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Watershed Analysis

Fish Creek Watershed

Mt. Hood National Forest

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Acronyms

CWD
Coarse woody debris - standing or down dead wood. Includes snags and logs.

LWD
Coarse Woody Debris/Large Woody Debris - Portion of a tree that has fallen or been cut and left in the woods or stream. Usually refers to pieces at least 20 inches in diameter.

FEMAT
Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. July 1993. Report of the Forest Ecosytem Management Assessment Team.

LSOG
Late Successional Old Growth. Mapped as significant old-growth by the "Gang-of-Four" (see the Scientific Panel on Late-Successional Forest Ecosystems, Johnson et. al. 1991.)

LSR
Late Successional Reserve. President's Plan land allocation.

MOM's
Mature and Overmature vegetation computer database (old growth).

Mt. Hood FP
Mt. Hood National Forest Land and Resource Management Plan. 1990. Also called Forest Plan.

REAP
Regional Ecological Assessment (USDA 1993).

RNC/RNV
Range of Natural Conditions/Variability. Natural variation identified in the Regional Ecological Assessment (REAP) for vegetation.

ROD
Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. 1994. Commonly referred to as the President's Forest Plan.

S&G's
Standards and Guidelines - The rules and limits governing actions, and the principles specifying the environmental conditions or levels to be achieved and maintained.

SCCA
Species and Communities Conservation Analysis computer database.

T, E & S
Threatened, Endangered or Sensitive plant and animal species (FSM 2670)

TRI
Total Resource Inventory computer and manual database.

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Chapter 1 – Introduction

Watershed Analysis

The purpose of watershed analysis is to develop and document a scientifically-based understanding of the ecological structures, functions, processes and interactions occurring within a watershed, and to identify desired trends, conditions, and restoration opportunities. Watershed analysis is the mechanism to support broad ecosystem management objectives at the watershed scale, as described in the President's 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). It examines the terrestrial, aquatic, and social aspects of the watershed.

Watershed analysis is one of the four elements of the Aquatic Conservation Strategy, as described in the President's Forest Plan. These four elements are designed to operate together to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems. Fish Creek is a Tier 1 watershed, which means that it has been identified as a crucial refugia for at-risk fish species.

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

Watershed Setting

Location

The Fish Creek watershed lies in north central Oregon on the west slope of the Cascade Range, comprising about 30,000 acres in the Estacada Ranger District of the Mt. Hood National Forest. Fish Creek is a principal tributary to the Clackamas River, having its confluence with the Clackamas River about 8.5 miles east of the North Fork Reservoir, near the community of Estacada (Map 1-1). The watershed encompasses primarily National Forest lands, with minor inclusions of public lands administered by the Bureau of Land Management located in the upper watershed (300 acres).

Climate

The climate is temperate, with average annual precipitation ranging from around 70 inches near the mouth to over 80 inches in the upper reaches of the watershed. Approximately 70% of the precipitation occurs from October though March, while less than 3% occurs in July and August. Approximately 77% of the watershed lies within the transient snow zone, where snow levels fluctuate throughout the winter. Average maximum daytime temperatures range from about 35 degrees (Fahrenheit) in January to about 80 degrees in July and August. Minimum daily temperatures range from about 28 degrees in January to about 52 degrees in July and August. Daily temperature extremes seldom vary more than 25 degrees in winter or 35 degrees in the summer. Strong winds in the watershed are usually from the south and southwest and are generally associated with major winter storms.

Physiography

Elevations in the watershed range from about 900 feet near the mouth of Fish Creek to over 5,000 feet at the crest. The watershed is approximately 13 miles long and averages around 6 miles in width. Fish Creek flows in a generally north direction to its confluence with the Clackamas River. Fish Creek has one principal tributary, Wash Creek, and numerous smaller tributary streams. For the purposes of analysis, seven subwatersheds have been identified (Map 1-2). Stream channel gradients are steep for Fish Creek and its numerous tributaries, generally exceeding 5 percent, except for the lower 3.7 miles where gradients average 2 percent. Fish Creek mainstem has a boulder and cobble substrate contributing to a predominantly riffle environment. Wash Creek and upper Fish Creek have steeper, more incised, narrow channels with a predominantly boulder and cobble substrate. Monthly mean flows at the mouth of Fish Creek range from about 13 cubic feet per second (cfs) in late summer to over 350 cfs during a typical winter and early spring. Extremes for the limited period of record range from a low flow of 6 cfs to a high flow of 3,830 cfs.

Geology/Geomorphology

Geology in the Fish Creek watershed is of volcanic origin. Resistant basalt and andesite rocks are interlayered with weak, weathered pyroclastic deposits. The upper portion of the watershed has been altered by alpine glaciation. Alluvial floodplains and terrace deposits parallel the mainstem of Fish Creek. The combination of geology and weathering processes has created a diverse topography, ranging from relatively gentle slopes of the alluvial and glacial valley bottoms and ancient landslide benches to extremely rugged and steep terrain associated with the near vertical basalt cliffs and dissected, incised valley sideslopes. Debris flows and other landslides have strongly influenced hillslope formation. Large ancient earthflows and other landslide masses are present within the watershed, and are generally stable.

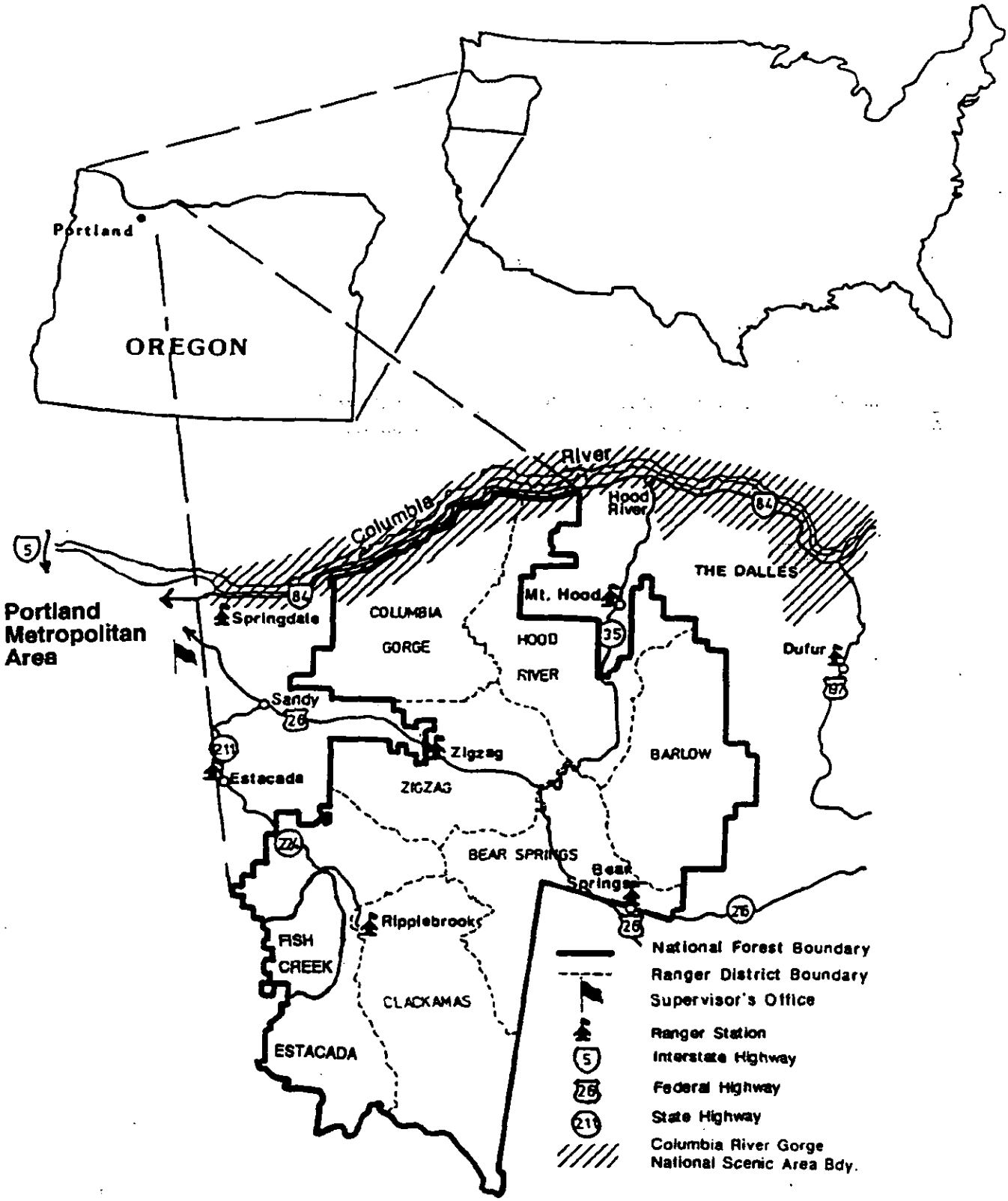
Plants and Animals

The watershed lies predominantly within the western hemlock and Pacific silver fir vegetation zones (45% and 52% respectively), with a minor portion (3%) of the watershed occurring within the mountain hemlock zone. Dominant tree species include Douglas-fir, western hemlock, western red cedar, Pacific silver fir, noble fir, red alder, and bigleaf maple. Understory species include vine maple, rhododendron, sword fern, salal, Alaska huckleberry, beargrass, and numerous grasses and forbs. Thirty-seven percent of the watershed is in an early seral stage, 17% in mid, and 46% in late seral. These plant communities provide habitat for a variety of animal species, including black-tailed deer, red-tailed hawk, and late seral forest associated species such as the northern spotted owl. In addition to the spotted owl, several other animals species considered to be in peril (i.e. typically species listed as threatened, endangered or sensitive, and others recognized as declining in species or population viability) currently inhabit the watershed for all or a portion of their life history requisites, e.g. Townsend's big-eared bat, harlequin duck and peregrine falcon. One sensitive plant species, Gorman's aster, is known to occur in the watershed.

