches, and there are summer stream temperature concerns in Alder Creek, Clear Fork and Clear Creek.

Resident Cutthroat Trout

Critical habitat components for resident cutthroat trout include:

- In-channel large woody debris
- Pools
- Flow regime within range of natural variation
- Sediment Regime within the range of natural variation
- Stream temperature within range of natural variation
- Habitat access (current availability compared to historical range of distribution)

The following bullet statements summarize the condition of key habitat components in stream reaches utilized by resident fish.

In-channel large woody debris

- Large woody debris levels are within the mid to upper range of the RNV for third, forth and fifth order channels.
- There is very limited large woody debris (0.4 pieces per mile) in sixth order streams
- The mainstem Sandy River has severe problems with stream structure identified in the 1988 DEQ nonpoint source assessment.

Pool Levels

- Pool levels are at the upper end or outside and above the RNV within third, forth, and fifth order channels.
- There are no pools identified in sixth order channels
- The mainstem Sandy River has severe problems with stream structure identified

Flow Regime

- Summer lowflows have been significantly reduced in the Sandy River below Marmot Dam and in Alder Creek below the city of Sandy's intake.
- Based on the DNR Hydrologic Change Module it appears that peakflow magnitudes have been increased with the potential to cause channel destabilization and increased sediment yields associated with streambank and inner gorge failures from both created openings and roads in the lower Sandy subwatersheds (Sandy River Brightwood, Sandy River Hackett, Sandy River Wildwood, and Sandy River Mensinger), Cedar Creek, Alder Creek, North Boulder Creek, and Clear Fork subwatersheds.

Sediment Regime

- Glacial Silt within the Sandy River and the Muddy Fork is a natural occurrence in this watershed and all the sixth and seventh order channels are affected by this occurrence

- Clear Creek and Little Clear Creek were affected by debris torrents associated with the February 1996 flood. The debris torrent in Clear Creek was not management related but the debris torrent in Little Clear Creek was.

Stream Temperature

- Based on monitoring data summer stream temperatures are of concern in Clear Creek, Clear Fork, and Alder Creek.
- The Sandy River below Marmot Dam is identified as Water Quality Limited for summer stream temperatures.
- Stream shade levels are well below the undisturbed condition in all the subwatersheds. The lower Sandy River subwatersheds, Badger Creek, and Clear Creek have less than 50% of the area in the riparian reserves with canopy closures over 70% (the undisturbed condition is 90% of the area with canopy closure over 70%).

Habitat Access

- There are no artificial barriers limiting access to habitat within this watershed.

Conclusions Resident Cutthroat Trout

In third, forth, and fifth order channels in-channel large woody debris and pools are at the upper end of the RNV, and the lowflow regime has not been altered. This indicates good habitat conditions for resident cutthroat trout. However, there are some concerns with habitat quality in these streams. Summer stream temperatures are of concern in Clear Creek, Clear Fork and Alder Creek. Stream shade levels are below the undisturbed condition across the watershed and very low in the lower Sandy River subwatersheds, Badger Creek, and Clear Fork subwatersheds. Alder Creek may be dewatered below the city of Sandy's water intake. Debris torrents from the February 1996 storm affected the sediment regime within Clear Creek and Little Clear Creek.

In sixth order streams there is no pool habitat, very limited large woody debris (0.4 pieces per mile), the lowflow regime has been altered in the lower section of Sandy River, glacial silt, and the Sandy River below Marmot Dam is Water Quality Limited for summer stream temperatures. These conditions indicate poor habitat conditions for cutthroat trout.

The mainstem Sandy River is listed with severe problems with stream structure in the 1988 nonpoint source assessment indicating poor habitat conditions.

89% of the habitat for resident fish within the National Forest is in third, forth, and fifth order streams and the habitat conditions within these streams appear adequate to meet the needs of resident cutthroat.

Hydrothyria venosa

Cold, clear streams provide habitat for two watershed analysis species of concern that have been documented within the Upper Sandy Watershed -- ***Hydrothyria venosa***, an aquatic lichen and ***Corydalis aquae-gelidae*****, cold-water corydalis.**

H. venosa is a Survey and Manage species that lives in clear-water small streams with average temperatures of 15^{0} C. This lichen requires clear, cold water (ROD, Appendix J2, p 341-243). The site only known site in the watershed is on a Clear Fork tributary ,upstream from the Bonneville Power Administration (BPA) powerline corridor and also adjacent to old timber harvest units. An uncut buffer on this creek should help to protect *H. venosa* from sediment or temperature impacts.

Within the Clear Fork subwatershed summer stream temperatures are of concern based on monitoring data. Stream shade levels are also well below that of the undisturbed condition.

Based on the DNR Hydrologic Change Module it appears that peakflow magnitudes have been increased in the Clear Creek subwatershed due to created openings and an increased stream network. Increased peakflows have the potential to increase stream sediment due to streambank and inner gorge failures within this subwatershed.

Stand structure within the Riparian Reserves in this subwatershed is also well outside the RNV for area in late seral stands. The current condition is 31% of the area in Riparian Reserves in late seral stands compared to RNV of 72-84%. This has the potential to affect stream structure by limited the recruitment of large woody debris.

It appears that the individual site is well protected but habitat conditions across the Clear Fork subwatershed are in a degraded condition.

Stream surveys in this watershed should include searches for *H. venosa*. In the future Riparian Reserves should help to provide cold, clear water for this and for other survey and manage aquatic lichens and bryophytes suspected to occur within the Upper Sandy Watershed.

Corydalis aquae-gelidae **(cold-water corydalis)**

Cold-water corydalis is an endemic Regional Forester's sensitive plant. Key habitat features include cold (average 10^0 C), clear seeps; springs; and streams with coarse sand/gravels and high forest canopy -- requirements similar to those for some fish species. Three documented sites occur in the Alder Creek drainage, which flows through federal and non-federal lands and serves as the City of Sandy's municipal watershed.

Summer stream temperatures in Alder Creek at the City of Sandy's intake for the period 1991-1996 have exceeded 10^0C every year. Based on daily stream temperatures at the intake 56% of the time stream temperatures are over 10^0C.

Stream shade is less than that of the undisturbed condition indicating that increased interception of solar radiation may be affecting stream temperatures.

Stand structure within the Riparian Reserves is also outside the RNV. Currently 12% of the area in the Riparian Reserves is late seral compared with the RNV of 72-84%. This has the potential to affect stream structure and stream stability due to the effect on large woody debris recruitment.

Based on the DNR Hydrologic Change Module it appears that peakflow magnitudes have been increased in the Alder Creek subwatershed due to created openings and an increased stream network. Increased peakflows have the potential to increase stream sediment due to streambank and inner gorge failures within this subwatershed.

Within the Alder Creek subwatershed the habitat for coldwater corydalis has been affected by increases in stream temperature and an altered sediment regime.

Federal land allocations along the Alder Creek drainage are Riparian Reserve and Special Emphasis Watershed (B6), which should provide protection for coldwater corydalis habitat. The recommended 300-foot buffer around all known populations of ROD Appendix J2, pp 273-274) should secure protection for sites in headwater areas.

On non-federal lands, buffers are determined by the State Forestry Practices Act. For domestic water use, these buffers can range from 20-70 feet. These widths may not provide adequate protection to coldwater corydalis[1]. Threats in the Alder Creek drainage -- as well as in other drainages with potential coldwater corydalis habitat -- could include increases in peak flows, and sediment yields directly and indirectly associated with timber harvest and road building. Thus, habitat connectivity for population dispersal could be impaired in this drainage and other drainages that include non-federal land ownership.

Bald eagle

Bald eagles inhabit forested lakeside or riparian associated habitats of Oregon during both the wintering and nesting seasons. In the winter, they are more abundant on the Columbia River and lower elevations. During the spring and summer breeding seasons, bald eagles migrate through the Upper Sandy Watershed and can be seen occasionally perching or soaring in the area.

Nesting habitat is found in all forest types bordering coastal, lake, or river areas. Nests, which usually consist of bulky stick platforms, are often located in the super-canopy of large trees. Nest sites are usually within ½ mile of large water bodies. No nest sites have been documented within the Upper Sandy Watershed. The Sandy River may be too narrow at higher elevations for good nesting habitat. At lower elevations, where the river is wider, there is less forested habitat and high human use which causes disturbance to nesting birds.

The Bull Run Watershed to the north supports higher quality nesting habitat adjacent to the reservoirs and Bull Run Lake. Eagles will also nest on the side of the ridge where the water body is located - therefore on the ridge side of Bull Run Lake which is outside the Upper Sandy Watershed.

Harlequin Duck

Harlequin ducks inhabit turbulent mountain streams in coniferous forests with dense shrubby streamside vegetation. In-stream structures (logs, boulders) are important for providing loafing sites for this species. Slower side channels and slower moving waters are important for brood-rearing. Harlequins use areas away from human activity with a dense shrub component (Cassier, 1989).

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1 Within the western Cascades riparian buffers of 100 feet are more are needed to approximate shade conditions of an undisturbed late seral forest (FEMAT V-28).
200 foot buffers were found to be effective in removing sediment if the buffer were measured from the edge of the floodplain (FEMAT V-29).

Harlequin ducks have been observed using the Sandy River and its tributaries. The species has been sighted regularly throughout the summer along the Sandy River, on Still Creek, Camp Creek, and the Zigzag River. The Sandy River functions as a migration flyway for the harlequin duck between its nesting habitat on generally higher elevation rivers and streams and its coastal wintering habitat (USDI, 1992).

A nest site was recorded on the Salmon River near Wemme in 1931, and on Clear Creek near its confluence with the Sandy River in 1991. Both young and adult birds have been observed in Lost Creek and Clear Creek. These areas provide foraging, loafing, nesting and brood rearing habitat for the ducks.

Habitat exists in the entire Upper Sandy River system for Harlequins. Introductions of boulders and in-channel large woody debris associated with fisheries projects have created loafing sites for adults, and calm water habitats for early brood rearing.

Key Question #5: How do conditions of the watershed affect the ability to meet the Aquatic Conservation Strategy (ACS) objectives?

The Aquatic Conservation Strategy was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands.

The Aquatic Conservation Strategy strives to maintain and restore ecosystem health at watershed and landscape scales to protect habitat for fish and other riparian dependent species and resources and to restore currently degraded habitats. This approach seeks to prevent further degredation and restore habitat over broad landscapes as opposed to individual projects or small watersheds.

This Key Question will be answered by evaluating the nine objectives of the ACS (ROD p. B-11) as they pertain to the Upper Sandy Watershed.

ACS Objective #1: Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.

Vegetative structure and composition served as the primary watershed and landscape-scale feature used to assess this objective. This feature best reflects watershed and landscape-scale conditions under which aquatic species, populations, and communities are uniquely adapted.

The current amount of late-seral forest is well below the Range of Natural Variability (RNV) within the Western Hemlock Zone of the Upper Sandy Watershed. Late-seral amounts appear to be within the RNV for both the Pacific Silver Fir and Mountain Hemlock Zones. Early-seral amounts are within the RNV for all three zones on federal lands.

The current arrangement of seral stage amounts on the landscape is altered from that of a natural condition. In the past, large contiguous forest patches dominated the landscape. A pattern of aggregated openings forms a west to east band across the watershed that dissects the large continuous forest landscape areas of the Bull Run to the north from those to the south in the Salmon-Huckleberry Wilderness. This area of the landscape, which also tends to have simplified structural diversity, accounts for approximately 60% of the watershed. Other portions of the watershed (approximately 15%) contain fairly evenly dispersed timber harvest units. Both conditions significantly reduce the level of forest connectivity and the amount of interior habitat in late-seral forests. *(Refer also to Chapter Four/ Vegetation and this Chapter, Key Question #2/ Connectivity).*

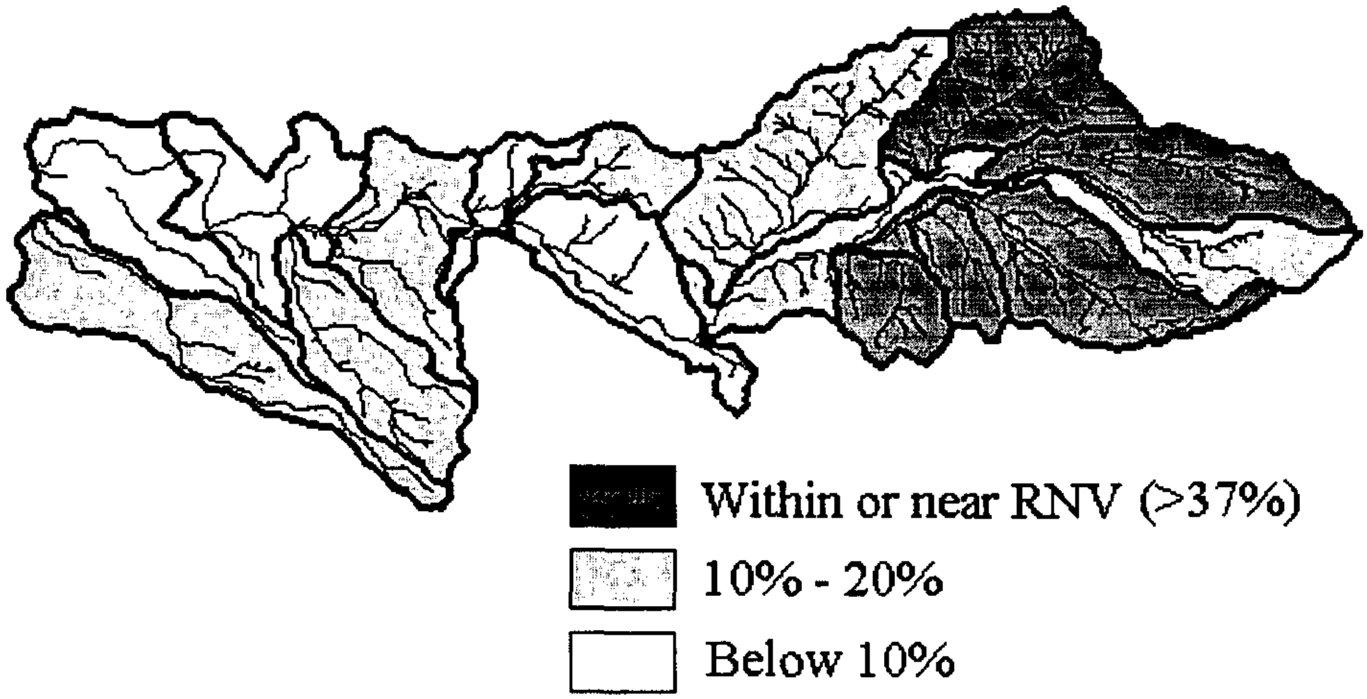
Vegetative composition and structure is simplified in some areas of the watershed as compared with natural conditions. Offsite plantations in the Wildcat Mountain area, in particular, lack the structural complexity of natural forest stands. Many of the watershed's existing early-seral stands and young mid-seral stands were initiated following past timber harvest activities. Therefore, they lack the structural components left behind by most natural disturbances such as snags, downed trees, large remnant trees and forest patches. *(Harvest activities since the late 1980's, however, tended to leave some structural components behind. Current Northwest Forest Plan standards and guidelines require even higher levels of these structural components to be retained after harvest, ROD p. C-39 to C-44.)*

Processes that depend on the amount and size of forest vegetation include rain or snow interception, fog drip, transpiration, and snow accumulation and melt. Altered stand structures may result in an altered peak flow regime outside the range in which the watershed's stream channels developed. The greatest likelihood for causing significant, long-term cumulative effects on forest hydrologic processes is through the influence of openings on snow accumulation and melt. (Refer to Chapter Four/ Hydrology/ Flow Regime for in depth discussion.)

Altered conditions and ecological processes exist in subwatersheds that are low in late-seral forests and dominated by aggregated harvest units. Five subwatersheds have late-seral amounts between 37%-55% which approximates the natural range of variability as determined at the basin level. These five subwatersheds are entirely within federal ownership. Ten of the Upper Sandy's fifteen subwatersheds have below 20% late-seral forest while four subwatersheds have below 10%. Six of the ten subwatersheds low in late-seral have only isolated patches of late-seral habitat that lack interior habitat. Likewise, these six are also high in early-seral and semi-open conditions. (All six are predominantly in non-federal ownership).

Figure 6-5 -- Late-Seral Amounts by Subwatershed

RNV = Range of Natural Variability



Early-seral stand conditions outside or at the extreme ends of the Range of Natural Variation (RNV) have the potential to alter the flow regime through increased peak flows and by decreasing base flows.

Based on current stand conditions, the majority of subwatersheds are over the threshold of concern for increased peak flows associated with created openings which increases the possibility for adverse effects. (See also Figure 6-9 Potential For Increased Peak Flows Current Vegetative Condition.)

Effects of fog drip on the lowflow regime were assessed on federal lands. Based on current stand conditions, lowflows are not effected by reductions in fog drip. Effects may, however, be present on the more developed private lands.

The Landscape Analysis and Design (LAD) process (Chapter Five) was used to depict what the watershed's stand structure would be like in the future based on current management direction. The distribution of seral stage amounts on federal lands in the watershed will be reasonably consistent with the RNV for all zones.

The future landscape on federal lands in the Upper Sandy Watershed will be less fragmented, including less openings in the northeast portion of the watershed. Patterns in the wilderness and LSR will be dominated by unfragmented landscapes of late-seral forest with scattered natural openings. Forest succession within reserved areas will greatly increase the amount of interior forest habitat and patch size even in the short term.

Landscape patterns outside reserve areas will be dominated by various sized patches of mid-seral forests connected by linear corridors of late-seral forests within the Riparian Reserves as well as some scattered early and late-seral patches. Landscape connectivity for many late-seral species will improve within the watershed (*see also Key Question #2, Connectivity*). While the future pattern of private lands is not known, it is suspected to be some arrangement of aggregated openings and fragmented forest lands -- similar to current patterns.

ACS Objective #2: Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling the life history requirements of aquatic and riparian-dependent species.

ACS Objective #7: Maintain and restore the timing, variability and duration of floodplain inundation and water table elevation in meadows and wetlands.

(Because many of the factors that influence connectivity throughout the watershed also affect the water table elevation in floodplains and wetlands, these two objectives [#2 and #7] were assessed together in this analysis.)

Habitat connectivity for aquatic and riparian-dependent species between the channel and floodplain has been altered through channel straightening and cleanout in the Sandy River. A number of riverine wetlands associated with scrub/shrub and forested wetlands along the Sandy River were affected by channel straightening activities after the 1964 Flood. The Sandy River was channelized from the confluence with Clear Fork to the Sleepy Hollow area just upstream from the confluence with Alder Creek. As part of this channelization effort dikes were constructed out of natural river rock to contain the channel (pers comm Roger Cooke). This has also affected the timing, variability, and duration of floodplain and wetland inundation in this area due to the disconnection of this habitat.

Stream surveys of Clear Creek have noted stream structures in the lower 3.2 miles of the stream, installed by private land owners, along the stream which have resulted in channelization and down-cutting within the stream channel (Clear Creek, 1993) resulting in disconnection of the floodplain.

Figure 6-6 Middle Section Sandy River

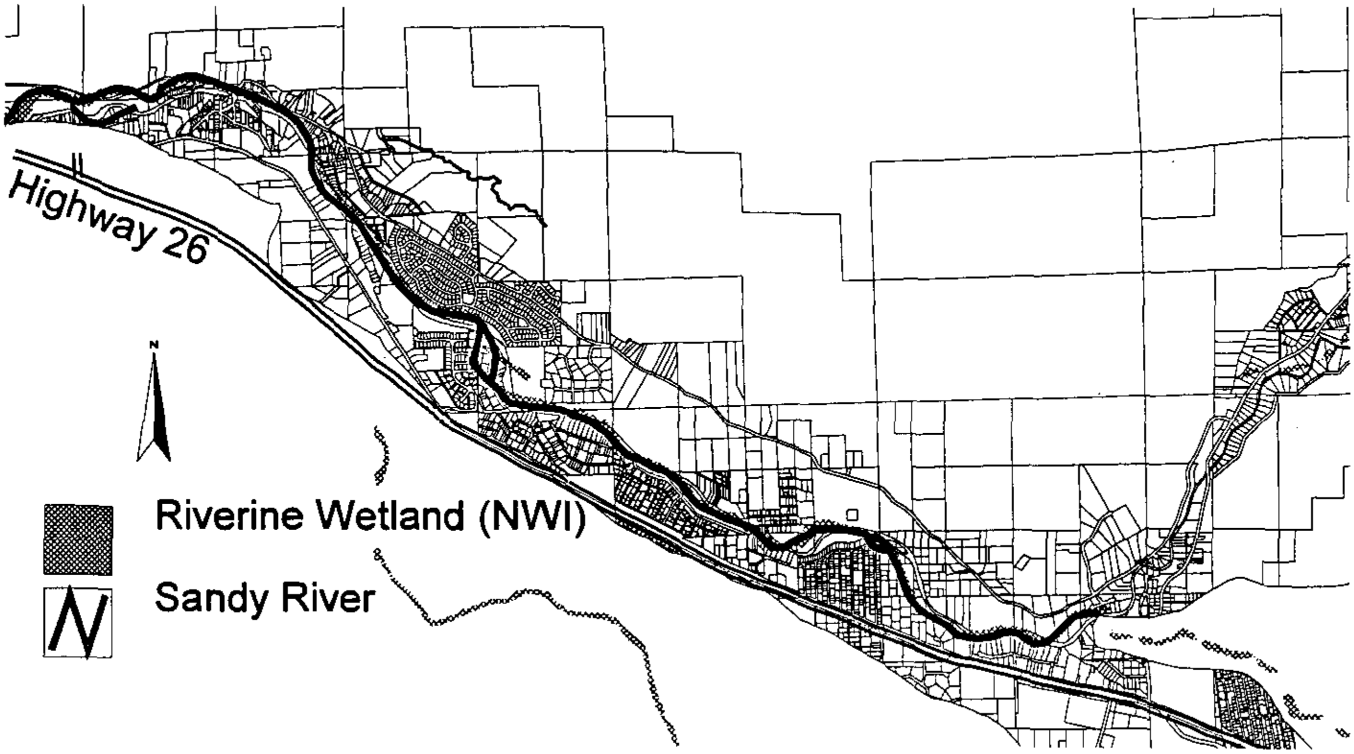


Figure 6-6 illustrates the development along the Sandy River from the area near Zigzag to the Brightwood area. The graphic demonstrates the lack of meanders in this area and indicates that the river has be straightened. The river is flowing in mudflow deposits in this area and would be expected to migrate laterally with associated streambank and inner gorge failures. There is a high degree of development in this area with the associated channel armoring to protect the development along the river. This armoring and historic channel straightening has channelized the river and is preventing the connection with the floodplain and wetlands.

Historically, beaver dams were probably important components of low-gradient reaches in the watershed. Beaver dams increase habitat complexity and moderate baseflow and peakflow changes. Beaver were present historically in this watershed. Eradication of beaver from the watershed resulted in less vegetative and hydrologic connectivity of wetlands due to channel incision and a lower water table.

Baseflows are of concern with respect to hydrologic connectivity and wetland innundation in the lower Sandy River and Alder Creek. In the lower Sandy River below Marmot Dam there is a 69% reduction in monthly mean flows for the month of July associated with hydropower operations. In Alder Creek there is the potential to dewater the stream if all the water rights are used. This potential reduction of baseflows associated with allocated uses, reduces hydrologic and vegetative connectivity, and results in altered patterns of wetland inundation during the summer lowflow period.

Current research indicates roads function hydrologically to modify streamflow generation in forested watersheds by altering the spatial distribution of surface and subsurface flowpaths. Observations suggest that roadside ditches and gullies function as effective surface flowpaths which substantially increase drainage density during storm events (B. Wemple, 1994). This function has the potential to quickly route stormflows off site, preventing the storage and slow release that maintains hydrologic connectivity and water table elevation in wetlands. This process is of concern in the lower Sandy River subwatersheds, Cedar Creek, Alder Creek, Clear Creek, Clear Fork, and Horseshoe Creek subwatersheds.

ACS Objective # 3: Maintain and restore the physical integrity of the aquatic system, including shorelines, banks and bottom configurations.

This objective was assessed by examining in-channel large woody debris, channel morphology and peakflow regime.

In-channel large woody debris plays an important role in stream channel stability. Debris jams are important transient features that can affect turbidity by controlling the mode and rate of channel erosion processes. Pools created downstream from debris jams provide sites where stream energy can dissipate in turbulent flow, rather than by eroding channel beds and banks (Keller and Swanson, 1979). Coarse bed materials that accumulate behind debris jams may armor channels and decrease erosion in weak parent materials such as unconsolidated tuffs and breccias (LaHusen, 1994).

A large portion of the streams in the Upper Sandy Watershed are classified with high streambank and inner gorge failure potential based in the geology that the streams are flowing through. The high streambank and inner gorge failure potential is evident in the mudflow deposits that the Sandy River and Muddy Fork of the Sandy cut through from the headwaters throughout the watershed.

Streams channel instability associated with high streambank and inner gorge failure potential will be exacerbated by increased channel scour associated with higher magnitude peakflows.

Those channels with high streambank and inner gorge failure potential, altered peakflow regime and limited large woody debris have the greatest potential for instability.

Table 6-7 Streambank and Inner Gorge Failure Potential by Stream Order (Entire Watershed)

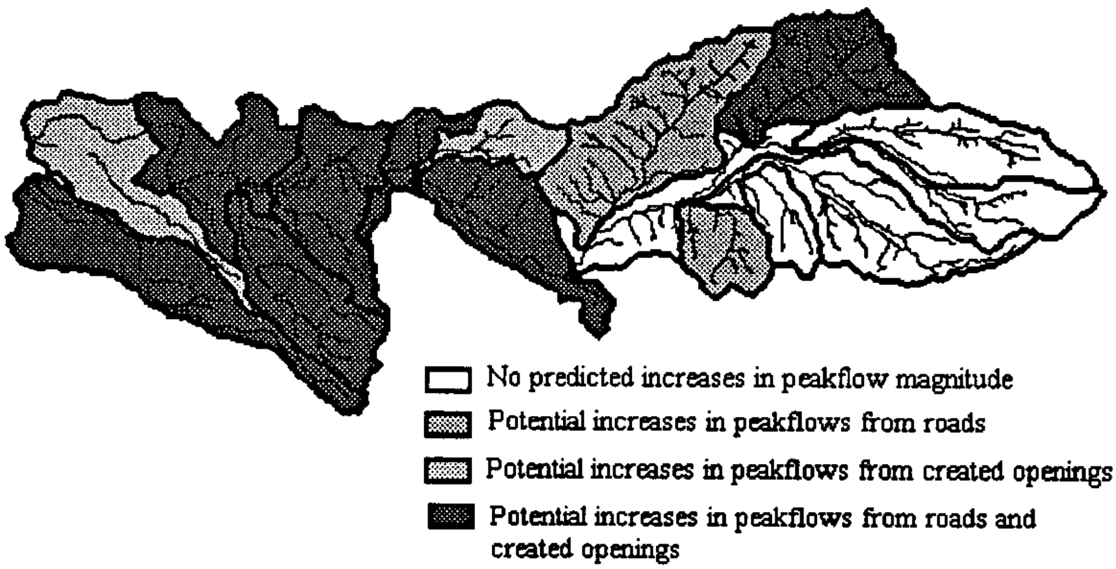
		Percent of Total Stream Length		
Stream Order	Miles of Stream	Low Failure Potential	Moderate Failure Potential	High Failure Potential
1	226.8	31	11	59
2	100.4	36	8	56
3	49.44	32	13	55
4	34.63	29	1	70
5	9.45	12	2	86
6	5.6	0	0	100
7	19.06	22	0	78

Table 6-8 In-Channel Large Woody Debris by Stream Order (Surveyed Streams)

Stream Order	lwd/mi	Median RNVlwd/mi
3	16.7	7
4	11.1	10
5	17.1	32
6	0.4	32

The Sandy River has not been surveyed for in-channel large woody debris from the Forest Boundary downstream towards Marmot Dam. However, the 1988 DEQ nonpoint assessment identified severe problems with stream structure (large woody debris, pools, aquatic habitat type, etc.) in this area.

Figure 6-7 Potential For Increased Peak Flows Current Condition



Conclusions: Physical Integrity of the Aquatic System

Seventh order streams include the Sandy River from the confluence with Clear Creek to the western extent of the watershed. This stream is characterized with a high percentage of stream length with high streambank and inner gorge failure potential, low levels of large woody debris, and an altered peakflow regime. The alteration of the peakflow regime is attributed to created openings and roads. Effects to stream structure are attributed at least in part to stream cleanout after the 1964 flood. Management activities within this area appear to have exacerbated instability in an area with naturally unstable stream channels.

Sixth order streams have 100% of the length in areas with high streambank and inner gorge failure potential, very limited levels of LWD, and the peakflow regime has been altered in Clear Fork and Horseshoe Creek subwatersheds in this area resulting in very unstable stream channels.

Low levels of in-channel large woody debris may be the natural condition for this area. In the upper reaches of the Sandy River where the survey data was collected the river is in Wilderness and Wild and Scenic River Allocations which would indicate limited influence from management activities. The Sandy River is in the Alpine, Mt. Hemlock and Pacific Silver Fir zones in most of this area which may account for the limited large woody debris. In the adjacent Zigzag watershed there is only 1.5 pieces of large woody debris per mile in the Pacific Silver Fir Zone in unmanaged areas (pers comm. Jeff Reis).

there is only 1.5 pieces of large woody debris per mile in the Pacific Silver Fir Zone in unmanaged areas (pers comm. Jeff Reis).

Forth and fifth order channels are characterized with moderate to high levels of stream length with high streambank and inner gorge failure potential, large woody debris levels within the RNV and an altered peakflow regime. The altered peakflow regime has the potential to cause moderate problems with stream stability in this area, however, the stream structure is within the RNV in this area and should help moderate any problems.

First, second, and third order channels are characterized with moderate levels of stream length with high streambank and inner gorge failure potential, levels of large woody debris at the upper end of the RNV (using third order streams as a proxy for the other streams), and an altered peakflow regime. This combination should result with moderate to low levels of problems with stream channel stability associated with impacts from management.

Across the watershed, many steams have been channelized to protect roads and developments. The Sandy River was straightened from the confluence with Clear Fork to the confluence with Clear Creek after the 1964 flood (pers comm., J.Jaqua). Based on channel sinuosity it appears that the Sandy River from the Zigzag to Brightwood area and Hackett Creek have also been channelized. This channel straightening has affected physical integrity of the aquatic system by removing large woody debris and disconnecting the channel from it's floodplain. Areas of unstable channels within volcanic mudflow deposits that have been straightened have the potential to be very unstable.

Stream surveys of Clear Creek have noted stream structures in the lower 3.2 miles of the stream, installed by private land owners, along the stream which have resulted in channelization and down-cutting within the stream channel (Clear Creek, 1993).

The bottom configuration of channels within the watershed have been altered due to deposition of sand associated with Highway 26 sanding activities. Bear Creek receives a high volume of sand through direct application, ditch runoff and culvert transport.

ACS Objective #4: Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical and chemical integrity of the system and benefits survival, growth, reproduction and migration of individuals composing aquatic and riparian communities.

Suspended Sediment

The 1988 Oregon Department of Environmental Quality (DEQ) assessment of nonpoint pollution indicates severe problems with sediment in Muddy Fork and moderate problems in the Sandy River, Clear Creek and Lost Creek. These problems are attributed to glacial runoff and flood damage in Muddy Fork, glacial runoff and unstable channels in the Sandy River, debris torrents in Clear Creek, and landslides and salvage logging in Lost Creek. Management effects include the debris torrent in Clear Creek (associated with a road fill failure) and salvage logging in Lost Creek.

The Sandy River is noted for the presence of fine suspended sediment known as "glacial flour". The "flour" originates on the glaciers at the river's source and is formed by the grinding of rock under the weight of the glaciers on the slopes of Mt. Hood. The glacial flour gives the Sandy River a pale green opacity or milky-gray color, which is most apparent in middle to late summer during the peak of glacial melt, when the flow contribution from non-glacial tributaries is relatively less. The Sandy River has been attributed as having one of the highest percentages of glacial melt of all the major Oregon rivers (USDI-BLM Sandy River Wild and Scenic River and State Scenic Waterway Environmental Assessment, 1992). The Muddy Fork, is aptly named and contributes a high proportion of suspended sediments as a result glacial runoff from the Sandy Glacier.

Clear Creek experienced debris torrents into the main channel in 1986 and 1996. The 1986 debris torrent was associated with a road fill failure and the 1996 event was a natural event associated with the February flood. Little Clear Creek also experienced a debris torrent with direct delivery to the stream in February 1996 from a road on private land.

Highway sanding has direct affects to streams within the watershed. Bear Creek receives a high volume of sand through direct application, ditch runoff, and culvert transport.

In the glacially influenced streams of the watershed, a naturally high suspended sediment yield may limit habitat for many species. The altered sediment regime in

Clear Creek, Little Clear Creek, and Bear Creek degrades habitat conditions for many aquatic species, including: coho salmon, spring chinook salmon, steelhead trout, cutthroat trout, Pacific lamprey, Copes giant salamander, and tailed frog.

Salmon Carcasses

Carcasses of coho salmon have been shown to be a critical source of nutrients for the stream ecosystem food web, and are directly associated to fingerling/smolt production (Bilby, et al., in press). Coho numbers appear to be 20% or less of populations documented in the 1890s, when populations were already significantly reduced by commercial fishing. Comparisons with fully seeded, unimpacted populations elsewhere in the Pacific Northwest indicate that existing populations may be less than 5% of pre-1850 populations.