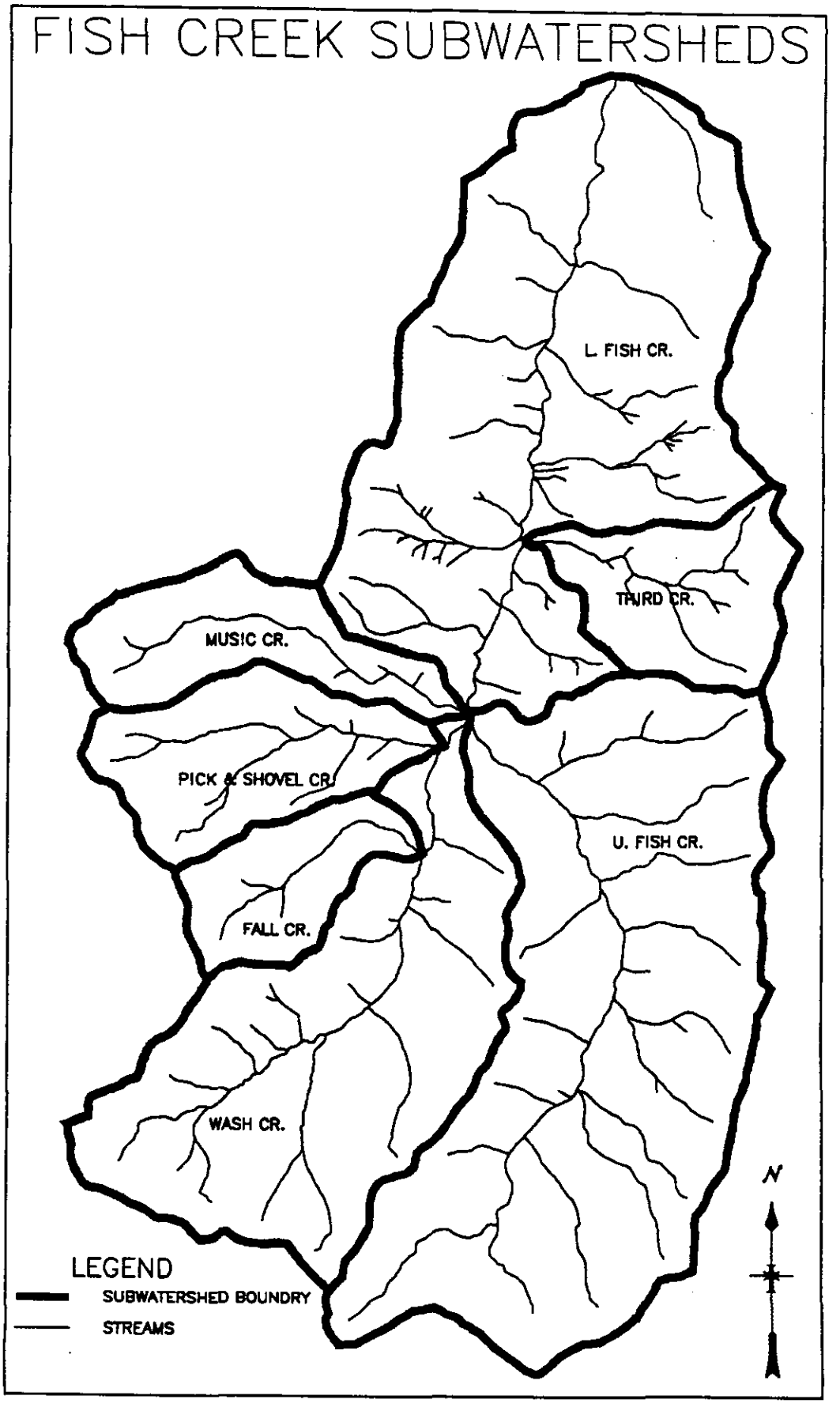
Aquatic

The watershed supports a variety of anadromous salmonids, including summer and winter steelhead trout, spring chinook salmon, and coho salmon. Late-run coho and winter steelhead were identified as "stocks at risk" (Nehlsen et al 1991). Tributary streams in the upper areas of the watershed support populations of resident rainbow and cutthroat trout. Few resident salmonids are found within the range of anadromous fish. The upper reaches of both Fish and Wash Creeks are blocked to anadromous salmonids by major waterfalls. In total, about 16.0 miles of habitat are utilized by anadromous salmonids. About 12.5 miles of habitat on Fish Creek and 5 miles of habitat on Wash Creek are unavailable to anadromous salmonids, but provide good resident trout habitat. Water temperatures in habitat used by anadromous fish are generally favorable. However, in times of low summer flows and high air temperatures, water temperatures can reach stressful levels.

Map 1-1. Mt. Hood National Forest Location Map



Map 1-2. Fish Creek Watershed and Subwatersheds



Social/People

Date of earliest occupancy within the Fish Creek drainage is unknown. Other sites within the Clackamas Subbasin have been evaluated as dating back 7000-8000 years. Key prehistoric uses within the Fish Creek watershed include:

- gathering areas near the mouth of Fish Creek and its confluence with Wash Creek (cedar bark was collected for clothing, storage containers and cordage, along with medicinal herbs),
- a fishing and camping corridor along lower Fish Creek, and
- a number of travel routes.

Euroamerican uses within the drainage centered primarily around fire suppression. A trail system, four lookouts, and two remote ranger stations were established within Fish Creek. Dates of existence of the lookouts were:

- Fish Creek Mountain (1915-1963),
- Baty Butte (1914-1950),
- Thunder Mountain (1929-1961), and
- South Fork Mountain (1931-1960).

The Fish Creek watershed was first entered for commercial timber production in the 1940's. The period of the 1960's through the 1980's was an era of extensive and intensive road construction and timber harvest activity. While the intensity of timber harvesting has declined in recent years, to date over 41% of the watershed has been harvested. During this period, timber harvest and related activities contributed substantially to the local economy. Currently, areas along the mainstem of Fish Creek and the lower portion of Wash Creek are popular dispersed camping and recreation sites.

Management Direction

The Mt. Hood National Forest Land and Resource Management Plan (Forest Plan) of 1991, as amended by the President's Plan of 1994, provides management direction for National Forest System lands within Fish Creek Watershed. The Forest Plan and the President's Plan together provide management direction in the form of goals, desired future conditions, land allocations and standards and guidelines. The following excerpt from the President's Plan ROD, page 12, provides clarity for meshing management direction from the two Plans:

> *"The existing land management plans contain many standards and guidelines that are not amended by this decision. Only those existing plan standards and guidelines in conflict with this decision are replaced. Where existing plans are more restrictive or provide greater benefits to late-successional forest related species than Attachment A (ROD Standards and Guidelines), the existing plan standards and guidelines will continue."*

Of the seven land allocations in the President's Plan, five pertain to Fish Creek Watershed. Of the 46 land allocations in the Mt. Hood Forest Plan, nine pertain to Fish Creek Watershed. Table 1-1 displays each of the pertinent land allocations for the two Plans, along with estimated acreages. The four groupings of land allocations are intended to lump similar management direction to allow comparison between the two plans. Overlapping land allocations are present in both plans.

Detailed management direction for each land allocation is available in the respective plans. Although the President's Plan identified much of Fish Creek Watershed as matrix land allocation (i.e. where timber harvest is emphasized), the Forest Plan designated most of Fish Creek as B6 Special Emphasis Watershed where timber harvest is a secondary goal. The B6 primary goal is watershed protection. In addition, the Forest Plan forestwide standard and guideline FW-065 established a hydrologic recovery requirement for the entire Fish Creek Watershed. A substantial portion of the watershed is currently in a hydrologically unrecovered state due to clearcut harvesting (see Chapter 4, Aquatic Systems) and the watershed as a whole is below the required recovery threshold. Consequently, regeneration timber harvest within at least the next decade would be inconsistent with the B6 and forestwide standards and guidelines management direction.

The matrix and B6 land allocations recognize timber volume as an important resource output. However, due to rapid timber harvest in the last 2 decades, future regeneration timber harvest will be delayed for at least the next decade.

Table 1-1. Fish Creek Watershed Land Allocation Acreages from the Forest Plan and the President's Plan are Displayed and Compared.

Mt. Hood Forest Plan	Acres	President's Plan	Acres
• Designated Wild & Scenic Rivers	307	• Designated Wild & Scenic Rivers	307
• Eligible Wild & Scenic River	3986		
• A9 Key Site Riparian	180	• Riparian Reserves (interim boundaries)	12802
• B7 General Riparian*	*		
• A8 Spotted Owl Habitat Area	2082	• LSRs ** (mapped and unmapped)	3085**
• A7 Special Old Growth	495		
• B2 Scenic Viewshed	85	• Matrix	13601
• B5 Pileated Woodpecker/ Pine Marten	2567		
• B6 Special Emphasis Watershed	24,848		
• B8 Earthflow	3880		
• B12 Backcountry Lake	261		

*B7 General Riparian is an unmapped land allocation. Specific riparian boundaries are to be established based on riparian objectives at the project planning level.

** Includes 300 acres of public lands administered by BLM.

Values and Uses

The Forest Ecosystem Management Assessment Team Report (FEMAT) identified eight categories of "social values" for forest resources: commodity values, amenity values, environmental quality values, ecological values, public use values, spiritual values, health values, and security values. The Fish Creek Watershed Analysis Team concentrated on the first five "value" categories to assist identifying beneficial uses, significant issues, and ecosystem components. The remaining three value categories were deemed to be more appropriately addressed at the subbasin scale or project-level, site-specific scale.

A goal of watershed analysis is to address the range of quantitative and qualitative values and uses, consistent with constraints imposed by time, data availability, and personnel limitations. These identified values and uses assist in development of "key questions" (presented in Chapter 2) which determine the emphasis areas and depth of analysis.

Values

In the context of the Fish Creek watershed and the Clackamas River sub-basin, several significant values are identified by category:

Commodity Values

- local employment related to timber harvest and road construction
- fishing (primarily downstream from Fish Creek watershed)
- special forest products

Amenity Values

- scenery

Public Use Values

- access and travel
- recreation
- land management policy

Environmental Quality Values

- water quality

Ecological Values

- protection of the forest ecosystem
- protection of aquatic and terrestrial habitats
- conservation of native plants and animals

Uses

Beneficial or benefiting uses are those uses which are dependent on the quantity, availability, and quality of natural resources present in the Fish Creek watershed, and towards which management resources are expended. Within the context of the identified values, several associated beneficial or benefiting uses include:

Potable/domestic Water Use: Including recreational, downstream domestic and municipal uses.

Cold Water Fisheries: Salmonids and associated biota.

Forest Commodities: supply of sawtimber, wood fiber, and special forest products contributing to local and regional economies.

Recreation and Experiential Uses: Driving, hiking, sight-seeing, hunting, fishing (lakes), dispersed camping, swimming and boating (kayaking), within the watershed or in the larger context of the subbasin or basin, are influenced by the quantity, quality, and accessibility of resources.