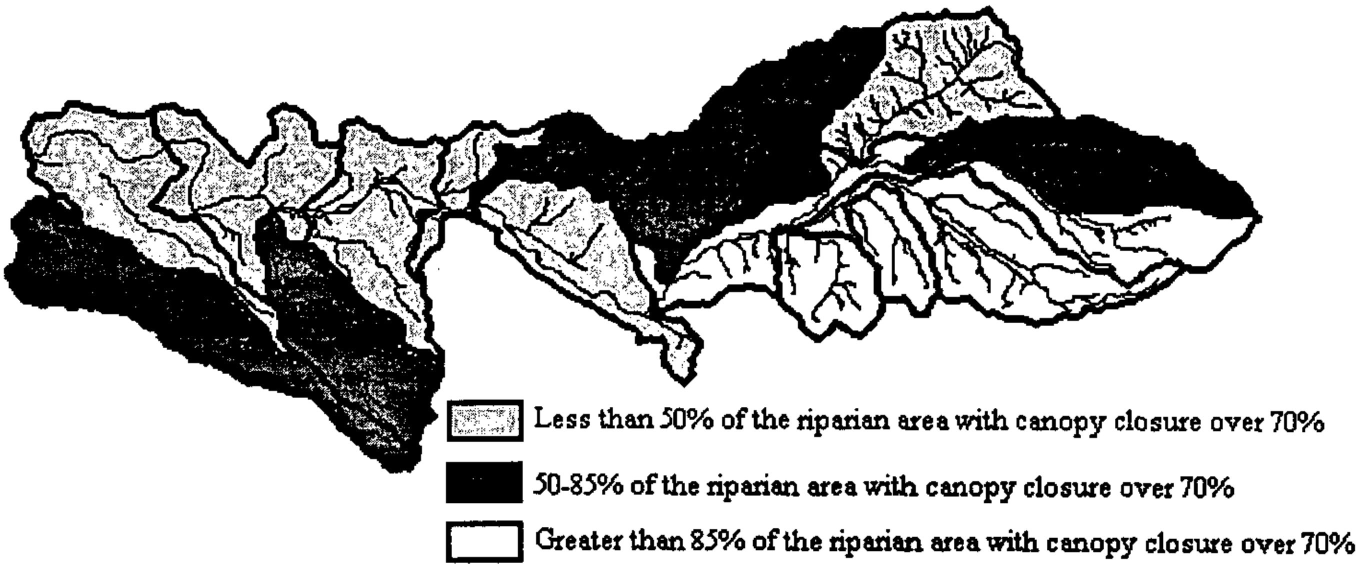
Stream Temperature

Increased water temperatures have the potential to increase biological activity. The optimal temperature range for most salmonid species is 12-14^{0}C. Lethal levels for salmonids are generally in the range of 20-25^{0}C. Spawning coho and steelhead may be intolerant of temperatures above 10^{0}C (Beschta et al. 1987). Within the Sandy River Watershed there are a number of species that require cold water including: cold water corydalis (average temperature of 10^{0}C), Cope's giant salamander (10^{0}C maximum), *Hydrothyria venosa*, (average temperatures of 15^0 C), and tailed frogs. State Water Quality Standards for the protection of cold water fish (1996 revision) are: for periods of salmonid spawning, egg incubation, and fry emergence (12.8^{0}C), and for absolute numeric criterion (17.8^{0}C)

The lower Sandy River (below Marmot Dam) is identified as water quality limited for summer stream temperatures. Clear Fork, Clear Creek, and Chance Creek have historically exceeded the old state water quality standards of 14.4^{0}C. Alder Creek exceeds the current state water quality standards for salmonid spawning, egg incubation, and fry emergence. Stream shade levels are also well below that of an undisturbed area.

Increased stream temperatures are often a result of created openings from timber harvest, roads and recreational facilities. Since limited temperature data was available across the watershed, stream shade levels were assessed for the riparian areas for all subwatersheds.

Figure 6-8 Stream Shade Levels by Subwatershed



Undisturbed condition equals 89% of riparian area with canopy closure over 70%

Alder Creek and Clear Creek are in the 50-85% of the riparian area with canopy closure over 70% and are known to be demonstrating increased summer stream temperatures. It would thus stand to reason that any colored subwatershed in Figure 6-8 would have concerns with increased summer stream temperatures. This would result in degraded habitat conditions for individual species across the subwatershed.

ACS Objective #5: Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate and character of sediment input, storage and transport.

Over the last 2,000 years, the aquatic system in this watershed has evolved in a dynamic sediment regime dominated by large scale geologic disturbances. Post glacial mudflows have deposited coarse sands, gravels and cobbles along the Sandy river to its mouth. Glaciers continue to weather and erode hillslopes in the upper watershed. Today, two distinct natural sediment regimes exist for streams within the watershed. The sediment regime in the mainstem of the Sandy (upper and lower subwatersheds) and the Muddy Fork of the Sandy is greatly influenced by both the mudflow deposits and glacial action. The majority of streams in the watershed are not influenced by contemporary glacial forces and their natural sediment regime is dominated by hillslope and channel stability.

Without direct measurements of the contributions of hillslopes, channels and glaciers to the natural sediment regime, characterization must be qualitative.

Natural Sediment Regime

Glacially Influenced Streams

The Muddy Fork and Upper Sandy subwatersheds are glacially influenced streams. The streams originate in sandy and gravelly unconsolidated deposits high on the slopes of Mt. Hood. In the valley bottoms, the main channels of these streams are forming in coarse sands and gravels derived from volcanic mudflow deposits. Hillslope stability on the upper slopes is generally low due to the steep slopes and loosely consolidated geologic materials. Channel stability in the main valley bottoms is naturally low due to frequent channel readjustment in these relatively young mudflow deposits.

Mass wasting is an important natural process in the Muddy Fork and Upper Sandy subwatersheds. Over 40% of the land area in these subwatersheds are rated as high landslide potential (compared with 20% over the watershed as a whole). The combination of unstable hillslopes and stream channel dissection results in high potential for streambank failure along much of the length of the Muddy Fork, Upper and Lower Sandy channels. Landform and stream stability are presented in detail in Chapter 4.

Rain and Snowmelt Dominated Streams

The majority of streams in the watershed are not influenced by glacial melt and therefore have a very different natural sediment regime than described above. The following subwatersheds are dominated by rain and snowmelt runoff processes:

Alder Creek
Badger Creek
Cast Creek
Cedar Creek
Clear Creek
Clear Fork
Horseshoe Creek
Lost Creek
North Boulder Creek
Sandy River, Brightwood
Sandy River, Hackett
Sandy River, Mensinger
Sandy River, Wildcat

These watersheds evolved in a sediment regime derived from geologic rates of hillslope and channel erosion. Natural rates of sediment production from hillslope processes are high in the Horseshoe subwatershed. Ground disturbance in this watershed is likely to increase natural rates of sediment supply.

Altered Sediment Regime

Glacially Influenced Streams

In the summer months, glacial erosion produces high quantities of suspended sediment throughout the length of the mainstem Sandy and Muddy Fork. During this time, hillslope erosion derived from human disturbance is at a minimum.

Calculated erosion rates from hillslope disturbance revealed relatively small amounts of sediment production and delivery from roads and harvest in the Muddy Fork subwatershed.

In the Upper Sandy subwatershed, several native surface roads on erosive landforms contribute high amounts of sediment to the stream system. Roads where this process is occurring include:

- 1825100 (Ramona Falls trailhead)
- 1825043
- 1825050
- 1825055

Rain and Snowmelt Dominated Streams

Human disturbances affecting the magnitude of the sediment supply are associated with ground disturbing activities such as roads, timber harvest and campsites. Created openings and road/stream intercepts contribute to an altered runoff regime and affect sediment derived from in-channel processes.

For undisturbed conditions, the timing of sediment delivery from hillslope processes would be limited to infrequent, intense winter storms. On site and instream recovery rates would be rapid. Sediment associated with roads is delivered during season flushing flows and peaks of winter storm flows. It is during fall and winter storm events that alterations to the natural sediment regime would occur.

Analysis of surface erosion processes indicates roads in the watershed are the most significant contributor to altered sediment supply in the watershed. Subwatersheds with the greatest overall effects from roads are Clear Creek and Clear Fork.

In the depositional reach at the confluence of Clear Creek and the mainstem of the Sandy, sediment deposition may be altered above the natural rates.

In subwatersheds with increased peakflow magnitudes (based on the DNR Hydrologic Change Module), from either created openings or road / stream intercepts, natural rates of bed and bank erosion in stream channels is likely to be altered.

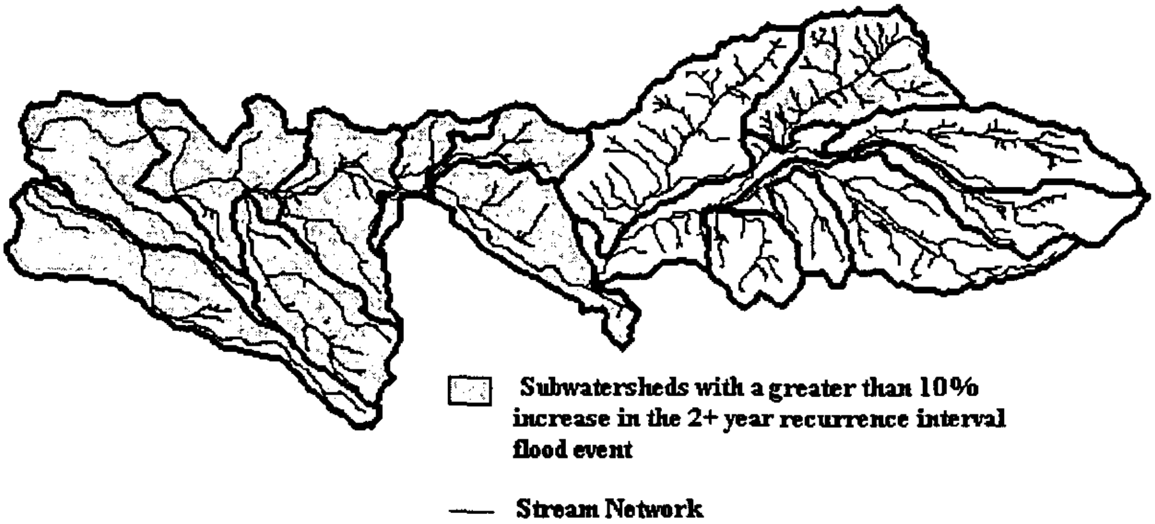
ACS Objective #6: Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient and wood routing. The timing, magnitude, duration and spatial distribution of peak, high and low flows must be protected.

Peak Streamflows

Conclusions with respect to peakflows in the Upper Sandy Watershed include:

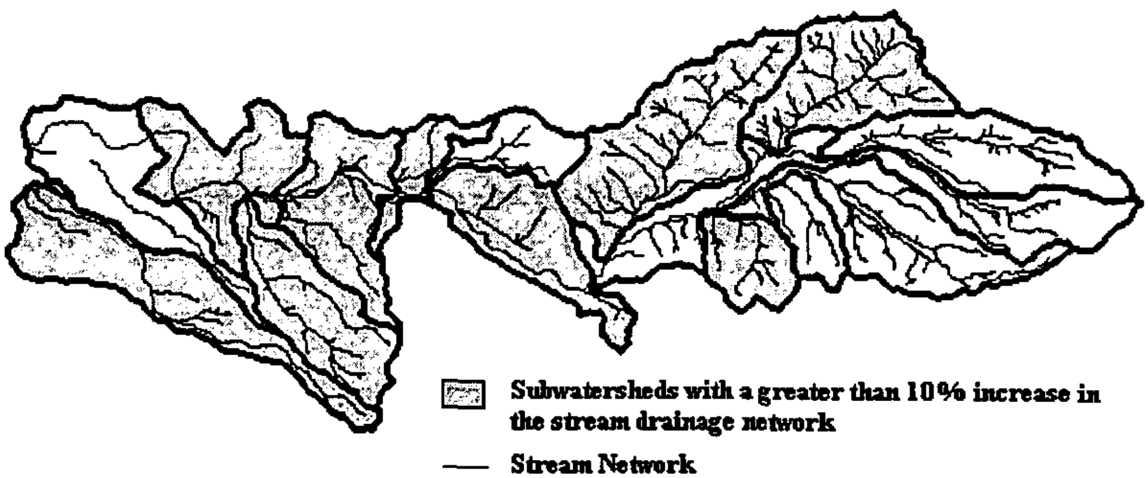
- The recurrence interval of the February 1996 peak flow event was higher in the Sandy River (as measured at Marmot Dam) than any other gaged location within the Sandy Basin.
- There is a slight increasing trend in peak flow magnitude for the period 1912-1996 that does not appear to be tied to forest management activities.
- The magnitude of peak flows per square mile are lower in the Sandy River (as measured at Marmot Dam) than the unmanaged control subatershed (Fir Creek) in the Bull Run Watershed. This is attributed to the influence of the snow pack in the Salmon, Zigzag and Upper Sandy Watersheds moderating the magnitude of peakflows from rain-on-snow events.
- Based on the DNR Hydrologic Change Module it appears that peakflow magnitudes have been increased in the majority of subwatersheds (Figure 6-9)and are above the threshold for the potential for adverse effects.

Figure 6-9 Potential For Increased Peak Flows Current Vegetative Condition



- Stream channel network expansion by roads is a concern in the majority of the subwatersheds (Figure 6-10). The effect of this process on the timing, magnitude, and duration of peak flows is unknown.

Figure 6-10 Stream Drainage Network Enhancement



Baseflows

Conclusions with respect to baseflows from the analysis include:

- A decreasing trend exists in low-flow yields for the period 1950-1994 that appears to be associated with water withdrawals and potentially hardwood encroachment into riparian areas.

- Lowflow yields are greater in the Upper Sandy Watershed than in Fir Creek. This is attributed to the influence of the glaciers.

- Effects of fog drip on the lowflow regime were assessed on federal lands. Based on current stand conditions, lowflows are not effected by reductions in fog drip. Effects may, however, be present on the more developed private lands within the watershed.

- Water Withdrawals are affecting lowflows in the Sandy River below Marmot Dam and Alder Creek. The lowflows in the Sandy River are reduced by 69% (based on monthly means) below Marmot Dam due to withdrawals for hydropower operations. Alder Creek has the potential to be dewatered if all the water rights are used during the summer lowflow period.

ACS Objective #8: Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration; and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

ACS Objective #9: Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

Both ACS Objectives #8 and #9 were assessed by evaluating stand structure and composition within the Riparian Reserves.

Seral Stage Distribution Riparian Areas

The seral stage of the riparian areas across the entire watershed (all ownerships) was assessed because of it's implications with respect to stand structure and it's influence on processes within the riparian area.

Chart 6-1 Seral Stage in Riparian Areas

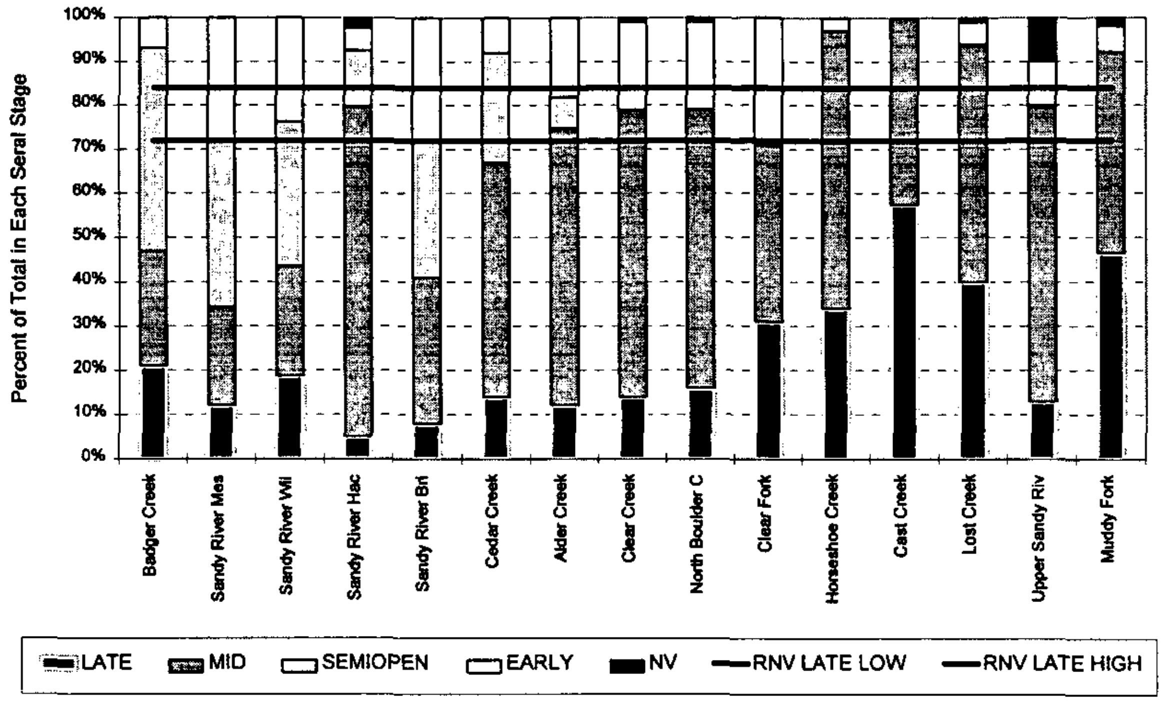


Table 6-9 Percent of Riparian Area in Late Seral Stands

Subwatershed	Percent of Late Seral[2]
Badger Creek	21
Sandy River Mes	12
Sandy River Wil	19
Sandy River Hac	4
Sandy River Bri	8
Cedar Creek	14
Alder Creek	12
Clear Creek	14
North Boulder C	16
Clear Fork	31
Horseshoe Creek	34
Cast Creek	57
Lost Creek	40
Upper Sandy Riv	13
Muddy Fork	47
Entire Watershed	**23**

[2] RNV for late-seral stands is 72-84% of the area in the Riparian Reserves based on Bull Run data

As Chart 6-1 and Table 6-9 detail all the subwatersheds are outside the RNV for late seral stand structure within the riparian areas. The RNV was based on conditions within the Western Hemlock Zone of the Bull Run Watershed. This RNV may be less applicable to subwatersheds outside the Western Hemlock Zone (Horseshoe Creek, Cast Creek, Lost Creek, Upper Sandy, and Muddy Fork). These subwatersheds are in land management allocations that preclude scheduled timber harvest and appear not to have been influenced by management activities, so this may be the natural condition for these areas. Early-seral stand conditions in these areas could be attributed to the mudflow and recent fire history.