Biodiversity and Ecosystem Function: Location and terrain features of the watershed, in the context of the larger landscape of the Clackamas subbasin, influence biodiversity relationships and ecosystem functions.

Threatened, Endangered, and Sensitive (TES) and Special Status Species: Terrestrial and aquatic TES and special status species within or potentially within the Fish Creek watershed are unique or have declining populations at the subbasin or larger scale, and continued viability requires special consideration at the watershed scale.

Chapter 2 – Key Questions

As a building step toward identifying key questions for Fish Creek Watershed Analysis, ecosystem processes were arrayed as Preliminary Issues for the Clackamas Subbasin (see Analysis File). From these subbasin scale issues a set of "ecosystem components" considered most pertinent to Fish Creek Watershed were developed. The Fish Creek Watershed Ecosystem Components list is provided in Appendix B.

Key questions focus the analysis on particular types and locations of cause-and-effect relationships and discern conditions as they relate to values, uses, and key ecosystem components and processes of the watershed. The questions have been grouped into three categories:

- **Terrestrial System** (including flora, fauna, and landscape patterns);
- **Aquatic System** (related to hydrology, water quality, riparian areas, and up-slope processes of erosion and landslides); and
- **Social System** (uses, needs, expectations).

We recognize that there is considerable overlap and interaction among the various ecosystem components and processes in a natural system. These broad categories serve as an organizational aid to facilitate analysis of complex systems.

Terrestrial System

Vegetation

- ☐ What is the current/potential vegetation within the watershed?
- ☐ Where and what kind of special habitats are present within the watershed?
- ☐ What plant species of concern or noxious weeds are found within the watershed?
- ☐ What is the current distribution of seral stages? Compared to the natural range of variability?
- ☐ What is the current condition and what processes effect late seral stands within the watershed?

Wildlife

- ☐ What wildlife species and species groups inhabit the watershed and what processes affect their welfare?
- ☐ What are the processes effecting wildlife biological diversity?
- ☐ What wildlife species recognized as in peril are associated with the watershed?
- ☐ What Fish Creek processes effect the level of imperilment?
- ☐ What role does the watershed play in providing for conservation or recovery of these species?

Landscape Patterns

- ☐ What historic disturbance processes have occurred across the landscape?
- ☐ How is the current landscape pattern different than what would be expected under the natural disturbance regime?
- ☐ What landscape pattern would best meet ecological objectives and social expectations for the watershed over time?

Aquatic System (including Hillslope and Hydrologic Processes)

Hillslope Processes

- ☐ What are the processes which deliver sediment to aquatic systems and where do these processes occur within the watershed?
- ☐ What effect has timber harvest and road construction activity had on hillslope processes that deliver sediment to aquatic systems?

Streamflow

- ☐ What management-related processes have the potential to change the natural magnitude and frequency of streamflow?
- ☐ Is there evidence of changes in the magnitude, timing, or frequency of peakflows or low flows for Fish Creek or its tributaries?

Water Quality

- ☐ Is there evidence of increased sediment loading and/or reduced water clarity in Fish Creek or any of its tributaries?
- ☐ What other types of potential water quality impacts may be associated with human activities in the watershed?

Large Wood Supply

- ☐ What are the processes which deliver large wood and where do they occur?
- ☐ What changes have occurred in the amount and distribution of large woody debris?

Riparian Canopy Disturbance and Stream Temperature

- ☐ What have the effects of land management been on stream temperatures?
- ☐ Are riparian shade values and water temperatures outside of the expected range of natural variation?

Channel Morphology and Condition

- ☐ Is there evidence of accelerated or detrimental changes in stream channel morphology or channel condition?

Effects of Physical Processes on Aquatic Organisms

- ☐ How have altered physical processes impacted aquatic organisms? What are the altered physical processes? Are there risks associated with these changes?

Aquatic Species, Habitat, and Populations

- ☐ What is the historic and current life history, populations and distribution of fish and other aquatic organisms?
- ☐ What are the current fish habitat conditions for the watershed?
- ☐ What aquatic species are recognized as at risk (e.g. threatened, endangered or sensitive) in Fish Creek?
- ☐ What role does (or should) the watershed play in providing for conservation or recovery of these species?

Social System

Commodities

- ☐ What resources used by humans have been extracted from the ecosystem in the past and at what magnitude?
- ☐ Where are opportunities for commodity extraction?

Public Use

- ☐ What have been the historic human uses and activities in the watershed?
- ☐ What types and intensity of recreational use occur in the watershed at present?
- ☐ What type of access and transportation system (roads, trails, etc.) has been and should be provided for activities such as timber harvest, watershed management, recreation, and fire fighting, etc.?
- ☐ What hunting, trapping, and fishing opportunities and trends occur?

Chapter 3 – Relationship to Larger Scales

One of the most important challenges of watershed analysis is recognizing the proper context within which to address key questions. The questions, "how does Fish Creek fit?" or "what is the watershed's role?" or even "what benefit does Fish Creek offer?" help capture the concept of getting the watershed "in context".

The President's Plan recognizes the importance of completing Basin and Subbasin analyses. As the President's Plan is implemented, gradually more and more of these higher level (or larger scale) analyses and plans will be completed. Fish Creek Watershed Analysis is being completed without the benefit of such analyses and plans to help put key questions and issues in context.

The objective of Chapter 3 is to help with the "in context" need. The first portion of the chapter is an abbreviated version of a Mt. Hood National Forest (forest-wide) analysis effort completed to help set the stage for watershed analyses. This effort, called the "Pulse", provided ecological and social information at a Forest-scale. Although the Forest-scale is not a recognized geographic scale in the President's Plan, this effort helped in getting watersheds across the Forest in context.

Subsequent portions of Chapter 3 address larger scales (primarily Willamette Basin and Clackamas Subbasin) focusing on recognizing pertinent terrestrial, aquatic and social issues within Fish Creek Watershed.

Forest-wide "PULSE"

In January and February of 1994, the Mt. Hood National Forest undertook what has been termed the forest-wide "PULSE" effort. Participants mobilized from all over the Forest to assemble, analyze, and synthesize information. The purpose was to develop larger-scale (Forest level) information and analyses in preparation for beginning watershed analysis. PULSE provided information about the context, both ecological and human, of watersheds within the overall Forest. It provided information about larger-scale processes, patterns, and uses so that watershed analysis could be shaped by larger-scale issues.

Table 3-1 summarizes unique and important features of the Fish Creek drainage that were identified through the PULSE analysis. Asterisks (*) identify unique features of Fish Creek watershed and Clackamas subbasin in relation to the rest of the forest.

The Fish Creek drainage contains important habitat for late run coho and sea run cutthroat. Both the Fish Creek drainage and the Clackamas subbasin have a high percentage of areas with potential for deep-seated and shallow mass wasting. Fish Creek has the largest proportion of area with potential for shallow mass wasting of any watershed on the forest. Road densities and stream crossing densities are highest of watersheds in the Clackamas subbasin, posing potential risks to fish habitat.

Fish Creek was found to be one of two watersheds on the forest with the lowest overall vascular plant species diversity. Human use of Fish Creek is low compared to other areas in the subbasin, except for the large number of dispersed sites along lower Fish Creek. Fish Creek is a fragmented watershed within a highly fragmented subbasin. One unfragmented block of mature forest, located at the confluence of Fish and Wash Creeks, stood out at the Forest-scale. Fish Creek was also found to be outside of the range of natural conditions for a number of key ecosystem elements (see Table 3-1).

Timber harvest, commodity production and associated community employment were not addressed in the PULSE exercise.

Table 3-1. Unique/Important Features Identified During PULSE

Topic	Subject	Fish Creek	Clackamas Subbasin
Fish	Late run coho	*	*
	Sea run cutthroat	*	*
	Bull trout		* suspect. hab.
Geology	Deep-seated mass wasting		* large % area
	Shallow mass wasting	* largest % area	*
	# road/stream crossings	*	
Wildlife	Spotted owls		* high density
	Deer/elk		
Species Diversity	Plants (Vascular)	* lowest	
	Animals		
Human Use	Historic		
	Pre-historic		*
	Misc. forest products		
	Rock & mineral sources		*
	Special areas & places		
	Trails		
	Destination recreation	* disp. camping	*
Landscape Pattern	Existing landscape pattern	* fragmented, 1 block unfrag.	* fragmented
Range of Natural Condition	Overall rating	* outside RNC	*
	Late seral		
	Early seral	* above RNC	*
	Water temperature	* above RNC	
	Early seral riparian	* above RNC	*
Disturb.	Windthrow		
	Off-site plantations		
	Disease		
	Insects		

** Unique features of Fish Creek Watershed and Clackamas Subbasin in relation to the rest of the Mt. Hood National Forest.*

Pulse Synthesis Findings

Sixteen key questions were addressed in the PULSE synthesis stage, pulling together all of the information that had been gathered (for more information see the Mt. Hood PULSE synthesis report). The following is a brief synopsis of risks / areas of concern within the Fish Creek drainage, that were identified during PULSE synthesis (individual ratings are subjective):

- lower portion of Fish Creek, a variety of risks to riparian reserves (including: timber harvest, roads, dispersed camping, low potential for large wood recruitment, potential for mass wasting, and rain on show events);
- landscape pattern outside of RNC -- fragmentation;
- vistas at risk, conflict with scenic resource objectives;
- Fish Creek currently contains a narrow area of late successional forest (LSOG). This area is narrow due to the fragmentation of the surrounding area as a result of timber harvest;
- moderate to high impacts on hydrologic regime due to harvest and road density;
- potential reduction in disturbance dependent special forest products (such as Christmas trees, boughs, firewood, and poles) in lower portion of drainage;
- high risk to fish populations at risk and fish species diversity;
- high sediment production potential;
- opportunities for riparian restoration.

Identified areas of risk/issues from PULSE were carried forward to look at in more detail during watershed analysis. It was determined that, except for dispersed camping, human use of the Fish Creek watershed is not a key issue.

Terrestrial System

Wildlife in Peril

Understanding proper context of a Basin's, a Subbasin's or a Watershed's role in maintenance of ecosystem processes is essential. For no issue is this understanding of context more crucial than in addressing recovery or conservation of species or populations threatened with loss of viability. Fish Creek's role is different today than it was historically and different than it will be in the future -- for every species recognized as currently in peril (i.e. threatened with loss of viability as a population or as a species). Two groups of species are addressed in this chapter:

- those species believed to have been extirpated from the west slope of the Oregon Cascade Range and adjacent valleys, and
- those species threatened with extirpation (i.e. typically species officially listed as threatened, endangered or sensitive).

Extirpated Species

Five wildlife species are believed to have been inhabitants of the west slope of the Oregon Cascade Range and adjacent valleys during the late 19th century that have since been extirpated. Very little historic population or life history data are available for these species. These species include:

- Columbian white-tailed deer
- California condor
- yellow-billed cuckoo
- grizzly bear
- gray wolf

The white-tailed deer, the condor and the cuckoo, although perhaps historically prevalent throughout much of the Willamette Valley, were likely limited to the lower elevation, western portions of the Clackamas River Subbasin. Their typical range would likely not have included what is today National Forest System lands; the condor may have been an occasional visitor to the mountainous regions of the subbasin. Extirpation of these species is pertinent at the Basin and Subbasin scales, but not at the Fish Creek Watershed scale.

Grizzly bear and gray wolf are believed to have been present throughout the basin, subbasin and watershed. Fish Creek Watershed may not have played any particularly significant role in the life history of either species due to limited and seasonal prey availability.

None of these 5 species are extinct. Re-establishment of any or all of the species is possible and would help restore a fully functioning ecosystem with all of it's inherent parts and processes. However, opportunities for re-establishing any of these species is minimal, at best. Large scale habitat alteration from agricultural development and urbanization limit most opportunities for the first 3 species (see Recovery Plans for condor and white-tailed deer). Human's desire to be safe when visiting the Forest and raise livestock adjacent to the Forest preclude much realistic opportunities for grizzly bear or gray wolf. Regardless of whether or not habitat is made conducive for these species, re-establishment would take physical relocation of the animals themselves to the area; such population management activities are the jurisdiction of Oregon Department of Fish and Wildlife and USDI-Fish and Wildlife Service.

The effects on the ecosystem of these elements being absent is intuitive and not well understood or documented.

Species Threatened With Extirpation

A Forestwide assessment was completed by wildlife biologists on the Mt. Hood National Forest (Huff, et al, working paper, see Analysis File). The assessment compared the list of species recognized as Threatened, Endangered or Sensitive on the Forest (FSM 2670) with habitat protection provided by the Forest Plan as amended by the President's Plan. The following conclusions of this work are pertinent at the Basin, Subbasin and Watershed scales.

The S&Gs of the President's Plan ROD should maintain the viability of the following riparian habitat associated T, E and S species (considered current inhabitants of the Forest):

Note: Inherent in this conclusion is the assumption that these species currently enjoy a population level and distribution at least adequate to maintain viability. Data sufficient to verify this assumption are very difficult to obtain and not currently available.

- Cope's giant salamander
- red-legged frog
- greater sandhill crane*
- harlequin duck*

- white-footed vole
- one-spot caddisfly
- Mt. Hood farulan
- Cascades Apatanian caddisfly

* Riparian habitat protection should provide for these species, however, both species are susceptible to human disturbance (see Chapter 4, Wildlife), and are therefore considered to be still at risk.

The S&Gs of the ROD should maintain the viability of the following late-successional habitat dependent species:

- northern spotted owl

Species whose life history needs are not completely met by the Forest Plan/President's Plan and are still considered to be at risk for maintenance of viability include:

- bald eagle
- peregrine falcon
- Townsend's big-eared bat
- California wolverine

These four species, along with greater sandhill crane, harlequin duck and western pond turtle are addressed in Table 3-2. A detailed description of the role the 3 geographic scales play in the recovery and conservation of these species is in the Analysis File. Table 3-2 provides:

- A subjective characterization of the relative importance (high, moderate and low) of the Basin, Subbasin and Watershed in supporting recovery and conservation of each species; and
- A subjective habitat quality description (high, moderate and low) for each species historically, currently and potentially.

Needs and opportunities for on-site and off-site mitigation work are also indicated.

Table 3-2. Relative importance of the Willamette Basin, Clackamas Subbasin and Fish Creek Watershed in providing for recovery and conservation of 7 selected TES species is subjectively provided. Habitat quality on a historic, current and potential basis is also displayed.

TES Species	Basin	Subbasin	Watershed
Peregrine falcon			
Relative importance	moderate	moderate	high
Habitat quality:			
historic	moderate +	moderate +	moderate
current	moderate - ; off-mitigation	moderate - ; off-mitigation	moderate - ; on-mitigation
potential	moderate +	moderate	moderate
Bald eagle			
Relative importance	low	moderate	low
Habitat quality:			
historic	high	moderate	low
current	low - ; off-mitigation	low - ; off-mitigation	low
potential	moderate	moderate	low
Townsend's big-eared bat			
Relative importance	moderate	high	high
Habitat quality:			
historic	unknown	moderate	moderate
current	unknown	low - ; off-mitigation	moderate - ; on-mitigation
potential	moderate	moderate	moderate
California wolverine			
Relative importance	high	high	moderate
Habitat quality:			
historic	high - ; off-mitigation	high - ; off-mitigation	low
current	low	low	low
potential	moderate -	moderate +	moderate
Greater sandhill crane			
Relative importance	moderate	high	outside range
Habitat quality:			
historic	moderate	moderate	NA
current	moderate -	moderate - ; on-mitigation -	NA
potential	moderate	moderate	NA
Harlequin duck			
Relative importance	high	high	moderate
Habitat quality:			
historic	high	high	high
current	moderate -	moderate; off-mitigation	moderate - ; on-mitigation
potential	moderate +	moderate +	moderate
Western pond turtle			
Relative importance	high	moderate	low
Habitat quality:			
historic	high	high	low
current	low	low -	moderate
potential	low -	low -	moderate

Legend: (Table 3-2)

Relative Importance: A subjective rating comparing the Willamette Basin with other Basins within the range of the species, comparing Clackamas Subbasin with other Subbasins in the Basin, and comparing Fish Creek Watershed with other Watersheds in the Subbasin (high, moderate and low).

Habitat Quality: A subjective (high, moderate and low) rating comparing the perceived ability of the basin, subbasin and watershed to provide for life history requisites - historically, currently and potentially. Additional descriptors include

- plus & minus to give emphasis,
- off-site and on-site mitigation to recognize habitat losses, needs and opportunities, and
- unknown and not applicable (N/A).

Aquatic System (Including Hillslope and Hydrologic Processes)

Aquatic

Beneficial Uses and Hydrologic Processes

Beneficial uses are designated by the Oregon Department of Environmental Quality (DEQ 1988). Specific beneficial uses have been identified for Fish Creek. In addition, there are downstream benefits also identified in Table 3-3. A rating of "high" or "medium" signifies the contribution of water from Fish Creek to the specified use.

Table 3-3. Specific Beneficial Uses

Beneficial Use	Basin: Willamette River or Columbia River	Subbasin: Clackamas River	Watershed: Fish Creek
cold water fisheries	medium	high**	high**
other aquatic life	medium	high	high**
aesthetic quality	medium	high**	high**
wildlife	medium	high	high**
domestic water users	high	high	N/A
hydroelectric	low	medium	N/A
irrigation	medium	medium	N/A

** *designated beneficial use by DEQ*

Aquatic Organisms

Current and desired conditions for aquatic organisms are described within the context of regional policy documents. Current policy documents include the Record of Decision for the President's Plan (ROD 1994), the Mt. Hood National Forest Land and Resource Management Plan (1990), the Columbia River Policy Implementation Guide/Salmon Summit (PIG 1991), the Integrated System Plan for Salmon and Steelhead Production in the Columbia River Basin (Oregon Department of Fish and Wildlife 1990; Columbia Basin Fish and Wildlife Authority 1990), the Oregon Department Fish and Wildlife Willamette River Basin Fish Management plan (1990), and the Oregon Department Fish and Wildlife Clackamas River sub-basin plan (1992).

The following Table 3-4 displays fish and other aquatic organisms at risk, and the relative importance of Fish Creek in providing habitat and/or contributing to their recovery in the future. "High" means the watershed, sub-basin or Basin is a crucial ecosystem component within the three scales, "medium" is a lesser role within the ecosystem, and "low" is a relatively minor component in the ecosystem.

Table 3-4. Fish and Other Aquatic Organisms at Risk

	Basin: Willamette River or Columbia River	Subbasin: Clackamas River	Watershed: Fish Creek
late run coho	high	high	high
wild winter steelhead	medium	high	medium
sea run cutthroat	high	high	medium
aquatic insects	unknown, insufficient data		
amphibians	unknown, insufficient data		

Currently the National Marine Fisheries Service is conducting a status review for the late run coho, sea run cutthroat, and wild winter steelhead pursuant to the Endangered Species Act.

Social System

Recreation Use

The primary factors determining pattern of recreation use in Fish Creek are:

- the proximity of the watershed to the Portland metropolitan area, and it's geographic location near the entrance to the Mt. Hood Forest, and
- the topography of the watershed (few flat places near water).

Other key factors influencing recreation use are:

- low elevation and resulting almost year-around access,
- extensive roaded access,
- steep topography reducing access except near mainstem Fish Creek and other water bodies,
- traditional/generational use,
- management direction in the Mt. Hood Forest Plan which limits facility development, and
- other management policy such as the fishing closure along mainstem Fish Creek and deer and elk herd management objectives.

Over one million people live within an hour's drive to the Mt. Hood National Forest. The Clackamas River Subbasin receives periodic intense recreation use, and a proportion of that use occurs in Fish Creek.

Chapter 4 – Past and Current Condition

Chapter 4 describes conditions in the watershed that are integral to answering the key questions identified in Chapter 2. The description of watershed conditions includes the identification of important processes regulating changes in terrestrial or physical conditions. An understanding of processes interacting in the watershed is essential to determining the relationships between past management actions and current physical and biological conditions. This chapter reviews watershed conditions before human disturbance and where possible identifies the natural range of variability present in physical features.

When watershed analysis was conducted for Fish Creek, the results were often complex and lengthy. Additional technical information developed for analyses are presented in Appendix A. The summary of those analyses is presented here in a combination of "key findings" and report summaries. We encourage the reader to refer to Appendix A and the analysis file to find additional information on methodology, expanded discussion of results and a complete display of tables and graphs.

Appendix A is a more complete display of the results of the Fish Creek watershed analysis. In addition, there is an analysis file at the Estacada Ranger District containing additional documentation of methodology and source data used in the analysis. Another important component of the Fish Creek watershed analysis was mapping done through the Geographic Information System and hand-drawn maps. These maps provide valuable information to interpret results such as identification of special habitats, roading history and distribution of species. These maps also provide a foundation for future management of the Fish Creek watershed as decision documents are written for site specific projects. These maps are also on file at the Estacada Ranger District.