Summer and Winter Thermal Regulation

Riparian buffers can have an effect on solar radiation, air temperature, wind speed, and relative humidity all of which have some influence on thermal regulation within the Riparian Reserves. Stand structure within the Riparian Reserves addresses many of these processes, however, direct solar radiation intercepting the stream surface is the principle factor in raising stream temperature in forested watersheds so canopy closure will be addressed in this section.

Chart 6-2 Riparian Buffer Effects on Microclimate (FEMAT Figure V-13)

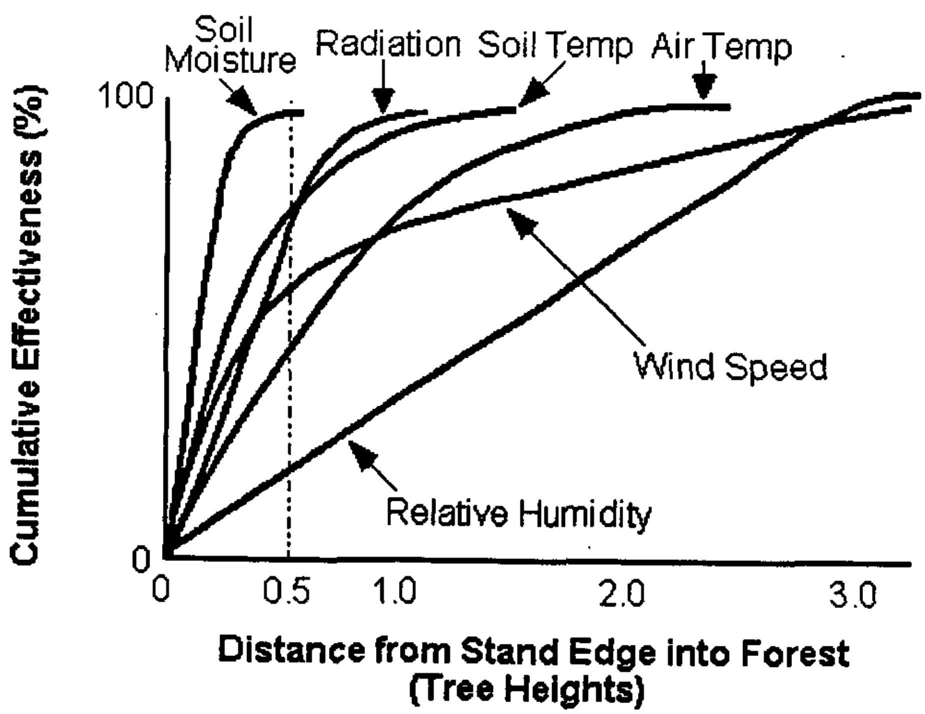


Figure 6-11 Canopy Closure Riparian Reserves

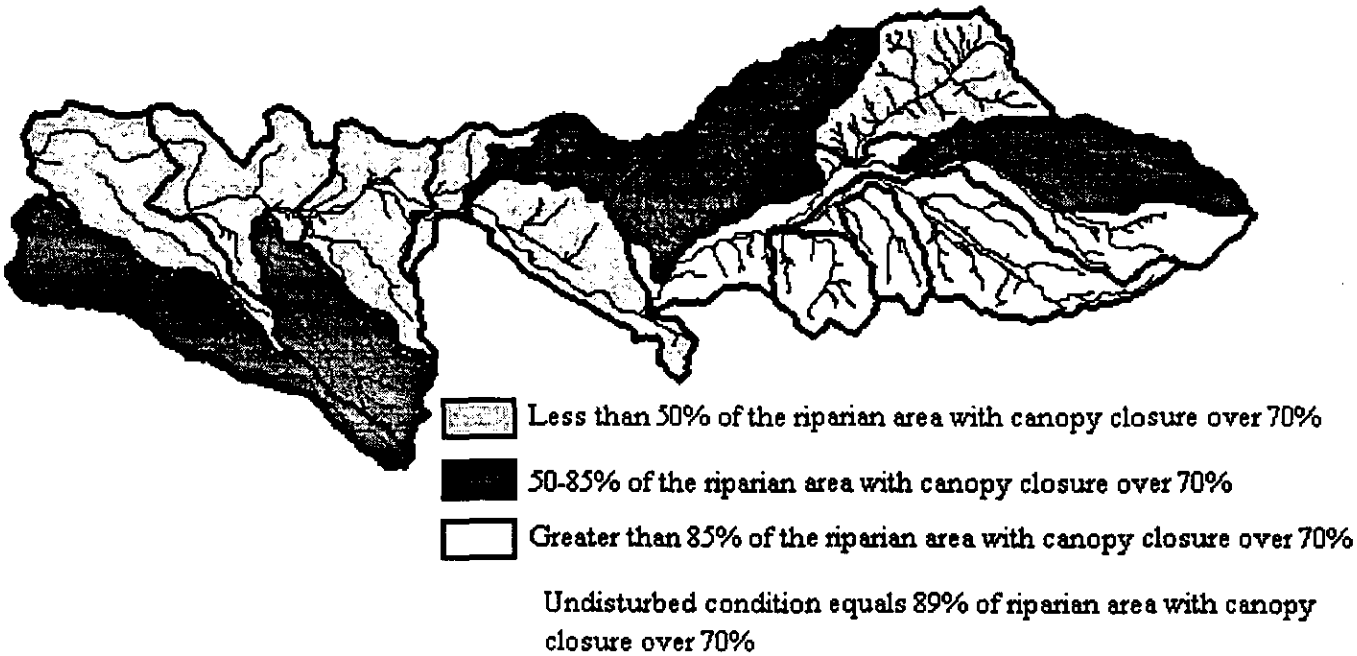


Figure 6-11 details shade levels across the watershed. As discussed earlier in this section, any colored subwatershed in the above figure has potential increases in summer stream temperatures associated with stream shade levels.

Nutrient Filtering

Riparian vegetation regulates the exchange of nutrients and material from upland forests to streams (Swanson et al. 1982 Gregory et al. 1991). Nitrogen will be the nutrient of concern, due to its importance to biological communities, and the potential for water quality concerns if its concentration becomes too great. Most of the non-toxic effects of nitrogen result because increased inorganic nitrogen stimulates primary production (e.g. bacteria and algae). Increased nitrogen loading in lakes and reservoirs is potentially more serious than an increase in stream nitrogen because of potential accumulation of nutrients. Over time, the accumulation of relatively small nitrogen inputs may stimulate algae growth to the point where eutrophication begins (MacDonald, 1991).

Most of the nitrogen lost from forests to streams is relatively small for most undisturbed forest ecosystems (Cole 1979, Triska et al. 1984). Nitrogen inputs from forest management activities are usually associated with: logging, fire, and forest fertilization. Recent research indicates that riparian zones are important sites for denitrification (Green and Kauffman 1989). Within the adjacent Bull Run Watershed's Fox Creek drainage, partial clearcutting caused a four-fold increase in nitrate-nitrogen when slash was broadcast burned and a six-fold increase when slash was allowed to decompose naturally.

The riparian areas within the Upper Sandy Watershed are outside the range of natural variation for stand structure especially within the Western Hemlock Zone. There is also a large proportion (over 20%) of the riparian area in early seral stands in some subwatersheds (Sandy River Mes., Sandy River Wil., Sandy River Bri., Clear Creek, North Boulder Creek, and Clear Fork). This indicates management activities such as timber harvest or development that may potentially contribute nutrient inputs. Inputs of nitrate-nitrogen may be of concern in these subwatersheds.

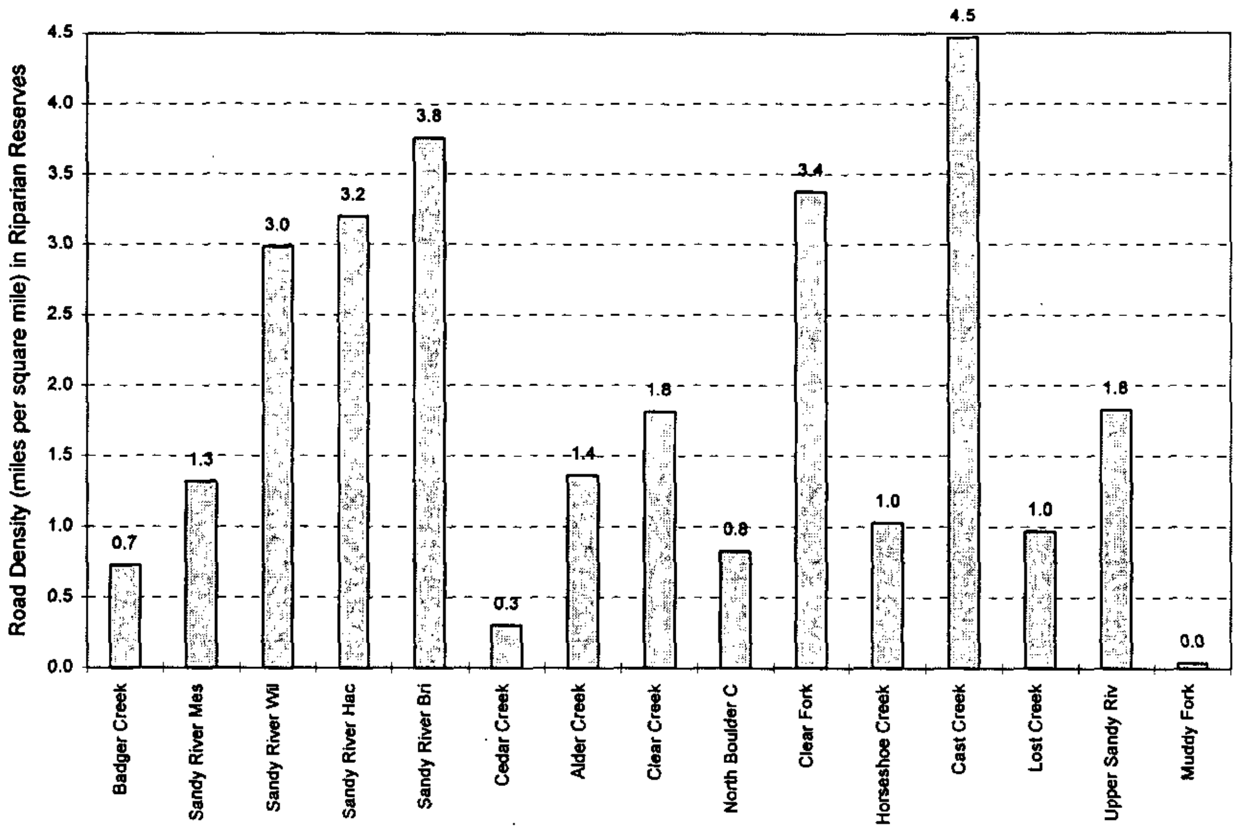
Within the aquatic system, organisms involved in nutrient cycling in streams (particularly bacteria, fungi, and algae) reside on surfaces such as wood and rock. These organisms are capable of transforming nitrogen, phosphorus, and other nutrients between inorganic and organic forms. Levels of large woody debris are within the RNV for third, forth, and fifth order streams. First through fifth order streams account for 94% of the stream length in this watershed. Levels of woody debris within these streams would indicate adequate sites for organisms involved in nutrient cycling.

Sediments, inorganic nutrients, and organic toxicants are removed by water that flows across wetlands (FEMAT Appendix V-E). Wetlands play a critical role in the nutrient filtering based on their ability to remove excess nutrients from the system. There appears to have been some impacts to wetlands associated with channel straightening of the Sandy River.

Surface Erosion

Species composition and structural diversity required to maintain appropriate rates of surface erosion is a function of effective ground cover within the delivery zone to streams. At the watershed scale, roads are the largest single impact to effective ground cover within this zone.

Chart 6-3 Road Density in Riparian Areas



As detailed in Chart 6-3 road densities are highest in the lower Sandy River subwatersheds, Clear Fork and Cast Creek. Maintenance and restoration of these conditions could result from effective road surfacing and revegetation of cut and fill slopes.

Bank Erosion and Channel Migration

Effects of watershed conditions on stream channel stability were discussed earlier in this key question. Lack of riparian vegetation next unstable channels with respect to streambank erosion and inner gorge failure will intensify any problems. Root systems in streambanks of the active channel stabilize banks, allow development and maintenance of undercut banks, and protect streambanks during large storm flows (FEMAT V-25). Late and mid seral stands should have the root strength required to prevent excessive bank erosion and channel migration. Those subwatersheds with a high (greater than 20%) percent of the riparian area with early seral stands would be of concern with respect to bank erosion and channel migration. Sandy River Mes, Sandy River Wil, Sandy River Bri, Clear Creek, North Boulder C, and Clear Fork all are in this category and may have levels of bank erosion and channel migration outside acceptable limits.

Large Woody Debris Inputs

Based on stand structure and composition the large woody debris recruitment potential is below the undisturbed condition in the Western Hemlock Zone and limited due to small tree size in the Pacific Silver Fir and Mt. Hemlock Zones.

ACS Objective #9: Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

Riparian areas are widely considered to be important wildlife habitat. A distinct microclimate is maintained along stream channels, created by cold air drainage and the presence of turbulent surface waters. Large wood on the ground is an important habitat component in riparian areas. Maintaining the integrity of the vegetation is particularly important for riparian-dependent organisms including amphibians, arthropods, mammals, birds, and bats (FEMAT V-25). In order to maintain habitat conditions to support native riparian dependent species the stand structure within the riparian area should approximate the RNV.

All of the subwatersheds are below the RNV for late-seral stand structure within the riparian areas. Within the Western Hemlock Zone this appears to be associated with management activities (timber harvest, land development, road building, and transmission line right-of-way maintenance). Above the Western Hemlock Zone riparian areas may be outside the RNV (albeit less) for seral stage due to natural disturbances such as mudflows and fires.

Riparian Reserves improve travel and dispersal corridors across federal and adjacent lands for many terrestrial animals and plants, and provide for greater connectivity of the watershed. The Riparian Reserves will also serve as connectivity corridors among the Late-Successional Reserves (ROD p. B-13). Key Question #2 further reviews the connectivity role of Riparian Reserves in the watershed.

Riparian Reserves of the of the Upper Sandy Watershed are projected to be corridors of largely late-seral forest in the future that connect larger blocks of continuous forest as well as provide well distributed patches of late-seral forest across the landscape. Currently, however, only 21% of the Riparian Reserves are in a late-seral state. In the short term (30-50 years) this amount may double, but it may take closer to 100 years to achieve late-seral conditions across the majority of the Riparian Reserves.

It would be prudent to maintain patches or structural components of late-seral forests on upland areas in the short term that are adjacent to Riparian Reserves that currently lack late-seral (or are have high amounts of early seral.). In addition, silvicultural techniques could be used to promote structural diversity (including down logs) and advancement of stands toward late-seral conditions in areas of concern. Chart 6-1 Seral Stage in Riparian Areas, displays areas of concern at the subwatershed level to help to focus activity location for landscape scale benefits.

Key Question #6: What is the relationship between federal land allocations, watershed conditions, and commodity production for: timber and other wood products and plant materials?

Timber

The principle factors affecting timber availability in the watershed include the land allocations and existing vegetation. The general management objectives combines allocations from the NWFP, Mt. Hood Forest Plan and Salem District BLM Resource Management Plan. Each allocation has accompanying standards and guidelines for timber harvest. On most of the lands in the watershed, timber harvest is unscheduled (see Table 6-10). Timber production is the principle management objective on 12% of the federal lands within the watershed. Timber harvest is a secondary management objective on an additional 7,420 acres (20% of the federal lands).