The format used earlier in this document is continued in Chapter four. The Fish Creek watershed is discussed in three major sub-headings: Terrestrial, Aquatic (including hillslope and hydrologic processes) and Social.

Information in this chapter is often described using three different stratification techniques that proved to be most suited for Fish Creek. They are:

- Landforms (landscapes that have similar geology and physical features) were a foundation for much of the analysis done in Fish Creek. Many of the impacts from roading and timber harvest were related to landform characteristics.

- Vegetation zones were useful for describing broad landscape patterns. There are three vegetation zones in Fish Creek: Western Hemlock, Pacific Silver Fir and Mountain Hemlock. Mountain Hemlock is a minor component of the watershed, and for the purpose of some analyses was combined with the Pacific Silver Fir zone.

- Subwatersheds were useful in describing hillslope and hydrologic processes and vegetation patterns.

Fish Creek has six major tributary streams with drainage areas referred to as subwatersheds. A seventh "subwatershed" (Lower Fish Creek) comprises numerous smaller tributaries, known as "facing" drainages. The seven subwatersheds (Map 1-2) range in size from approximately 1,200 acres to slightly over 9,000 acres (Table 4-1).

Table 4-1. Subwatersheds in Fish Creek

Subwatersheds	Acres
Lower Fish Creek (smaller "facing" tributaries)	8,454
Third Creek	1,623
Upper Fish Creek	9,128
Pick Creek	2,055
Fall Creek	1,198
Wash Creek	5,702
Music Creek	1,622

Terrestrial System

Vegetation

Existing Vegetation

Seral Stages

Approximately 41% of the Fish Creek watershed has been harvested since harvest began in the drainage in 1944, primarily by clearcutting. Salvage, or other activities such as "pre-logging" (where the Western hemlock understory was removed), has occurred in many of the remaining older stands. Currently, 37% of the watershed is in an early seral condition, 17% in mid seral, and 46% in late (Map 4-1).

The early seral stands in Fish Creek were created almost entirely through clearcutting. Mid seral stands within the watershed include both older managed stands and some areas where mid-size stand replacement fires occurred around the turn of the century.

For this analysis, seral stages were defined according to stand structure, rather than stand age. Late seral stands were defined as stands dominated by conifers at least 21 inches in diameter at breast height (these stands are generally older than 80 years). The mid seral category included closed sapling pole stands (average stand diameter less than 8 inches, dense canopy) and small sawtimber (stands dominated by conifer trees ranging from 8-21 inches in diameter). A problem with this definition is that some late successional stands on poorer, high elevation sites are included in the mid seral category. The early seral category consists of grass/forb/shrub stands, shelterwood and leave tree stands, and open sapling pole stands (conifers greater than 10 feet tall, less than 60% canopy cover).

Distribution of seral stages within the drainage does not vary much between the three forest series present (western hemlock, Pacific silver fir, mountain hemlock) (Figure 4-1), or between the seven subwatersheds (Figure 4-2). One subwatershed, however, does stand out. Third Creek has a larger proportion of mid seral stands (54%) and less late seral (14%) than the other subwatersheds. This is primarily the result of stand replacement fires around the turn of the century, coupled with some older harvest activity.

Landscape Structure

Fish Creek drainage is highly fragmented. Map (4-2) is a landscape structure map which displays the current condition of the Fish Creek watershed. The structural elements of the Fish Creek landscape are divided into six broad categories: matrix, hardwood patches, immature forest patches, wetland patches, aquatic patches, and rock patches.

Figure 4-1 Seral stage by forest series. Values shown are percentage of each forest series in early, mid, and late seral stage.

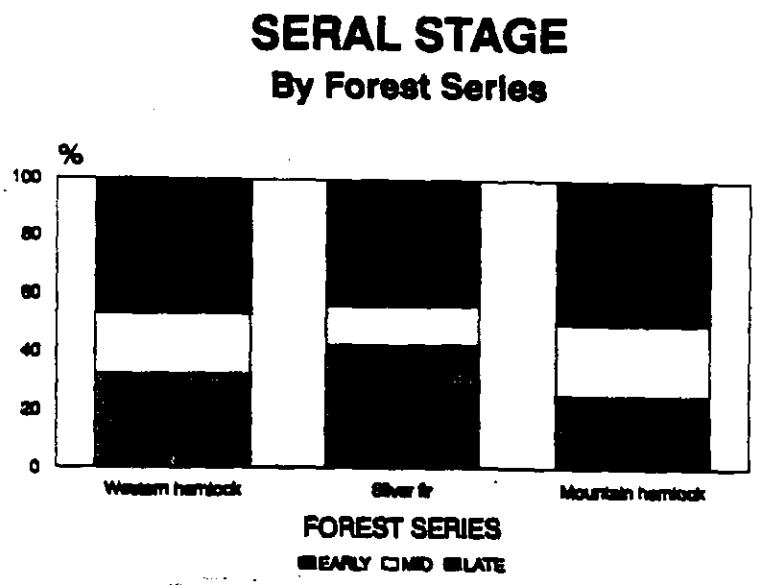
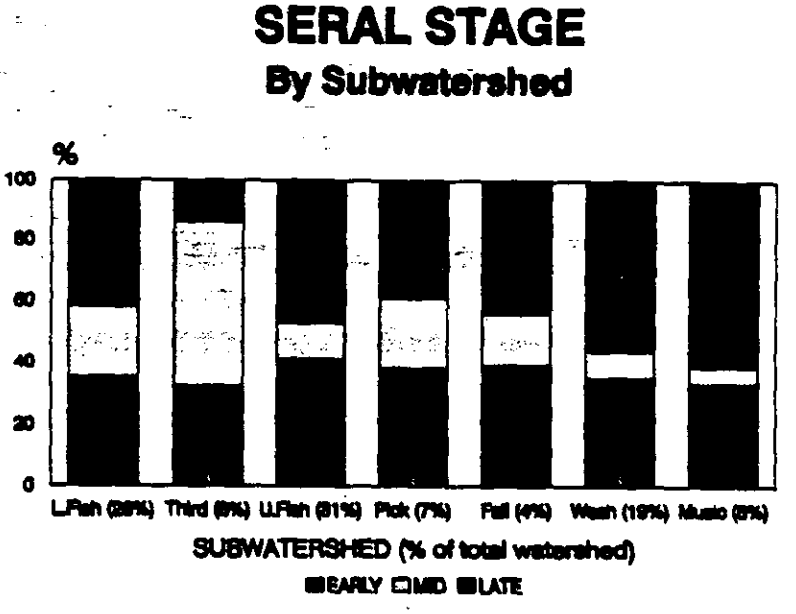


Figure 4-2. Seral stage by subwatershed. Values shown are percentage of each subwatershed in early, mid, and late seral stage.



The "matrix", in landscape ecology terminology, is defined as the most connected portion of the landscape, the vegetation type that exerts the most control over landscape dynamics (Forman and Godron 1986, Diaz and Apostol 1992). [Note the difference between use of the word "matrix" here and the President's Forest Plan matrix.] The matrix within Fish Creek is defined as mature forest, a combination of large sawtimber (late seral) and small sawtimber (mid seral in this analysis). Although Fish Creek is quite fragmented, mature forest is still the most connected forest type.

Composition of the mature forest matrix varies by vegetation zone and stand structural class (see Appendix A for more information). The small sawtimber matrix areas within Fish Creek are primarily mid seral stands, although some are actually late successional stands on poorer, high elevation sites. Complexes of noble fir and Sitka alder wet areas, found in the headwalls of Fish and Wash Creeks, are also part of the mature forest matrix.

Immature forest patches include the following structural classes: grass/forb/shrub (early seral), open sapling pole (early seral), closed sapling pole (mid seral), and leave tree and shelterwood stands (early seral).

Other landscape patch types identified within the Fish Creek watershed are: hardwood patches (both mixed red alder-conifer stands and stands of pure red alder or bigleaf maple); Sitka alder shrub patches; wetland patches (shrub-graminoid meadows and red alder swamps); aquatic patches (lakes and ponds); and rock patches (rock outcrops, talus slopes, and quarries).

Special Habitats

There are 898 acres of rock outcrop, 93 acres of talus slope, and 1,040 acres of wetland special habitat areas within the drainage (Map 4-2). Wetland areas (Map 4-3) include: 5 red alder wetlands, 2 small meadows, 2 lakes, and 2 ponds. Two other types of wet areas were included that occur in headwater areas: Sitka alder patches with numerous seeps and springs, and noble fir/Sitka alder complexes with scattered seeps and springs (Map 4-3). These areas were identified based on vegetative characteristics, combined with local knowledge, and need further ground-truthing. All of these special habitats are important contributors to habitat and species diversity within the watershed (see Appendix A, Terrestrial and Chapter 7, Riparian Reserves).

Stand Age

Map (4-4) shows the ages of unmanaged stands within Fish Creek, by 50 year increments. The oldest stands in the watershed are between 395 and 444 years old. These stands are located primarily in the southwestern quarter of the watershed. Most of the unmanaged stands in the watershed are between 245 and 344 years old. The younger unmanaged stands are found primarily along the ridges.

Range of Natural Variability

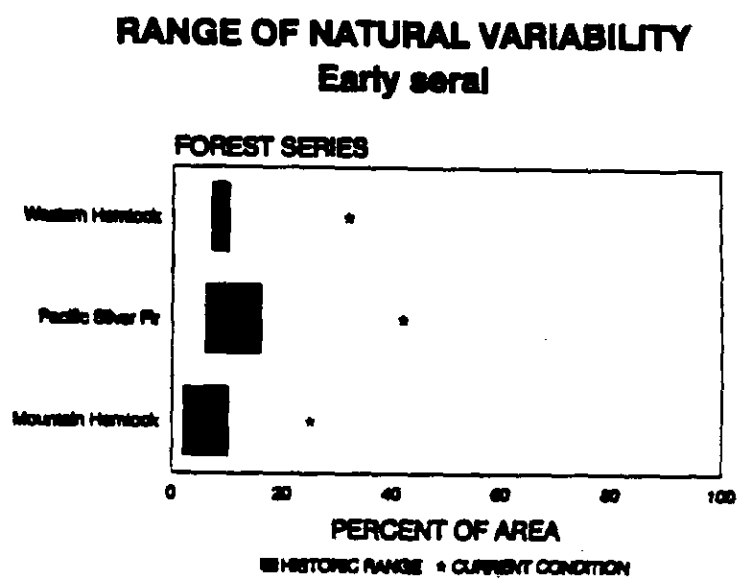
The idea of the range of natural variability acknowledges that ecosystems are not static and that they vary over time and space. The dynamic nature of ecosystems exemplifies the need for us to consider ranges of conditions under natural disturbance regimes, rather than single points in time. A key assumption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

In 1993, the Pacific Northwest Region undertook an assessment of the natural range of variability for a number of key ecosystem elements, elements that are believed to be key to ecosystem health and sustainability. This analysis was done at the subbasin scale and is referred to as REAP (Regional Ecological Assessment)(USDA, 1993).

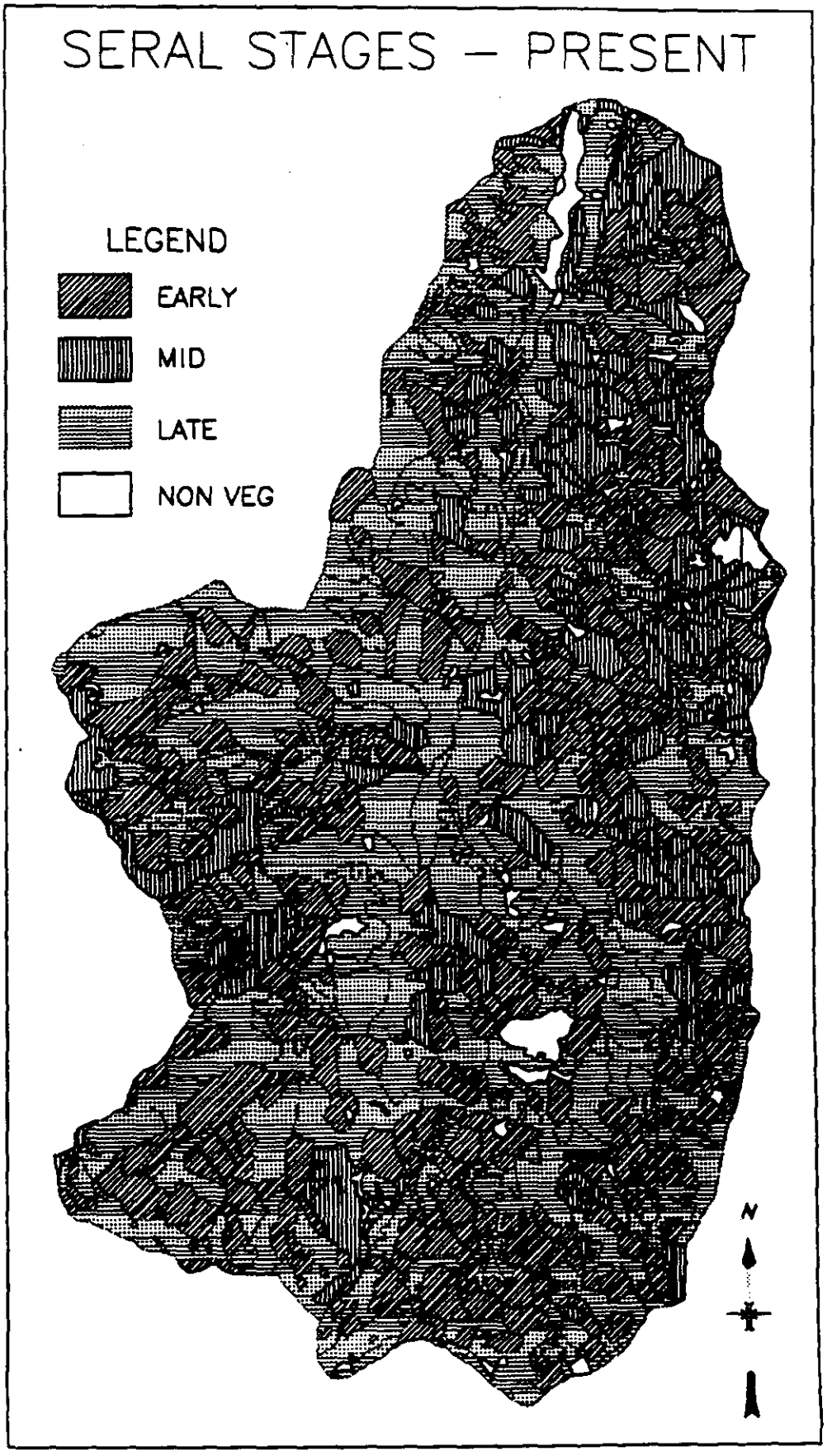
Figure (4-3) shows the relationship between the current condition in Fish Creek and the natural range of variability (as determined during REAP, at the subbasin scale) for one of these key ecosystem elements, amount of early seral vegetation (see Appendix A for other key ecosystem elements). Numbers expressed are the percent of the total area (either watershed or subbasin) within each forest series, in an early seral condition. The amount of early seral vegetation in Fish Creek is outside of the natural range of variability in all three forest series. There is currently 22% more of the western hemlock zone in early seral than would be expected under the natural disturbance regime, 26% more in the Pacific silver fir zone, and 15% more in the mountain hemlock zone. This is due almost entirely to timber harvest and some associated blowdown, there have been only minor areas impacted by fire in Fish Creek in the last 95 years.

It is important to note that overall percentage of area within various seral stages is not the only factor that has been altered by timber management activities, it has also greatly effected the pattern of the vegetation (see Landscape Pattern section).

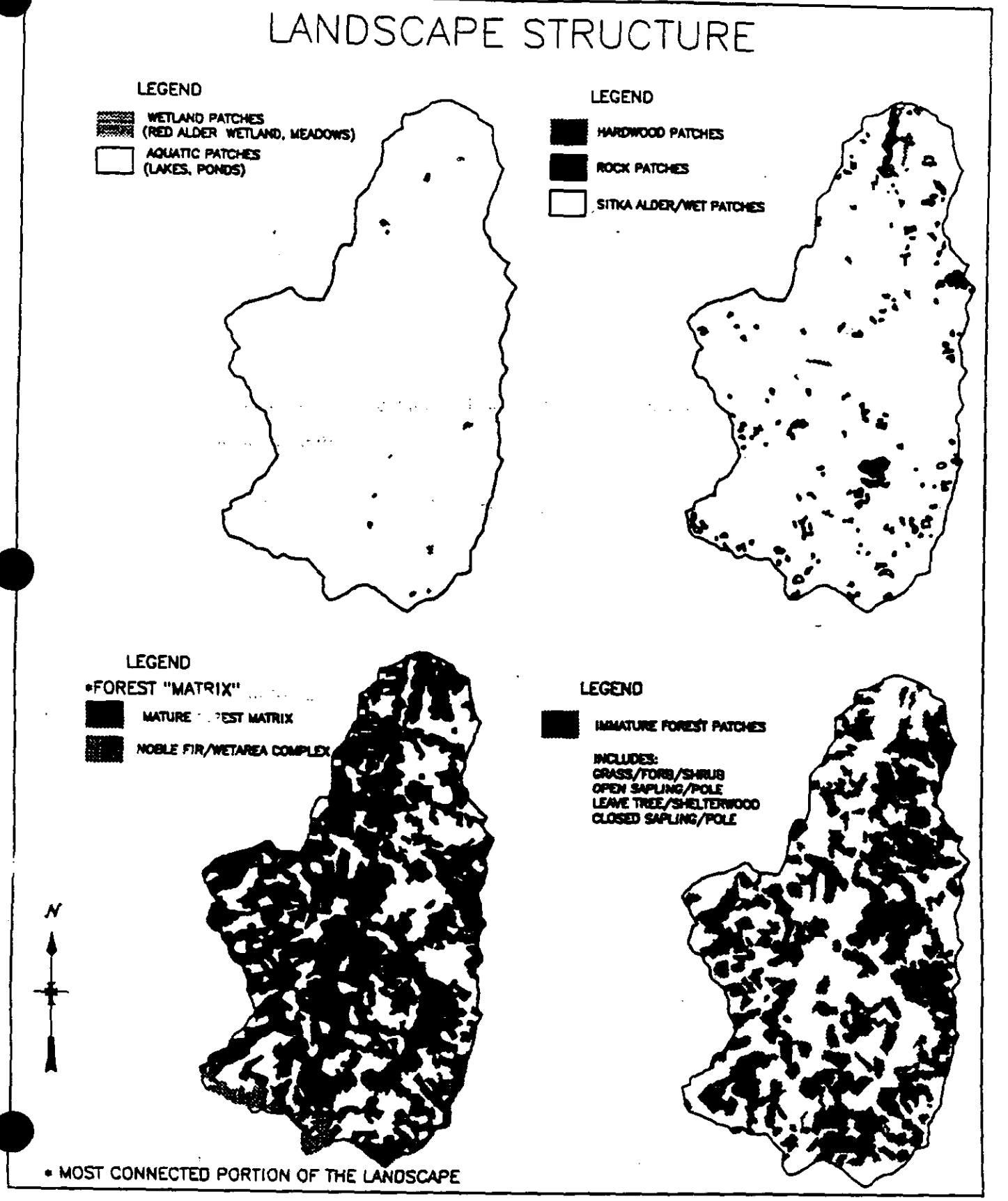
Figure 4-3. Current condition compared to historic range of amount of early seral vegetation. Values shown are percentage of the total area within each forest series.