The following sections summarize the guidance for timber harvest for these land allocations and the potential for future harvest (short term) given current vegetation conditions. The Conceptual Landscape Design (Chapter 5) identifies long-term vegetation objectives for the land allocations in the watershed. The landscape pattern represented by the design cells is also presented.

Scheduled Harvest

There are 11,656 acres of land with scheduled (USFS) or PSQ (BLM) harvest in the watershed.

Land allocations where timber harvest is a principle management objective and a scheduled output include:

- C-1 Timber Emphasis
- BLM General Forest Management Area

Land allocations where timber harvest is a secondary management objective and a scheduled output include:

- B-2 Scenic Viewshed
- B-6 Special Emphasis Watershed
- DC-1 Bull Run Timber Emphasis
- B-5 Pine Marten, Pileated Woodpecker Habitat Area
- BLM Connectivity
- B-10 Deer and Elk Winter Range
- DB-2 Bull Run Scenic Viewshed

Table 6-10 General Management Direction

GENERAL MANAGEMENT DIRECTION	ACRES IN WATERSHED	PERCENT OF WATERSHED	TIMBER HARVEST SCHEDULED?
Non-Federal lands	25,866	38	not evaluated
A-2 Wilderness	14,944	22	NO
Riparian Reserve	8,000	12	NO
C-1 Timber Emphasis	3,376	5	YES
A-1 Wild and Scenic River	3,139	5	NO
B-2 Scenic Viewshed	3,122	5	YES
Late Successional Reserve	2,460	4	NO
BLM General Forest Management Area	1,788	3	YES
B-6 Special Emphasis Watershed	1,670	2	YES
DC-1 Bull Run Timber Emphasis	1,074	2	YES
BLM Scenic Viewshed	941	1	NO
B-5 Pine Marten, Pileated Woodpecker Habitat Area	477	< 1	YES
A-9 Key Site Riparian	296	< 1	NO
Unmapped Late Successional Reserve	254	< 1	NO
A-4 Special Emphasis Area	193	< 1	NO
BLM Connectivity	119	< 1	YES
DA-9 Bull Run Key Site Riparian	40	< 1	NO
B-10 Deer and Elk Winter Range	27	< 1	YES
DB-2 Bull Run Scenic Viewshed	7	< 1	YES

C1 Timber Emphasis

There are 3,376 acres of this land allocation in the watershed, which is equivalent to approximately 5% of the total watershed area. Timber production is the primary objective of this land allocation. Timber emphasis lands account for 8% of the federal land base within the watershed. Timber harvest is scheduled to occur on these lands.

Timber Emphasis lands are represented by the Mixed Aged Forest / Sandy design cell. In this design cell, the future landscape pattern would appear as a mosaic of managed stands of varying ages.

BLM General Forest Management Area

A total of 1,788 acres of this management area exist within the watershed, equivalent to 3 percent of the total watershed acres. Timber production is the primary objective of this land allocation. Secondary objectives are to provide for long term site productivity, forest health, cavity nesting habitat and biological legacies.

General Forest Management Areas are represented by the Mixed Aged Forest / Sandy design cell. The vegetation pattern in this design cell would appear as a discontinuous forest canopy with multi-aged trees.

B-2 Scenic Viewshed

There are 3,139 acres of National Forest Scenic Viewshed in the watershed, equivalent to 5 percent of the total watershed area. Timber harvest is scheduled on these lands, however, harvest and salvage will occur only where these actions maintain the "desired landscape character".

Scenic Viewshed lands are represented by the Mature Forest / Small Opening landscape design cell. Within this design cell, the forest canopy would be largely continuous with irregularly dispersed, small, naturally appearing openings.

B-6 Special Emphasis Watershed

This management area represents only 2% of the total watershed area or 1,670 acres. The Alder Creek Special Emphasis Watershed comprises nearly 4% of the federally owned acreage within the Upper Sandy Watershed.

The primary goal of the Special Emphasis Watershed is to maintain or improve watershed, riparian, and aquatic habitat. Maintenance of a healthy forest condition through timber management is a secondary goal. Timber harvest is scheduled on these lands.

Special Emphasis Watershed lands are represented by the Mixed Forest / Sandy landscape design cell. The landscape pattern of this design cell would be a discontinuous forest canopy with multi-aged stands.

DC-1 Bull Run Watershed / Timber Emphasis

There are 1,074 acres of this management area in the watershed, which is equivalent to 2% of the total watershed area. These lands are not located within the Bull Run physical drainage. Timber harvest is scheduled to occur on these lands.

The primary objective of these lands is to maintain and protect water quality and quantity. Timber production is a secondary objective.

Bull Run Watershed / Timber Emphasis lands are represented by the Mixed Forest / Buffer design cell. The future landscape pattern for these lands is a discontinuous forest canopy with multi-aged and multi-storied stands. Harvest designs would prioritize the protection of water quality. Secondarily, harvest designs would address windthrow risk and fuel reduction. The BPA transmission lines cross through a small area of this land allocation.

B-5 Pine Marten, Pileated Woodpecker Habitat Area

There are 477 acres of Pileated Woodpecker habitat area mapped (outside of Riparian Reserves) in the Upper Sandy Watershed. This amounts to approximately 1% of the federal land area in the watershed.

The principle management objective of these lands is to provide mature or old - growth forest habitat to sustain viable populations of pileated woodpecker and pine marten. An implementation management guide is to be prepared for the Pileated Woodpecker / Pine Marten Habitat Area prior to management activities (LRMP p. Four-21).

The Pileated Woodpecker / Pine Marten Habitat Area is represented in the landscape design by the Old Forest / Continuous and Wet Meadow design cells. The future landscape pattern would be continuous old forest interrupted by small natural openings.

BLM Connectivity

BLM Connectivity areas comprise less than 1% of the lands in the watershed (119 acres). Timber harvest is scheduled to occur on these lands. Management objectives are to provide movement, dispersal and connectivity opportunities while adding to the richness and diversity of the landscape. Approximately 25-30 percent of the area is to be retained in an old-growth forest condition.
BLM Connectivity lands are represented by the Mixed Forest / Sandy landscape design cell. The landscape pattern of this design cell would be a discontinuous forest canopy with multi-aged stands.

B-10 Deer and Elk Winter Range

There are 27 acres of this land allocation in the watershed, which is equivalent to less than 1% of the total watershed area. Timber harvest is scheduled on these lands and will occur as long as winter habitat for deer and elk is provided.

Deer and Elk winter Range is represented by the Mature Forest / Small Openings design cell. The future landscape pattern represented by this design cell would be largely continuous with irregularly dispersed, small naturally appearing openings.

DB-2 Bull Run Watershed / Scenic Viewshed

There are less than 10 acres of Bull Run / Scenic Viewshed within the Upper Sandy Watershed. Timber harvest is scheduled on these lands, however, harvest and salvage will occur only where these actions maintain the "desired landscape character". Harvest designs would prioritize the protection of water quality.

Bull Run Watershed / Scenic Viewshed lands are represented by the Mature Forest Small Openings landscape design cell. Within this design cell, the forest canopy would be largely continuous with irregularly dispersed, small, naturally appearing openings.

Current Stand Conditions

For the land allocations where timber harvest is a scheduled output, Table 6-11 illustrates the approximate acreage of commercially sized stands. This table is presented only as an estimate of the current condition for watershed-scale planning efforts.

Table 6-11 Current Stand Size Class

GENERAL MGT. DIRECTION	Closed Small Conifer (9-21" dbh and >70% canopy cover)	Open Small Conifer (9-21" dbh, and canopy cover >40% & <70%)	Large Conifer (> 21" dbh and >40% canopy cover)	Non-commercial size class
C-1 Timber Emphasis	1,237	625	89	1,425
BLM-GFMA	578	158	42	1,010
B-2 Scenic Viewshed	1,260	425	77	1,360
B-6 Special Emphasis Watershed	793	420	47	410
DC1 Bull Run / Timber Emphasis	447	136	12	479
B-5 Pileated / Pine Marten	57	32	232	156
BLM Connectivity	104	10	0	5
B-10 Deer and Elk Winter Range	0	0	0	27
DB-2 Bull Run / Scenic Viewshed	2	5	0	0
TOTAL	5736	2231	576	4,872

Additional Considerations

Additional considerations for timber management in the watershed include:

- retention of fragmented, large diameter, late seral stands
- unmapped Riparian Reserves for unstable and potentially unstable lands
- rock outcrops, talus and other lands posing regeneration difficulty
- hydrologic recovery and stream drainage network extension

Harvest Not Scheduled

Timber harvest is not scheduled on the lands in the following management allocations. In some cases, timber harvest may occur to enhance the management objectives of the land allocation. In other cases, timber harvest is prohibited within the land allocation.

Wilderness

There are 14,944 acres of the Mt. Hood Wilderness within the Upper Sandy Watershed, equivalent to 22% of the watershed's total acreage. Wilderness lands comprise 36% of federal lands in the watershed. Timber harvest is not permitted on wilderness lands.

Wilderness lands are represented by the Alpine, Old Maid Flat and Old Forest / Continuous landscape design cells. Within these design cells, natural vegetation patterns will predominate.

Riparian Reserve

There are 8,000 acres of this management area within the watershed, which is equivalent to approximately 12% of the total watershed area. Riparian Reserves account for nearly 20% of the federally owned lands within the watershed. Riparian Reserve acres are withdrawn from scheduled harvest however, harvest of live trees may occur to achieve riparian vegetation characteristics as described by the Aquatic Conservation Strategy (ACS) objectives. Salvage is allowed if ACS objectives are not adversely affected.

Riparian Reserves are represented by the Old Forest / Linear and Old Forest / Continuous design cells. The future landscape pattern of these lands would be a continuous, old forest with small, natural openings, following streams throughout the watershed.

Late Successional Reserve

There are nearly 2,500 acres of this management area within the watershed, which is equivalent to 4% of the total watershed acres. Late Successional Reserve lands are withdrawn from scheduled timber harvest.

In general, timber harvest may occur in Late Successional Reserves if prescribed treatments benefit late-successional habitat. No harvest is allowed in stands over 80 years old. Thinning to benefit late-successional habitat may occur in stands up to 80 years old. However, a management assessment -- subject to review by the Regional Ecosystem Office -- must be completed prior to any harvest or salvage activity.

The Late Successional Reserves are represented by the Old Forest / Continuous design cell. The future landscape pattern would be a continuos old forest interrupted only by small, natural openings.

BLM Scenic Viewshed

There are 941 acres of this land allocation within the Hoodland corridor of the Upper Sandy Watershed analysis area. This amounts to approximately 1% of the total watershed acres or 2% of the federal lands within the watershed.

BLM Scenic Viewshed lands are non-PSQ lands. Some very limited management activities may occur in these lands. Activities should be designed to reflect the natural features of the characteristic landscape. The viewshed lands described in the Oregon Resource Conservation Act of 1996 (S 1662 Sec 401) were not evaluated in this analysis as complete exchange data were not available.

BLM Scenic Viewshed lands are represented by the Old Forest / Discontinuous design cell. The future landscape pattern would be a patchy arrangement of old forest in isolated sections.

A-1 Wild and Scenic River

There are over 3,000 acres of Wild and Scenic River in the Upper Sandy Watershed. This is equivalent to approximately 5% of the total watershed or 7% of the federal lands within the watershed.

Within wild river segments regulated timber harvest is prohibited (see Upper Sandy Wild and Scenic River Management Plan; USDA Forest Service, 1994). Within the recreational segment, regulated timber harvest should not occur. Timber harvest may occur to restore, protect, or enhance identified river values or protect forest health in the recreational segment.

Wild and Scenic River lands are represented by the Old Maid Flat and Old Forest / Continuous landscape design cell. Within these design cells, natural vegetation patterns will predominate.

100 Acre Late Successional Reserves (Known Spotted Owl Activity Centers)

There are 254 acres of this management area within the watershed, which is equivalent to less than 1% of the total watershed acres. 100 Acre Late Successional Reserve lands are withdrawn from scheduled timber harvest. Timber harvest is allowed under the circumstances previously described for Late-Successional Reserves. Management of stands in the matrix surrounding these areas will be designed to reduce risks of natural disturbance (ROD C-45).

The 100 acre LSR's (Known Spotted Owl Activity Centers) are represented by the Old Forest / Continuous design cell. The future landscape pattern would be a continuous forest interrupted only by small, natural openings.

A-9 Key Site Riparian

There are 296 acres of this management area within the watershed, which is equivalent to less than 1% of the total watershed acres. Key Site Riparian areas are withdrawn from scheduled timber harvest. Harvest may occur to enhance riparian dependent resource values.

Key site riparian lands are represented by the Old Forest / Linear and Wet Meadow design cells. The future landscape pattern of these lands would be continuous, old forest following streams and bordering the North Mountain wetland complex within the watershed.

A-4 Special Emphasis Area

The Old Maid Flat geologic area comprises 193 acres or less than 1% of the total watershed acres. The Special Interest Area is withdrawn from scheduled timber harvest.

The Old Maid Flat area is represented by the Old Forest / Continuous landscape design cell. Under this concept, natural vegetation patterns would be present.

DA-9 Bull Run Key Site Riparian

There are less than 40 acres of this management area within the watershed, which is less than 1% of the total watershed acres. It is located on the watershed divide between the Little Sandy and Upper Sandy Watersheds. Key Site Riparian areas are withdrawn from scheduled timber harvest. Harvest may occur to enhance riparian dependent resource values.

Bull Run / Key Site Riparian lands are represented by the Wet Meadow design cell. The future landscape pattern of these lands would be old forest bordering the North Mountain wetland complex on the northern watershed boundary.

Non-Federal lands

Thirty-eight percent (25,861 acres) of the lands in the watershed are in non-federal ownership. Of these, approximately 17,640 acres are zoned as timber lands.

Probable Sale Quantity Validation -- Mt. Hood National Forest

Following the adoption of the Northwest Forest Plan, the Mt. Hood National Forest used the Forplan model to estimate the probable timber yield under the amended land management direction. Broad assumptions were made for percent of lands in Riparian Reserves, unstable lands and owl activity centers.

The watershed analysis updated the vegetation data base and incorporated site specific analysis to re-calculate the acreage in riparian reserves, unstable lands and owl activity centers. Improved information on geology, the stream network, and spotted owl data contributed to a new tally of lands in the "other withdrawals and adjustments" category of the PSQ analysis. Site potential tree heights were established for Riparian Reserves and these were mapped for the watershed. Actual Riparian Reserve acreage may vary during field implementation. Unstable lands were estimated from landform mapping and still require field validation. Known spotted owl activity centers, (ROD C-10) were delineated for the watershed. The updated information for "other withdrawals and adjustments" is provided below (Table 6-12).

Table 6-12-- Updated "withdrawals and adjustments" Upper Sandy Watershed

Watershed Analysis Acres

Land Allocation	"A"	"B"	"C"	"DA"	"DB"	"DC"	LSR	All Lands
Riparian Buffers	6,345	3,233	2,601	17		1,121	887	**14,204**
Unstable Lands	7,276	1,195	360			365	780	**9,976**
Owl Activity Centers	67	133	27		7	86		**320**

No analysis was completed for visual restrictions.

Special Forest Products

A wide range of plant materials other than timber products are available within the Upper Sandy Watershed. The variety of habitats within the watershed allow for a diversity of special forest products. Products collected on Federal lands within the watershed include: cedar bolts, posts, transplants and sawlogs; mushrooms; Christmas trees and boughs; firewood; huckleberries; medicinal and pharmaceutical plants; floral greens live transplants and landscape materials.

Conditions of the watershed which influence the commercial collection of special forest products include: land ownership and accessibility; habit and distribution of plant species; and land management objectives.

Land ownership and accessibility

The watershed analysis considered special forest product availability primarily on National Forest lands. Special forest products are ocasionally available on BLM lands in the watershed. On National Forest lands, the principle collection areas are: Lolo Pass / Clear Fork, Old Maid Flat, North Mountain / Clear Creek, and Wildcat Mountain. Old Maid Flat is probably the most intensively used area for special forest products in the watershed. Public access restrictions in the Bull Run Watershed Management Unit limit forest product gathering in the north east portion of the watershed. The Bull Run Watershed Management Unit is adjacent to the Lolo Pass and North Mountain areas. North Mountain access is also limited by its relatively steep slopes and minimal road network. Access to the Wildcat Mountain area is limited to a single road (Road 3626).

Habitat and Distribution

Cedar.

Western redcedar is primarily found on moist sites along stream bottoms, flats, and benches throughout the watershed. Lesser amounts of cedar can be found on all slopes, aspects and forested sites within the watershed.

Mushrooms.

The watershed contains a number of edible species including chanterelle, several boletes, oysters and a variety of others. The most commonly sought species in the watershed are the yellow chanterelle and matsutake. The yellow chanterelle is a popular, choice edible, commonly associated with Douglas - fir stands 30-130 years old. The best sites are generally believed to be undisturbed forest. It is also thought that when the sites with the yellow chanterelle begin declining, the white chanterelle begins to dominate. The Wildcat area is dominated by stands less than 130 years with many less than 100 years-of-age. The Old Maid Flat mudflow surface is noted for the occurrence of matsutake mushrooms. There is relatively little information known about either the extent of the mushroom resource or the numbers harvested.

Christmas trees and boughs.

Tree species sought for Christmas trees include: noble fir, Pacific silver fir, Douglas-fir and, to a limited extent western white pine. Favored species for boughs that occur include those listed above as well as mountain hemlock, western redcedar and lodgepole pine. The powerline right-of-way in the Clear Fork drainage has traditionally been the principle source for Christmas trees in the watershed. There is proportionally far greater demand for bough materials than Christmas trees and significantly less supply, especially for noble fir.

Firewood.

Firewood and post and pole products are traditionally secondary products of timber harvest. Designated firewood areas are usually restricted to timber sale areas and landings. Secondary wood product availability is directly related to timber harvest levels.

Huckleberries.

Huckleberries are found on well drained, relatively open sites. The ridges and uplands in the Wildcat Mountain area offer the greatest diversity and concentration of huckleberries in the watershed. Huckleberry habitat is also present in the Bald Mountain area above Old Maid Flat.

The remaining products (medicinal and pharmaceutical plants; floral greens live transplants and landscape materials) are found throughout the watershed in a variety of habitats.

Land management objectives

Commercial collection of special forest products is prohibited on wilderness lands. Fuelwood gathering is restricted in both Late Successional and Riparian Reserves. Removal of cedar products may be limited in Riparian Reserves as well. Site specific information is required to evaluate the opportunities for gathering special forest products in Late Successional and Riparian Reserves.

Harvest of Christmas trees and boughs are most readily available in young plantations. The Lolo Pass / Clear Fork and Wildcat areas currently contain the largest acreages of plantations with suitable species for Christmas trees and boughs.

The transmission corridor that dissects the upper watershed has been a source of many special forest products over the years. Land management objectives for the powerline right-of-way are consistent with the production of Christmas trees and boughs and many transplant materials. With objectives to maintain early-seral forest stages, the right-of-way is potentially the best source area for many forest products in the future.

Product availability across the watershed will change as forest stands change over time. Additional information on Special Forest Products in the watershed is available in the analysis file.

Key Question #7: How do conditions of the watershed affect water quality in Alder Creek?

Background

The City of Sandy has expressed concerns with management activities within the Alder Creek subwatershed and their effect on raw water quality for the City's municipal supply.

Hydrologic processes which have the potential to be altered by management activities have been analyzed for the Alder Creek subwatershed. In addition, daily water quality data from Alder Creek has been analyzed for trends over time and compared to a unmanaged control subwatershed (Fir Creek) in the Bull Run Watershed.

Hydrologic processes analyzed include:

- Changes in peak flows associated with rain-on-snow events
- Changes in peak flows associated with stream drainage network expansion
- Changes in base flows associated with fog drip
- Stream channel stability with respect to streambank and inner gorge failure potential

Results

Increase In Peak Flow Magnitude From Rain-On-Snow Events

Figure 6-12 Potential Increase in Peak Flows from Hydrologically Mature Conditions (based on DNR Hydrologic Change Module)

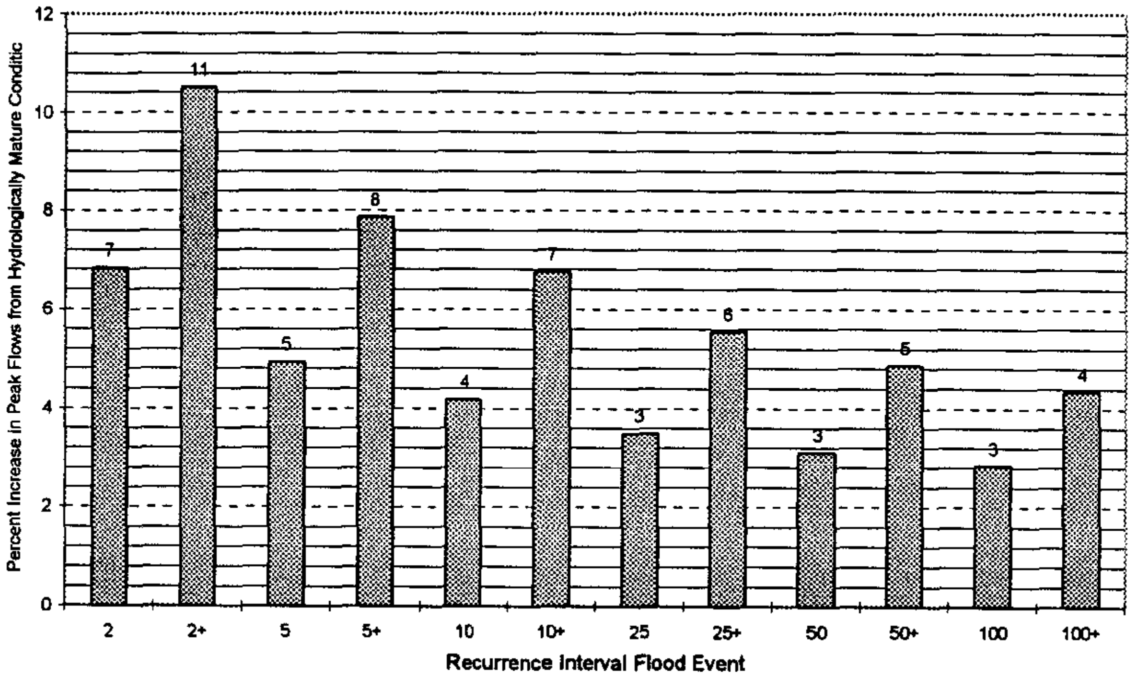


Figure 6-12 presents the predicted percent increase in peak flow magnitude from rain-on-snow events based on current vegetative conditions for different recurrence interval storm events. The + next to the recurrence interval indicates an "unusual" storm (representing a less frequent higher intensity storm). Hydrologically recovered conditions for vegetative cover were assumed to be 70% canopy closure of trees more than 8 inches diameter at breast height (DBH) in coniferous stands.

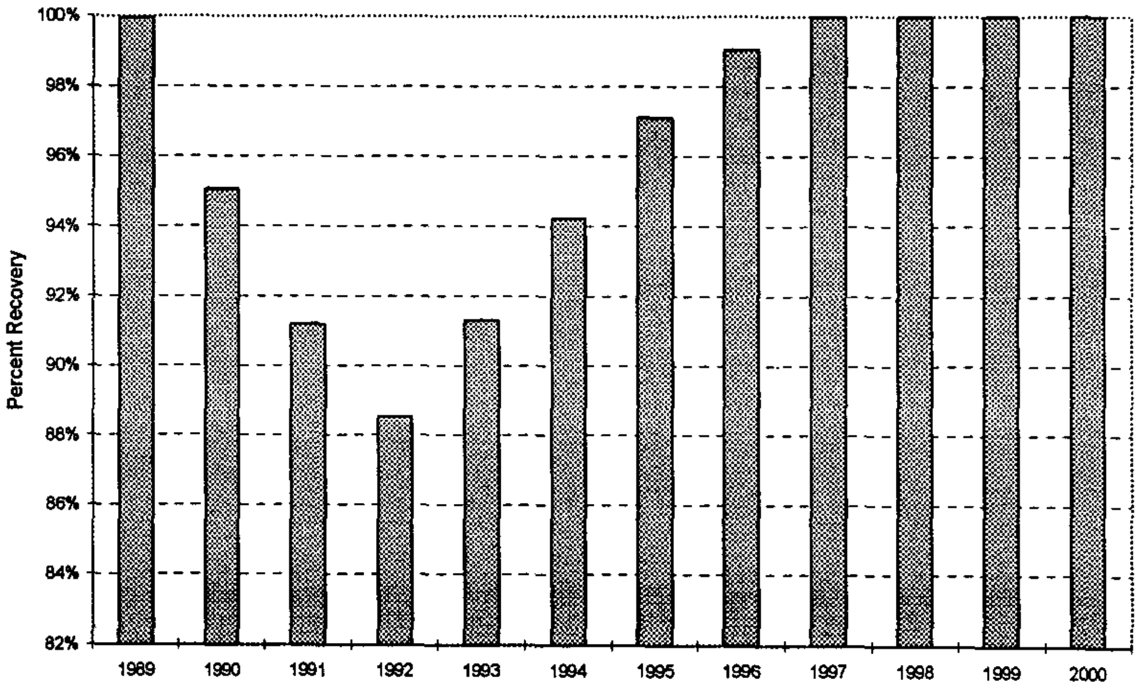
Peak flow increases greater than 10% offer the possibility for adverse effects and were assessed for impacts on beneficial uses. As the graphic indicates. based on current vegetative conditions the 2+ year recurrence interval storm increases peak flows more than 10% (based on the DNR Hydrologic Change Module)..

Stream Drainage Network Enhancement

There are 18 miles of road with 25 road and stream intersects in the Alder Creek subwatershed. With the assumption that the average culvert spacing is 500 feet this results in a 16% increase in the stream drainage network.

Base Flows and Fog Drip

Figure 6-13 Hydrologic Recovery Base Flows

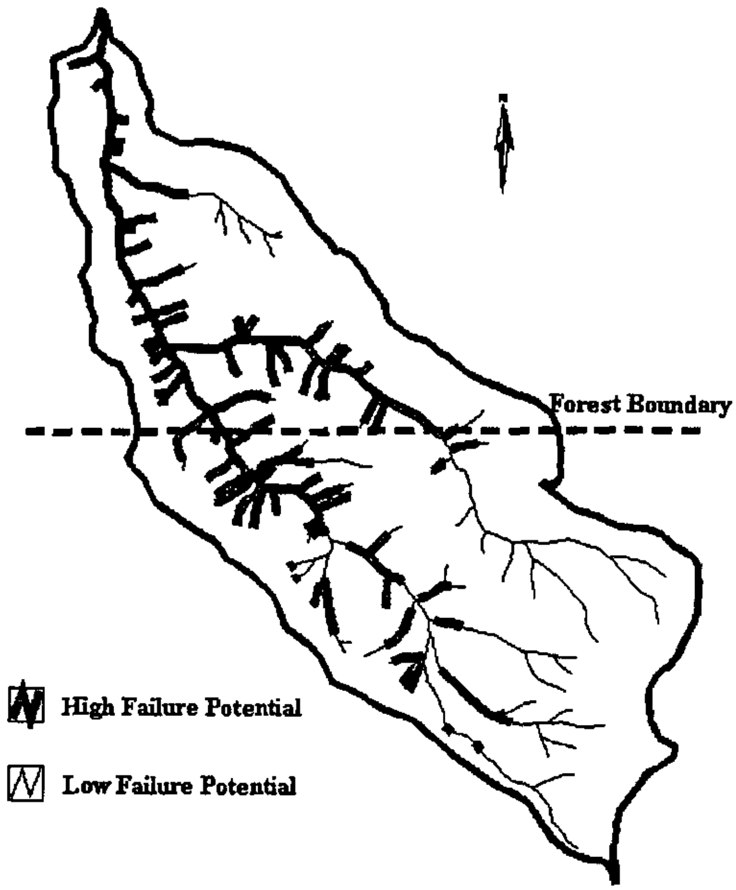


Hydrologic recovery with respect to decreased base flows from reductions in fog drip is currently 99% with a low in 1992 of 89%.

In the Bull Run watershed reductions in base flow were noted when 25% of a subwatershed was clearcut harvested. Currently 15% of the Alder Creek subwatershed is in structural stages that would indicate recent clearcutting. With hydrologic recovery with respect to decreased base flows from reductions in fog drip at 99% and clearcut area less than 25% of the subwatershed it would indicate that reduced base flows from reductions in fog drip are not a concern.

Stream Channel Stability

Figure 6-14 Streambank and Inner Gorge Failure Potential



As the graphic illustrates a large portion of the streams in the Alder Creek subwatershed are classified as having a high potential for streambank and inner gorge failures (59% of the total channel length). This was validated by stream surveys of Alder Creek in 1993 that classified 49% of the length of Alder Creek above the Forest Boundary as having a high sensitivity to disturbance.

Turbidity

Seasonal Kendall Trends Analysis

Seasonal Kendall trends analysis indicates a slight decreasing trend (0.04 NTU's per year) that is statistically significant at the 99% confidence level for data for the entire year. If the data for the months of November through March, when high flows associated with rain-on-snow events would be expected, is analyzed there is a similar trend, however, it is not statistically significant (P-level less than 0.10).

Comparison to Fir Creek

When turbidity levels from Alder Creek are compared to the unmanaged control subwatershed in the Bull Run there are statistically significant (P-level less than 0.10) differences for both the entire year and the period from November through March. The statistical significance of the differences may be less important than the fact that the magnitude of the differences (0.09 and 0.08 NTU's) has no practical significance.

Temperature

Seasonal Kendall Trends Analysis

There is a statistically significant decreasing trend for the period 1991-1996 for stream temperature at the rate of 0.6^0 Celsius per year based on data for the entire year. For the months of July to September, where increases in summer stream temperatures would be expected due to increased interception of solar radiation from created openings, there is a slight decreasing trend that is not statistically significant.

Comparison to Fir Creek

When stream temperatures from Alder Creek are compared to Fir Creek there are statistically significant differences for the entire year and for the period July through September. For the entire year the difference is 3.3^0 Celsius and for the period July through September the difference is 2.7^0 Celsius. These differences are both statistically significant and of practical significance. In Alder Creek, stream temperatures exceeded State Water Quality Standards (14.4^{0} C for 1991-1995 and 12.8^{0}C for 1996) for the Sandy Basin in 1991, 1992, 1993, 1994 and 1996.

Conclusions

There are predicted increases in peak flow magnitude(based on the DNR Hydrologic Change Module) associated with rain-on-snow events and increased stream drainage network expansion. These increases have the potential to increase suspended sediment and turbidity levels in Alder Creek due to in-channel processes such as streambank and inner gorge failures. The stream survey of Alder Creek in 1993 noted erosion and undercut streambanks throughout the entire surveyed area.

Based on daily water quality data from Alder Creek turbidiy levels are on a downward trend which may be due in part to climatic conditions during this period. Turbidity levels were compared to Fir Creek for the same time period to factor out climatic influences. Turbidity levels are higher in Alder Creek in a statistically significant relationship. However, the statistical significance is less important than the fact that the magnitude of the difference (0.09 NTU's) has no practical significance.

Stream temperatures are also experiencing a downward trend for the period 1991 through 1996 which may be due in part to climatic conditions. When temperatures are compared to Fir Creek for the same time period to factor out climatic influence, stream temperatures in Alder Creek are higher at levels (3.26 and 2.68 degrees Celsius) that are statistically significant and of practical significance due to exceedences of water quality standards and effects on aquatic organisms..

Chapter 7:

Recommendations

Chapter 7 - Recommendations

Introduction

This chapter will focus on guidance and recommendations for project-level planning and overall land management planning, based on the findings presented and discussed in previous chapters.

This chapter will present recommendations for:

- Setting and refining Riparian Reserve boundaries
- Habitat in the North Mountain area
- Late Successional Reserve Assessment
- Restoration Strategy
- Monitoring Strategy

Also included in this chapter are:

- Data and Analysis gaps
- Altered Processes
- Suggestions for the next iteration

Recommended Riparian Reserves

Riparian Reserves, a key element of the Aquatic Conservation Strategy (ACS), provide areas along streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Riparian Reserves are also important to the terrestrial ecosystem, serving as dispersal habitat for certain terrestrial species and connectivity corridors among late successional habitats.

To provide effective habitat connectivity within the watershed, as well as to address a variety of landscape level concerns, it is recommended that Riparian Reserve widths be consistent throughout the major vegetation zones. Delineating Riparian Reserves in this manner will eliminate small-scale variations, while ensuring larger-scale connectivity and function. Additionally, this method will facilitate administration, analysis and mapping.

The Upper Sandy Watershed Analysis recommends the following reserve widths by vegetation zone (Table 7-1). Assumptions for establishing the site potential tree height and the supporting documentation from the watershed analysis is also presented in this table. Final Riparian Reserve boundaries are prescribed during site specific analysis and through the National Environmental Protection Act (NEPA) decision-making process (ROD B-13).