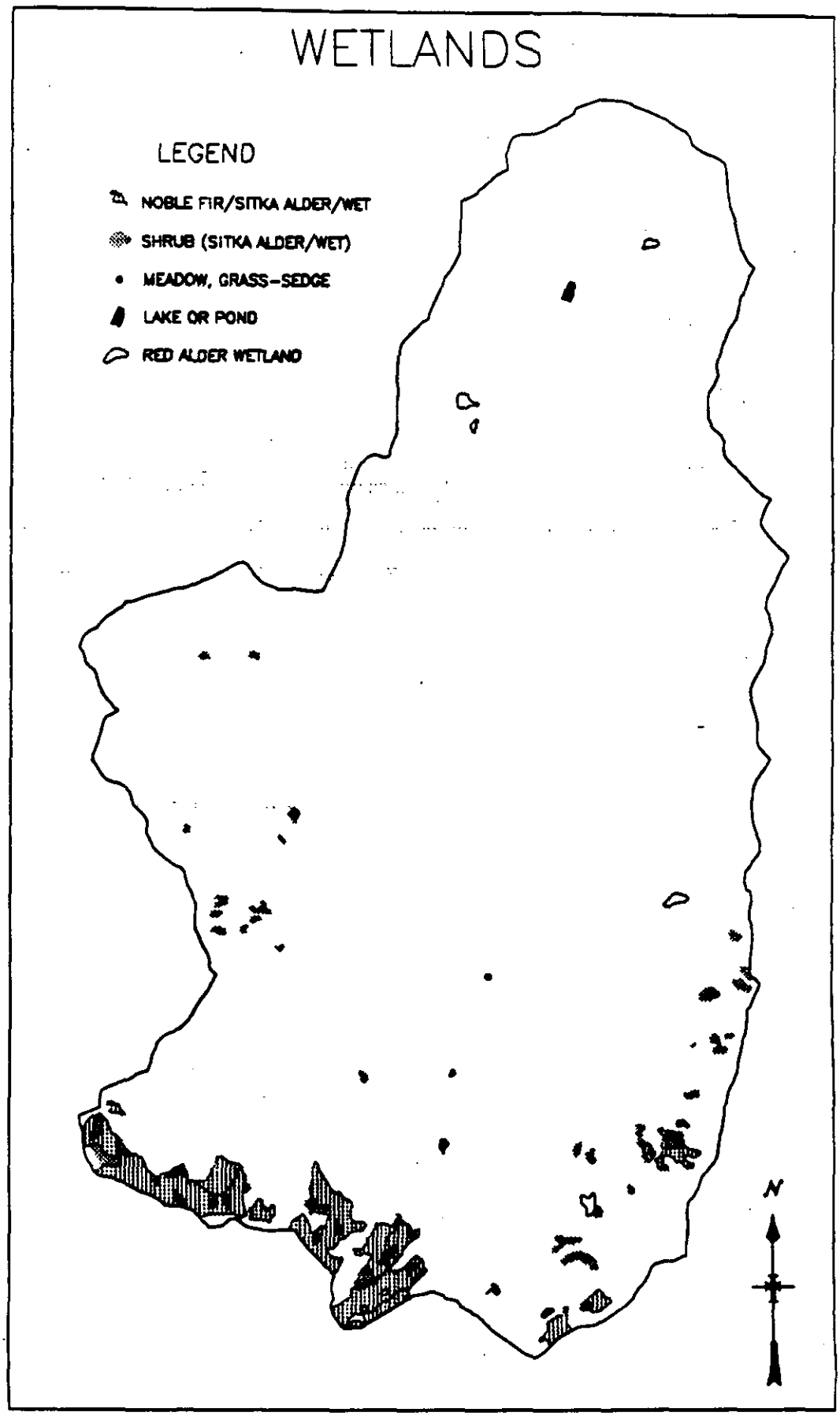
Map 4-1. Seral Stages - Present



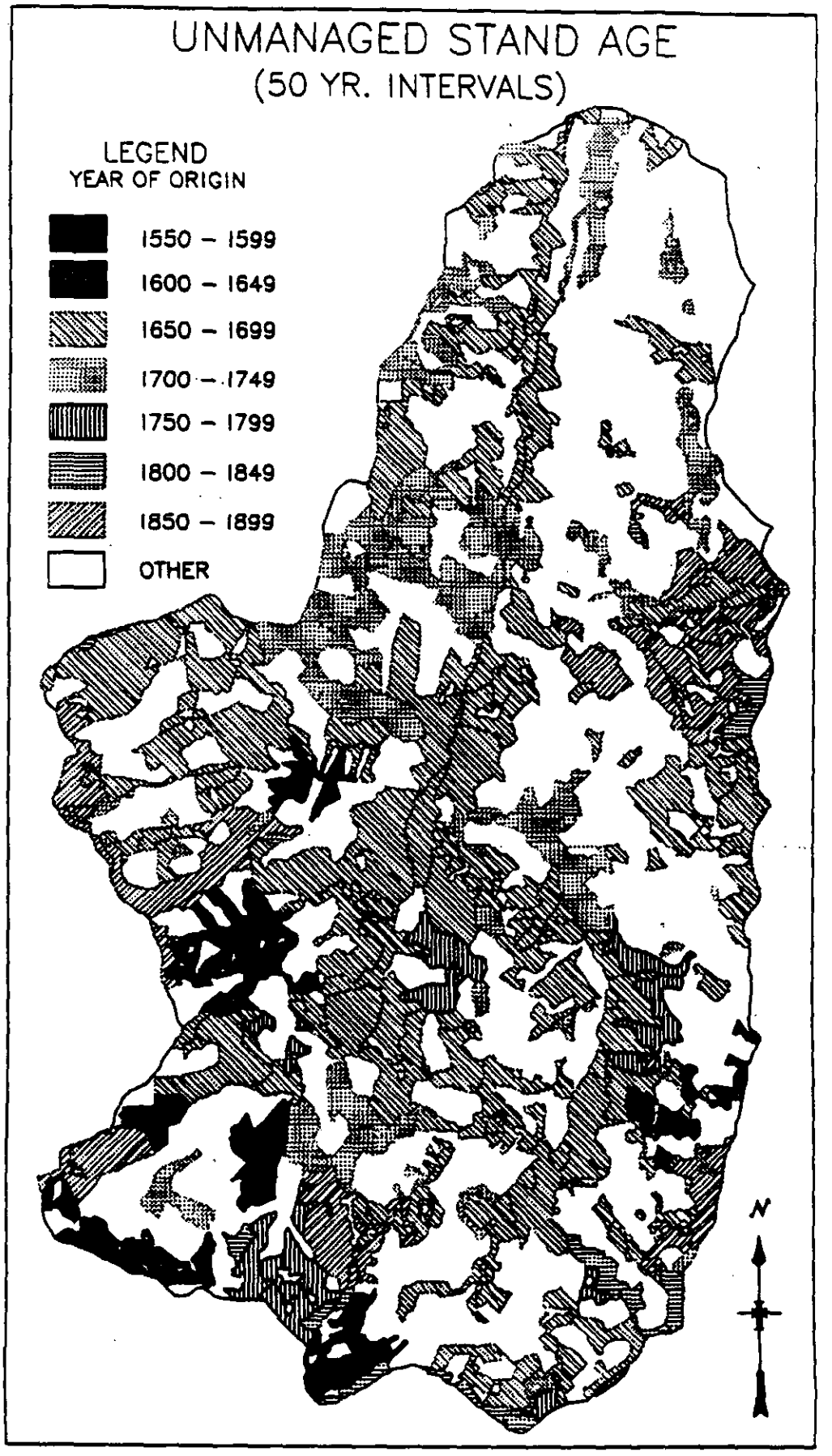
Map 4-2. Current Landscape Structure



Map 4-3. Special Habitats: Wet Areas



Map 4-4. Stand Age



Potential Vegetation

Forest Series

There are three forest series found within the Fish Creek drainage: western hemlock, Pacific silver fir, and mountain hemlock (Halverson et al., 1986, Hemstrom et al., 1982). A forest series (or vegetation zone) is the area within which a particular tree species is dominant in the climax plant community. The western hemlock zone occurs at lower elevations within the drainage, occupying approximately 45% of the watershed. Fifty-two percent of the watershed is in the mid to higher elevation Pacific silver fir zone, and approximately 3% of the watershed is in the high elevation, mountain hemlock zone.

Plant Associations

Plant associations are units that are used to classify plant communities. They are groupings of plant species recurring across the landscape within particular environments (Daubenmire, 1968). Plant associations describe the potential, or climax, plant community, the vegetation that would eventually occupy a site in the absence of disturbance.

Fish Creek drainage supports a wide variety of plant associations. There are 15 western hemlock, 14 Pacific silver fir, and 3 mountain hemlock associations found within the watershed. The drainage was stratified into areas of five broad groups of plant associations: wet, headwall associations; dry, cliff associations; warm associations; Rhododendron associations; and moist associations. (See Appendix A for plant association list and stratification.)

Plant Species of Concern

There are four documented locations of the sensitive species Aster gormanii within the watershed, and five sites just outside the watershed boundary. This species is a candidate for federal listing as threatened or endangered.

There are no other documented sensitive plant species locations. There are several other sensitive vascular plant species that have potential to be found within the watershed (see Appendix A for species list). Highest probability habitat is found in riparian and rocky areas.

The President's Forest Plan calls for the survey and management of numerous species of fungi, lichens, bryophytes, and vascular plants. Information on these species within the Fish Creek drainage, especially non-vascular plants, is lacking. Fish Creek does contain potential habitat for many of these species (see Analysis File).

The introduction of non-native species, especially noxious weeds, is a potential threat to native biological diversity. Noxious weed species occurring within the Fish Creek drainage include:

- St. Johnswort;
- tansy ragwort;
- Canada thistle; and
- scotch broom.