Table 7-1 – Recommended Riparian Reserve Widths

STREAM/RIPARIAN ZONE TYPE	WESTERN HEMLOCK ZONE	PACIFIC SILVER FIR ZONE	MOUNTAIN HEMLOCK ZONE
Fish bearing streams (2 site-potential tree heights)	420'/side 840' total	340'/side 680' total	300'/side 600' total
Non-fish bearing, permanently flowing streams (1 site-potential tree height)	210'/side 420' total	170'/side 340' total	150'/side 300' total
Seasonally flowing or intermittent streams (1 site potential tree height)	210'/side 420' total	170'/side 340' total	100'/side 200' total
Lakes and natural ponds (2 site potential tree heights)	420' surrounding	340' surrounding	300' surrounding
Wetlands (1 site-potential tree height)	210' surrounding	170' surrounding	150' surrounding
Unstable and potentially unstable areas (see note below) (1 site-potential tree height)	210' surrounding	170' surrounding	100' surrounding
Key Site Riparian	See comment below		

Key Site Riparian

Key Site Riparian designations of the LRMP (A9 and DA9) are incorporated into the Riparian Reserve network. 328 acres of Key Site Riparian, however, extend beyond the widths in Table 7-1. In such instances, these Riparian Reserve widths would be increased to include these additional acres.

Unstable and Potentially Unstable Lands

It is recommended that when unstable and potentially unstable lands are encountered, a geologist or soil scientist field verify the extent of instability.

The Riparian Reserve width will begin at the edge of the instability and will include the entire extent of the unstable area or areas. The analysis file includes tools to identify unstable conditions within the watershed that will trigger additional field investigation.

Supporting Documentation for Riparian Reserve Recommendations

Determination of Riparian Reserve Widths

Direction for designating Riparian Reserve widths is stated in the ROD (Standards and Guidelines, pages C-30 and C-31). Riparian Reserve widths are discussed in terms of site potential tree height, or a given slope distance -- whichever is greater. For the Upper Sandy Watershed, *measured* site-potential tree heights were used to delineate the recommended width as the measured heights reflect the greatest distance.

A site potential tree is defined as the average maximum height of the tallest dominant trees (200 years or older) for a given site class. Nancy Diaz, Mt. Hood NF Area Ecologist, compared two approaches to determine average maximum tree heights. The first approach averaged site indices and then determined the maximum height for the average site index. The second approach averaged actual heights of older site index quality trees measured on plots (with Douglas-fir used as the predominant species).

It was found that averaging site indices provided a significantly lower tree height than actually measured on the plots. This may be due to the productivity of the riparian zone. (Reference: Riparian Tree Height Information from Ecology Plots, Nancy Diaz, Mt. Hood National Forest.) The measured tree heights method yields a more applicable estimate of buffer width and will be used for both the Western Hemlock Zone and the Pacific Silver Fir Zone.

For the Mountain Hemlock Zone, the recommendation is to use slope distances from the ROD since there were too few plots measured in this zone to accurately ascertain average maximum tree height. It is also thought the smaller tree heights of higher elevation species would be best approximated by the ROD distances.

Based on this process, the site potential tree heights are listed in Table 7-2 below.

Table 7-2 -- Site Potential Tree Heights

WESTERN HEMLOCK ZONE	Douglas fir measured tree ht. 210'
PACIFIC SILVER FIR ZONE	Douglas fir measured tree ht. 170'
MOUNTAIN HEMLOCK ZONE	Limited measured data Use recommended widths (table 7-1)

Analysis of conditions and trends within the Upper Sandy Watershed reveals the processes and existing effects important to riparian habitat within the watershed. The discussion of Key Question #5 details watershed conditions with respect to the ACS objectives. Additional key questions identify terrestrial processes and functions supported by Riparian Reserves. Key points from these analyses that support the recommendation of consistent Riparian Reserve widths are summarized below. (For an extensive discussion of the analysis, consult the appropriate sections of this document.)

Current Conditions

The standards and guidelines for Riparian Reserves are described in the ROD (pages C-31 through C38). In general, when current conditions within Riparian Reserves retard or prevent attainment of the Aquatic Conservation Strategy Objectives (see Key Question #5), efforts should be taken to modify or mitigate the detrimental conditions.

Structure and Function

Riparian vegetation serves an important function in a number of processes

- Regulates the exchange of nutrients and material from upland forests to streams
- Determines levels of large woody debris loading
- Moderates stream temperatures and light levels
- Stabilizes banks, allowing development and maintenance of undercut banks, and protects banks during large storm flows

- Contributes leaves, twigs, and other forms of fine litter that are an important component of the aquatic ecosystem food base
- Important for riparian-dependent organisms including amphibians, arthropods, mammals, birds, and bats (FEMAT).
- Provides for greater connectivity of late-successional forests within and among LSR's for dispersal of mobile species, and serve as refugia for species that disperse short distances (ROD 5, 7, B-13)

Based on current conditions, the Riparian Reserves in the Upper Sandy Watershed may not be fully providing these functions as envisioned by the Northwest Forest Plan and the ACS.

Chart 1 Riparian Reserve Seral Stage Federal Ownership

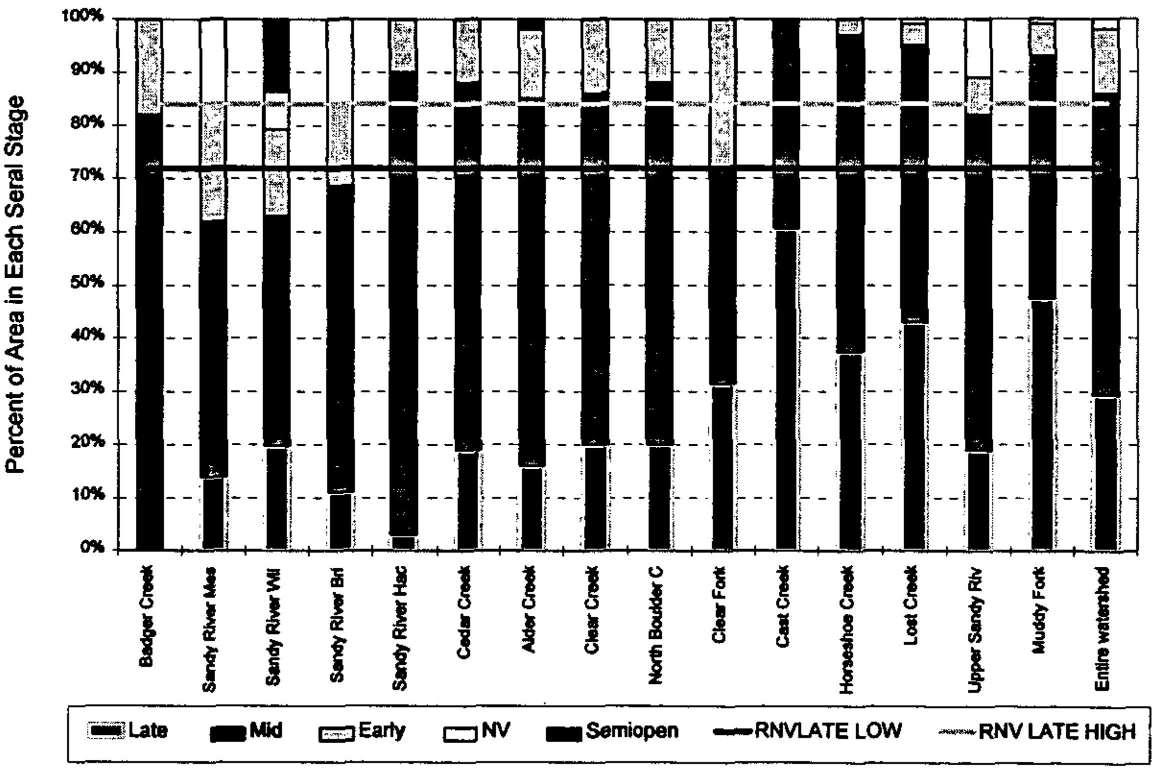


Table 7-3 Riparian Reserve Seral Stage Federal Lands

(percent of Riparian Reserves by subwatershed)

Subwatershed	Late[1]	Early	Acres of Federal Ownership
Badger Creek	0	18	42
Sandy River Mensinger	14	22	227
Sandy River Wildcat	23	19	477
Sandy River Brightwood	11	17	205
Sandy River Hackett	3	10	294
Cedar Creek	19	12	380
Alder Creek	16	13	1097
Clear Creek	20	14	2608
North Boulder Creek	20	12	716
Clear Fork	31	28	2344
Cast Creek	60	0	664
Horseshoe Creek	37	3	877
Lost Creek	43	4	2169
Upper Sandy River	19	7	1865
Muddy Fork	47	6	1556
Entire Watershed	29	12	15521

Stand structure as expressed by seral stage is well outside the RNV for the Upper Sandy Watershed. Subwatersheds with the majority of the land base in the Western Hemlock Zone vary from 0-31% of the Riparian Reserves in late seral stand conditions. In the upper watershed there is slightly more late seral stand structure (19-60%) but these areas are still well below the RNV. This has resulted in impacts to:

- Stream temperature due to the reductions in stream shade levels
- Large woody debris recruitment potential due to the lack of large trees in the riparian areas
- Aquatic habitat in sixth order channels (pool and large woody debris levels are very limited)

The Sandy River from the confluence with the Muddy Fork to the western extent of the watershed is listed with severe problems with stream structure in the 1988 DEQ nonpoint source assessment. This condition may be a reflection of upstream conditions and the lack of LWD recruitment on Forest Service and BLM ownership lands.

[1] RNV for late seral stands is 72-84% of the area in the Riparian Reserves based on Bull Run data

Effects to riparian habitat for plant and animal species of concern include:

- Water temperatures are outside the optimum range for coldwater corydalis, *hydrotheria venosa*, Cope's giant salamander, and salmonids.
- An altered sediment regime affecting coldwater corydalis, *hydrotheria venosa*, Cope's giant salamander, and Pacific lamprey.
- Limited large woody debris and pools in sixth and greater order streams limiting habitat for chinook salmon.
- Low amounts of cool, moist old-growth forest that serve as habitat for three survey and manage lichen species (Key Question #4)

Connectivity

The Upper Sandy Watershed is currently below the range of natural variation for late-seral forest in the Western Hemlock Zone. This may place increased pressure on riparian habitats to serve as connectors of late-seral patches, as well as emphasize the landscape level importance of any late-seral forests currently existing within riparian areas. (See Chart 1 Riparian Reserve Seral Stage Federal Ownership and Table 7-3 Riparian Reserve Seral Stage Federal Lands.)

Private lands are not subject to the ACS objectives. As a result, riparian areas on private lands may be afforded lesser protection than those on national forest lands. Concentrations of private lands in the western half of the watershed, contribute to reduced connectivity of Riparian Reserves. This adds increased importance to the role of Riparian Reserves in isolated blocks of federal ownership within the same area. These isolated blocks may become stepping stone habitat for mobile late-seral species, and refugia areas for non-mobile species linked to late-seral forests.

North Mountain Recommendations

Pileated Woodpecker and Pine Marten Areas (B-5 Areas)

Page C-3 of the ROD states that: *Administratively Withdrawn Areas that are specified in current Forest Plans to benefit American martens, pileated woodpeckers, and other late-successional species are returned to the Matrix unless local knowledge indicates that other allocations and these standard and guidelines will not meet the objectives for these species.*

A forest-wide analysis was drafted (July, 1995) that assessed the relative importance of individual B-5 land allocation areas based on their contribution to late-seral forest conditions at the watershed level. The analysis procedure started by screening out any B-5 area that was in reserved land allocations. The remaining areas were further reviewed for their relation to the Northwest Forest Plan land allocations.

The forest-wide analysis recommended that one of the B-5 areas within Matrix lands in the watershed be retained. District biologists concurred. This Management Requirement Area is located in the North Mountain area of the Upper Sandy watershed and was designated to benefit pileated woodpecker habitat. The entire Management Area is 625 acres. Of this, 383 are currently providing late-seral habitat, 175 mid-seral, and 67 early-seral.

Late-seral habitat is low within the watershed and the North Mountain area provides a large block of contiguous, late-seral habitat including well developed old-growth stands. This habitat is also important to the connectivity of LSR habitat to the north and south of the watershed. It contains the southern most range of the sensitive plant, Krushea. Work with the winter tracking program in the watershed found cougar and intensive bobcat presence in the North Boulder area as well.

Within pileated woodpecker habitat areas, at least 300 acres of mature and/or old-growth forest habitat shall be maintained within each 600 acre Management Area (LRMP B5-008). Each 300 acre of mature and/or old-growth habitat should be contiguous (LRMP B5-009).

The easternmost half of the B-5 Area contains the best and most contiguous mature and old-growth habitat. This area was delineated using aerial photographs and was incorporated into the "Old Forest/Continuous" design cell on the Landscape Analysis Design Map.

It is the recommendation of this analysis to retain the entire North Mountain B-5 Area with the easternmost half providing the 300 acres of contiguous mature and old-growth habitat.

Protection of Krushea Populations

North Mountain was selected as one of five major population sites for protection in the draft *Species Management Guide for Streptopus streptopoides* (Kagan and Vrilakas 1993). The Northwest Forest Plan also suggests protecting this type of rare plant site as a mitigation measure (ROD, p 33). The North Mountain population may represent a unique gene pool as it is the southern-most population of **krushea** found North America.

Krushea requires thick duff and rotting wood in cool, moist forests that have not been subject to fire for a period of approximately 300 years. The old-growth stands in the North Mountain area provide such habitat. Krushea habitat is not expected elsewhere in the Upper Sandy Watershed.

The North Mountain krushea population and adjacent habitat encompass approximately 500 acres. Much of this population is located within the proposed B5 Pine Marten/Pileated Woodpecker Management Area. The majority of krushea on North Mountain grows in old-growth forest patches which are fragmented, *not* contiguous, and thus may not be protected from disturbance by the B5 allocation.

Protection for existing krushea plants and habitat equates to retaining all old-growth fragments on North Mountain in an undisturbed state. Any timber harvest in this stand type may be detrimental to krushea's microclimate and substrate requirements. Additional no-timber harvest acres including krushea sites need to be designated on North Mountain. While plantations can be thinned as needed to encourage tree growth, to encourage a thick duff layer, disturbance to the forest floor should always be minimal.

It is the recommendation of this analysis to implement the draft Species Management Guide for Streptopus streptopoides in the North Mountain area.

Maintenance of Important Old-Growth Stands

Together, the fire history, human development, and land management activities in the Upper Sandy Watershed have contributed to a very low level of forest stands dominated by trees >21" in diameter. Old forest patches of large trees such as those on North Mountain are rare in this watershed. Only 6% of the federal lands contain these stands of large old trees and complex structural and biological diversity. Most of these patches are currently within reserve areas (LSR, Wilderness, Riparian Reserves).

It is the recommendation of this analysis to maintain patches or elements of these old growth stands on the landscape whenever possible.

Maintenance of Survey and Manage Lichens

For two survey and manage lichens in this watershed that occur within riparian areas, the Northwest Forest Plan states that Riparian Reserves do not provide suitable habitat (ROD, Appendix J2, p 226-227). These are: ***Hypogymnia duplicata*** and ***Loxosporopsis coraliferra***. Riparian Reserves may need to be linked to blocks of old-growth forest to provide suitable interior canopy habitat for these lichens. Generally the highest biomass and diversity of lichens is found in the oldest forests. Many of the nitrogen-fixing and forage species will not colonize stands until they are at least 100-200 years old.

Isolated old-growth stands outside LSR's, such as those on North Mountain, are an important source of lichen propagules for the colonization of younger stands.

LSR Summary and Recommendations

The ROD states that "a management assessment should be prepared for each Late Successional Reserve (LSR) ,or group of smaller LSRs, before habitat manipulation activities are designed and implemented" (ROD C-11). A management assessment for the Bull Run LSR will be scheduled in the future.

Information derived from the Upper Sandy Watershed Analysis is recommended to be carried forward in support of the overall LSR assessment.

Effectiveness of Habitat

A primary goal of the Northwest Forest Plan is to provide for a functional and interconnected old-growth forest ecosystem of which LSR's are an integral part. One measure of the current effectiveness of LSRs is the percentage of late seral habitat present. Intuitively, a fully functioning LSR should be largely in a late-seral condition.

The portion of the Bull Run LSR (2460 acres) that is in the Upper Sandy Watershed (NE corner) currently has only 31% late-seral habitat. This area is fragmented and contains little contiguous late-seral habitat. Although its role in the overall functioning of the Bull Run LSR needs to be assessed, this area may provide an important landscape link from the Bull Run LSR to the Mt. Hood Wilderness and LSR areas to the south (as forests mature).

Table 7-4 displays present and future conditions of the LSR in terms of forest seral stage. Future, *long term*, assumes full implementation of the Northwest Forest Plan, an absence of large scale natural disturbances, and sufficient time for successional processes to progress from early through late (approximately 120 years). Future, *short term*, projects forest changes over the next 30-50 years that are attributed to growth.

Table 7-4 -- LSR Seral Stage: Current Condition and Trends

Habitat	Current	Future (short term)	Future (long term)
Late-seral	31%	42%	100%
Mid-seral	39%	58%	0%
Early-seral	30%	0%	0%

Even in the near future, less than one half of the LSR will be in a late-seral condition. Silvicultural treatments in stands less than 80 years old may be applied to hasten the development of late-seral structure (ROD p. C-12). Approximately 756 acres are comprised of stands under 80 years in age *(most are young plantations less than 30 years of age).*

Actions that will facilitate meeting the late-successional forest objectives for this area are recommended. Silvicultural activities in stands less than 80 years of age should be prioritized to areas that offer the best opportunities to enhance: riparian functioning; interior habitat; and habitat connectivity across the landscape. Any activities in this portion of the watershed must be consistent with the Bull Run Watershed Management Unit goals of continued production of pure, clear, raw potable water.

Watershed analysis products with particular relevance to preparation of a management assessment for the LSR lands include:

- Chapter 2 -- General Management Objectives
- Chapter 4 -- Seral Stage, Stand Structure and Landscape Pattern discussions
- Chapter 5 -- Future Landscape Pattern and Future Seral Stage
- Chapter 6 -- Key Question 2; Terrestrial Connectivity

Restoration Opportunities

Introduction

Guidance for assembling this section came from: the Aquatic Conservation and Late Successional Reserve strategies in the Northwest Forest Plan; the Interagency Watershed Restoration Strategy (Regional Ecosystem Office, October, 1994); the Report of the Forest Ecosystem Management Assessment Team (1993) and analysis of the current watershed condition and trends. The restoration projects described in this section apply to Federal lands within the watershed. The watershed analysis may be used as a guide for restoration opportunities on non-federal lands with the caution that site specific data was lacking for certain watershed conditions. In addition, Clackamas County (pers. Comm. Troy Moore, 11/96), is interested in joint enhancement projects.

Restoration projects result from altered landscape processes affecting beneficial uses. This list includes all the restoration opportunities identified during the analysis, however they are not prioritized. Prioritization could occur during the Interim Landscape Analysis and Design step that occurs after watershed analysis.

Table 7-5 Restoration Opportunities Upper Sandy Watershed

ALTERED PROCESS	WATERSHED LOCATION(s)	RESTORATION OBJECTIVE	RESTORATION PROJECT
Reduced site productivity	See ATM (ch.5)	Restore site productivity through road reclamation	Decompact road beds and revegetate surfaces
	Wildcat Mountain area	Reduce soil compaction	Subsoil tractor skid trails
	Wildcat Mountain area	Restore productivity on offsite plantations	Replace offsite stands with locally adapted stocks
Existing stand structure is outside the RNV in Riparian Reserves	All subwatersheds, especially those in Western Hemlock Zone	Restore structural complexity of riparian vegetation Increase large woody debris recruitment potential	Riparian silviculture and plantings Conifer plantings in alder dominated riparian areas Promote conditions conducive to natural regeneration

ALTERED PROCESS	WATERSHED LOCATION(s)	RESTORATION OBJECTIVE	RESTORATION PROJECT
Simplification of stand structure over large areas	Clear Fork, Wildcat and North Boulder subwatersheds, offsite plantations	Improve stand structure (large trees, layered canopy, LWD, patchiness of stands)	Thin managed stands to create patchiness and larger trees. Maintain and create snags, LWD.
Late-seral forest habitat below the RNV	Western Hemlock Zone	Improve connectivity for late-seral species of concern, especially less mobile species (ex. red tree vole) Restore late-seral habitat for viability of late-seral species	Maintain structural components adjacent to riparian reserves where connectivity corridors are needed Silvicultural treatments in managed stands to advance late-successional structure (multi-storied canopy, snags and LWD) Protect existing patches
Reduced connectivity of late-seral habitat in Riparian Reserves	North Boulder, Alder, Wildcat, Clear Creek and Clear Fork subwatersheds	Promote late-seral connectivity within Riparian Reserves	Natural recovery and riparian silviculture to accelerate late-successional development (multi-storied canopy, snags, LWD) Maintain late-successional stands adjacent to Riparian Reserves until riparian habitat recovers

ALTERED PROCESS	WATERSHED LOCATION(s)	RESTORATION OBJECTIVE	RESTORATION PROJECT
Reduced biodiversity through the introduction of noxious weeds and invasive, non-native plants	Power line corridor Highway 26 Road 18 to Lolo Pass	Prevent introduction and spread of noxious weeds, Decrease noxious weed populations Secure viability and distribution of native plants; Reduce size of existing populations Reestablish native plant communities in weed-dominated areas	Use certified weed free seed for all seed and mulch Pull all knapweeds Clean construction equipment prior to entry in the watershed; Minimize areas of disturbed soil in project work Use manual and biocontrol to reduce Scotch broom populations (outlier sites are first priority) Plant trees and shrubs at Scotch broom removal sites to shade out seedlings
Decreased structure and composition of riparian vegetation	North Boulder, Alder, Wildcat, Clear Creek, and Clear Fork subwatersheds	Restore structure and composition of riparian vegetation Increase LWD recruitment potential where current levels are below forest plan standards	Riparian plantings, natural regeneration and riparian silviculture to move stands from moderate and low LWD recruitment potential to high LWD recruitment potential
Altered vegetation structure and composition at high use recreation sites within the Mt. Hood Wilderness	Paradise Park, Ramona Falls, Burnt Lake, Cast Lake, Upper Sandy Guard Station, Mt. Hood Wilderness campsites	Restore vegetation and habitat characteristics	Exclude users from sensitive areas Revegetation Site decompaction through tilling and mulching
Water Quality: Increased stream temperature	Subwatersheds within the Western Hemlock Zone	Maintain water quality to meet state standards and to meet life cycle requirements of aquatic flora and fauna	Increase stream shade in subwatersheds where either measured or modeled stream temperatures do not meet state standards or life cycle requrements of aquatic species

ALTERED PROCESS	WATERSHED LOCATION(s)	RESTORATION OBJECTIVE	RESTORATION PROJECT
Water Quality: Altered sediment regime	Clear Creek, Clear Fork, Alder Creek; power line access roads; Highway 26, trail crossings in Cast Creek; Bear Creek	Reduce sediment production and delivery to stream channels from roads(especially power line access roads) and other ground disturbing activities Maintain water quality and aquatic habitat for aquatic species (i.e. corydalis) and for the municipal water supply	Install barriers to trap and contain highway sand Road obliteration and revegetation Re-vegetation of road cuts and fills Replace culverts to accommodate 100 year floods Harden erosional surfaces Maintain roads and trails in riparian areas
Subsurface Intercepts	Rd 1200400 (Upper Clear Creek), Rd 1825-111 and 1825-380, Rd 1825-125 (Chance Creek), Rd 1825-118 (Top Spur)	Reduce detrimental effects to water temperature, peak flow, base flow, and water quality	Promote infiltration through tilling and mulching Redirect intercepted flows Control storm water runoff
Reduced vegetative and hydrologic connectivity between streams and wetlands	Sandy River Clear Creek	Restore the timing, variability, and duration of floodplain inundation and water level elevation in floodplains and wetlands	Reconnect and restore side channels Rehabilitate disturbed areas Enhance connectivity between disjunct wetlands and streams Riparian plantings and silviculture
Terrestrial Connectivity	BPA power line LSR	Increase opportunities for terrestrial habitat connectivity across key barriers	Promote connected forest patches across power line corridor at draws and canyons Silvicultural activities to promote late-seral forest development in key patches of young stands in LSR

ALTERED PROCESS	WATERSHED LOCATION(s)	RESTORATION OBJECTIVE	RESTORATION PROJECT
Aquatic habitat connectivity	Barrier culverts	Restore habitat connectivity	Replace barrier culvert
Increased peak flows from drainage network expansion	Alder, Cedar, Clear Creek, Clear Fork, Horseshoe and Upper Sandy River subwatersheds; Sandy River Brightwood, Hackett, Mensinger, and Wildcat subwatersheds.	Restore peak flows to range of natural variation, or minimize increases in peak stream flows due to management activities Reduce effects of increased peak flow on channel stability and fish habitat	Reduce road and stream crossings to a drainage network expansion of less than 10% Active road decommissioning
Predicted increased peak flows from created openings (based on DNR methodology)	Badger Creek, Sandy River Brightwood, Hackett, Mensinger, and Wildcat subwatersheds, Cedar Creek, Alder Creek,North Boulder Creek, and Clear Fork	Restore peak flows to range of natural variation, or minimize increases in peak stream flows due to management activities Reduce effects of increased peak flow on channel stability and fish habitat	Silvicultural activities to move created openings to hydrologic recovery (8 inches DBH and 70% canopy closure)
Simplified stream channel morphology and reduction in side channel habitat effectiveness	Upper and Lower Sandy River, Clear Fork, Sandy River, Hackett subwatersheds; Bear creek	Improve aquatic function, complexity and connectivity Increase side channel quality	Restore floodplain connectivity and channel structure Reconnect and restore side channels Incorporate large woody debris
Ground disturbance in Old Maid Flats - Special Interest Area	Dispersed campsites and trails on the mudflow	Restore vegetation and habitat characteristics in Old Maid Flats sites Promote public awareness and understanding of ecosystem function Limit harvest of mosses and mushrooms	Exclude users from sensitive areas Reduce dispersed camping and off trail horseback riding by enhancing existing facilities Interpretive site describing unique habitats

Monitoring

The purpose of this section is to identify monitoring opportunities associated with key processes and functions within the watershed. The processes and functions identified are critical to maintaining or restoring the key attributes. Monitoring within this section falls into two broad categories: 1) baseline monitoring to assesses the current condition prior to implementation of the Northwest Forest Plan, and 2) implementation and effectiveness monitoring associated with implementation of the Northwest Forest Plan (which includes restoration projects identified in this document).

Table 7-6 Monitoring Recommendations

PROCESS OR FUNCTION	MONITORING QUESTION	MONITORING OPPORTUNITY	EMPHASIS AREAS
Lichen and fungi species occurrence in Old Maid Flat	What lichen and fungi species occur on the Old Maid Flat mudflow?	Baseline lichen and fungi surveys and monitoring over time for population viability	Old Maid Flat
Rare plant species occurrence in wetland habitat	What plants occur in the North Mountain wetlands complex?	Plant surveys to document species diversity and monitoring for population viability	North Mountain wetlands complex
Implementation of other plans and management standards	Is implementation of Wild and Scenic River Plan occurring? Are Outstandingly Remarkable Values being protected?	Implementation and effectiveness monitoring for Wild and Scenic River. Establish measurement criteria for Outstandingly Remarkable Values and monitor for consistency with established criteria.	Sandy Wild and Scenic River
Native plants and wildlife habitat	Are noxious weeds and invasive non-native species spreading within the watershed?	Monitor for noxious weeds and invasive non-native plants adjacent to known sites	Old Maid Flats, North Mountain, Lolo pass, power line corridor, Wildcat Mtn., Highway 26

PROCESS OR FUNCTION	MONITORING QUESTION	MONITORING OPPORTUNITY	EMPHASIS AREAS
Wilderness values	Are Wilderness values being maintained?	Continue to monitor high use areas of Mt. Hood Wilderness for resource degradation.	Paradise Park, Ramona Falls Trail
Plant and wildlife species of concern	What is the status of survey and manage and other species of concern in the watershed?	Survey and manage as per protocol.	Known and potential habitats of individual species. LSR for spotted owls. B5 for pileated woodpeckers.
Protection Buffers	Are ROD (sec J-2) protection buffers implemented and effective for species conservation within the watershed?	Monitor buffer implementation and effectiveness for Corydalis populations	Project areas adjacent to known populations (Alder Creek)
Riparian Reserves	Are riparian reserve widths being implemented according to recommendations in this analysis and site specific circumstances?	Monitor implementation of riparian reserves.	Project areas where disturbance to the riparian reserve may occur.
Sediment transport and deposition	What is the impact of road related sediment delivery on aquatic habitat conditions?	Particle size distribution above and below road crossings or parallel to streams.	
Water quality: stream temperatures	Do stream temperatures meet state standards and requirements of aquatic species	Run SHADOW model Stream temperature measurements	Entire watershed
Water quality: chloride concentrations	Is there an increase in chloride concentrations in the Sandy River from the salting of Palmer snowfield	Monitor chloride concentration during salting of Palmer snowfield. Monitor total dissolved solids.	Sandy River below confluence with Zigzag and Salmon rivers

PROCESS OR FUNCTION	MONITORING QUESTION	MONITORING OPPORTUNITY	EMPHASIS AREAS
Flow regime pealflows	Are created openings and stream drainage network enchancement causing an increase in peakflow magnitudes	Establish crest stage gages	Alder Creek, Cedar Creek, North Boulder Creek, and Clear Fork

Data and Analysis Gaps

Data and analysis gaps were noted in the analysis when a key process could not be addressed adequately to fully answer the key question. Data gaps were identified as missing or incomplete information needed to assess a process or concern. Analysis gaps were analyses that were not completed due to time, money, resource or data constraints. In the process of implementing ecosystem management it would be appropriate for the districts or forest to address these data and information gaps.

Table 7-7 Data and Analysis Gaps

PROCESS	DATA GAP	ANALYSIS GAP
Population viability for survey and manage species	Location of strategy 1 and 2 species; Determination of population health; Information on dispersal needs	
Large woody debris and snag habitat	Quantity and quality of large woody debris and snags in managed and unmanaged stands	Summarize and evaluate contribution of LWD and snags to stand structure across the watershed.
Biodiversity of Old Maid Flat	Effect of mushroom and moss harvest and corresponding site disturbance on plant species abundance and diversity	
Erosional processes	Geologic rates of surface erosion and mass wasting	
Soil productivity	Detrimental soil conditions on managed sites	Consistency of management activities with standards and guidelines for soil productivity
Slope stability	Location and extent of unstable and potentially unstable riparian reserves	

PROCESS	DATA GAP	ANALYSIS GAP
Sediment production	Digital location and extent of roads accessing transmission towers. Location and extent of unvegetated road cuts.	Erosion and sediment delivery potential
Road network	Extent of road network on non-federal lands	Role of all roads in sediment and peak flow regime, road densities and other processes.
Road closures	Projected road closures on BLM lands in watershed	Comparison of Future Road Network to Landscape Design
Late seral habitat	Field validation of managed plantations and natural stands with opportunities for silvicultural treatment to promote or hasten late seral structure	
Wolverine habitat	Field verify map of potential habitat	Mt. Hood Wilderness (see Ch.4 / Wildlife / Wolverine Habitat Map
Terrestrial Connectivity		Identification of critical connectivity points along Highway 26 where effects of the physical barrier can be mitigated. Identify critical species and connectivity needs.
Fire Regime	Range of Natural Variation for fire in the Mt. Hood Wilderness	Management plan for role of fire in the wilderness
Fire Regime	Initial attack resources required to protect non-timber values	
Commodity production		Acres and volume available for timber harvest by decade
Special forest products gathering	Effects to C-3 species, species of concern and sensitive habitats	Role of LSRs and Riparian Reserves in providing special forest products
Wildlife population viability	Evaluate biological status of late seral associates: orthern spotted owl and others	Late Successional Reserve
Fish distribution	Location of barrier culverts	

PROCESS	DATA GAP	ANALYSIS GAP
Aquatic species habitat: water temperature	Current continuous water temperature data for all subwatersheds	Use stream temperature model such as SHADOW to assess effects of reductions of stream shade in all subwatersheds
Aquatic species habitat: in-channel fine sediment	Particle size distribution for depositional reaches, storm and "first flush": data for turbidity and/or suspended solids	Sediment fluctuations associated with management activities
Flow regime	Undocumented and / or unrecorded water withdrawals	Effects on base flow
Landscape Structure		Interim Landscape Analysis and Design steps
Public use and demand	Level of public use in the watershed for hiking, camping, fishing and other recreational uses.	Effects of use on special habitats
Population viability for coho salmon, winter steelhead, sea-run cutthroat and spring chinook salmon	Presence, numbers and distribution of coho salmon, winter steelhead, sea-run cutthroat and spring chinook salmon	Quantitative viability modeling for coho salmon, winter steelhead, sea-run cutthroat and spring chinook salmon

Altered Processes

This section presents a list of altered physical or biological processes that have been recognized in the watershed analysis as outside the range of natural variation. These altered processes generally stem from the use of the watershed for municipal water supply and hydroelectric power. These uses are consistent with the overriding management direction or regulations for the watershed.

Table 7-8 Altered Processes

ALTERED PROCESS	WATERSHED LOCATION
Aquatic Habitat Connectivity	Marmot Dam
Water Quality: Stream Temperature	Mainstem Sandy River
Base Flows	Below Marmot Dam, Below City of Sandy municipal intake
Seral Stage	Power line Corridor

Next Iteration

These are suggested items to include in the next iteration of Watershed Analysis for the Upper Sandy Watershed since they were not fully developed in this iteration.

- Reclassify Bureau of Land Management Visual Resource Management Class I land as administratively withdrawn.
- Include additional information on non-federal lands such as road network, stream data, and land use objectives. This involves additional coordination with other non-federal landowners and land management agencies.

Chapter 8:

References

Chapter 8 - References

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Chapter 9:

Acknowledgements

Chapter 9 Acknowledgements

The Upper Sandy Watershed Analysis has many contributors. The Watershed Analysis Team would like to thank all those individuals and agencies who contributed to this analysis process and document, including providing data or review.

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