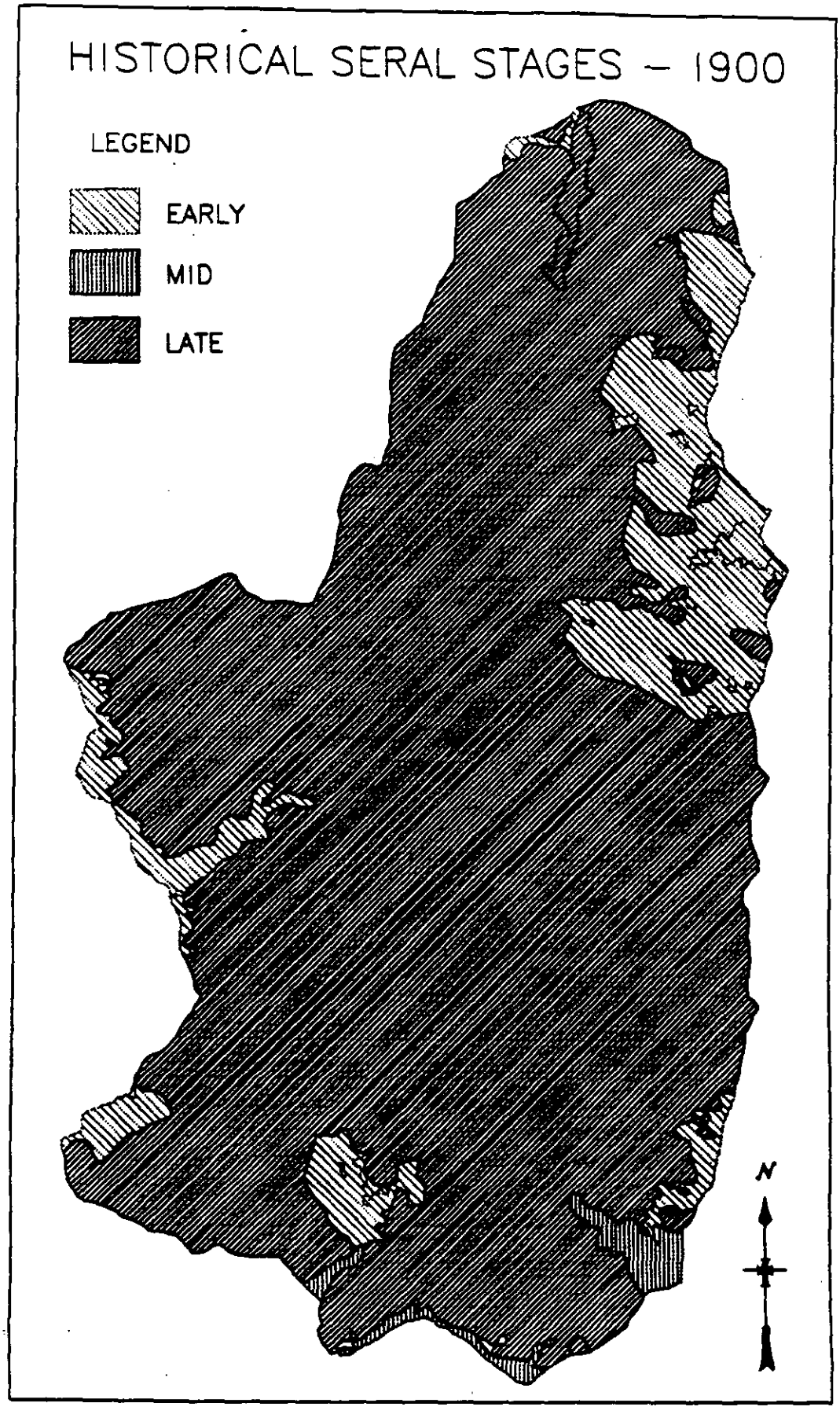
These species are found throughout the watershed, in areas associated with roads, timber harvest activities and recreational use. Other non-native invasive species are found in the same kinds of locations. Human activities have also altered the native vegetation and introduced non-native species at the Fish Creek pier site.

Fish Creek was found to be one of two watersheds on the Mt. Hood NF with the lowest total vascular plant species diversity. It was found to contain potential habitat for 450 plant species.

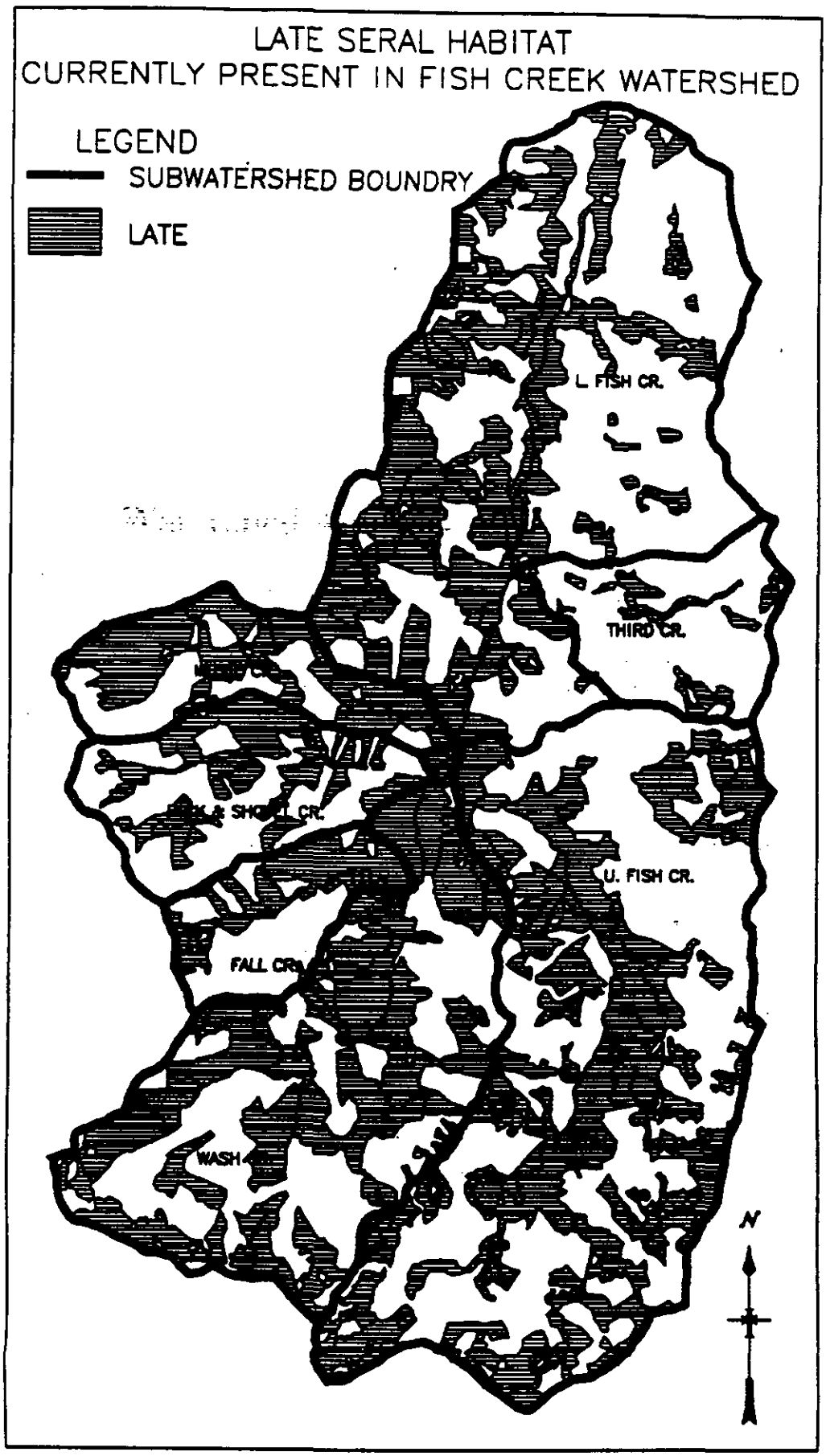
Late Seral

In the late 19th century approximately 86% of the watershed was late seral forest (Map 4-5). Today late seral forest habitat comprises 46% of the watershed (Map 4-6).

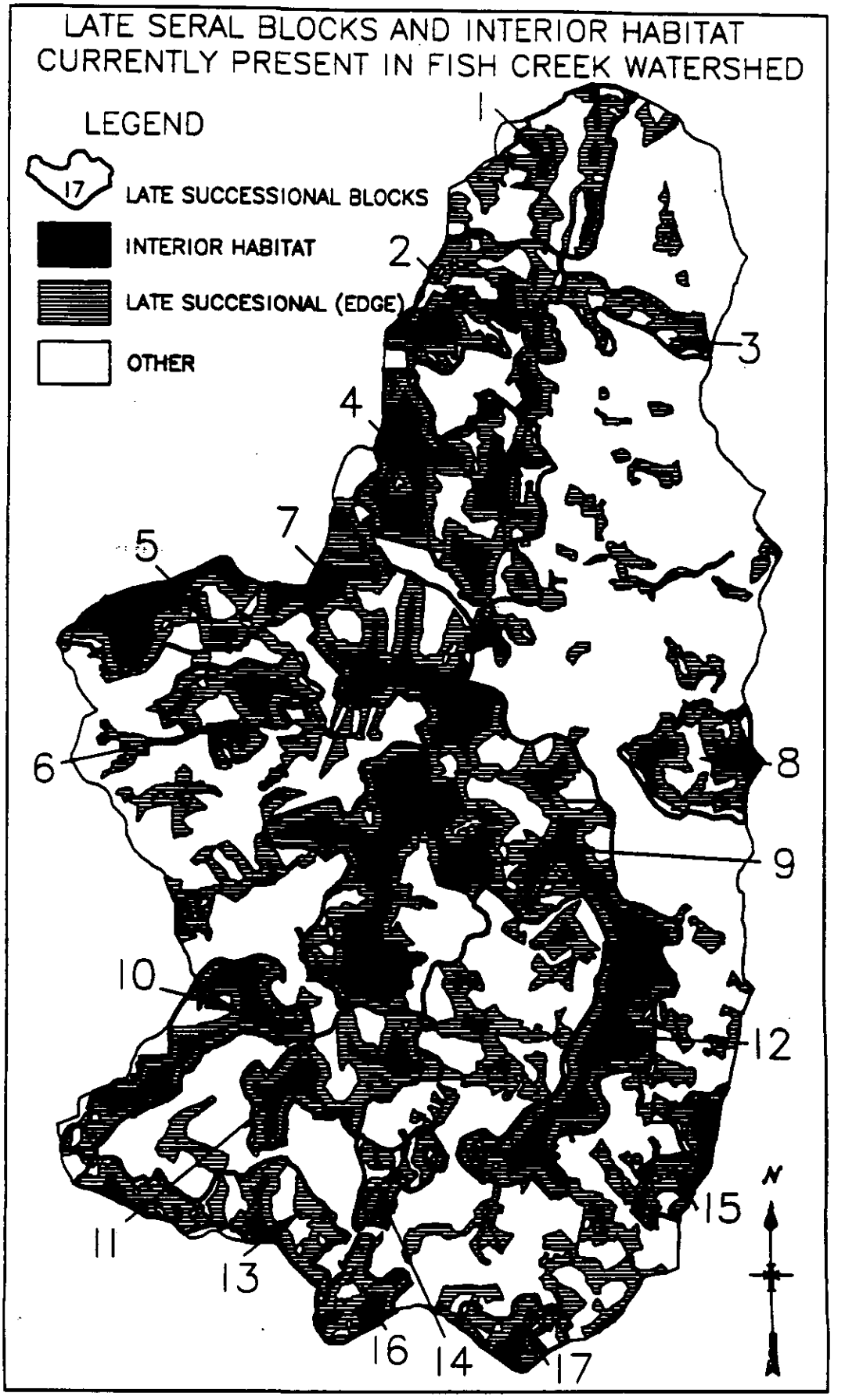
Map 4-5. Historic Seral Stages - 1900



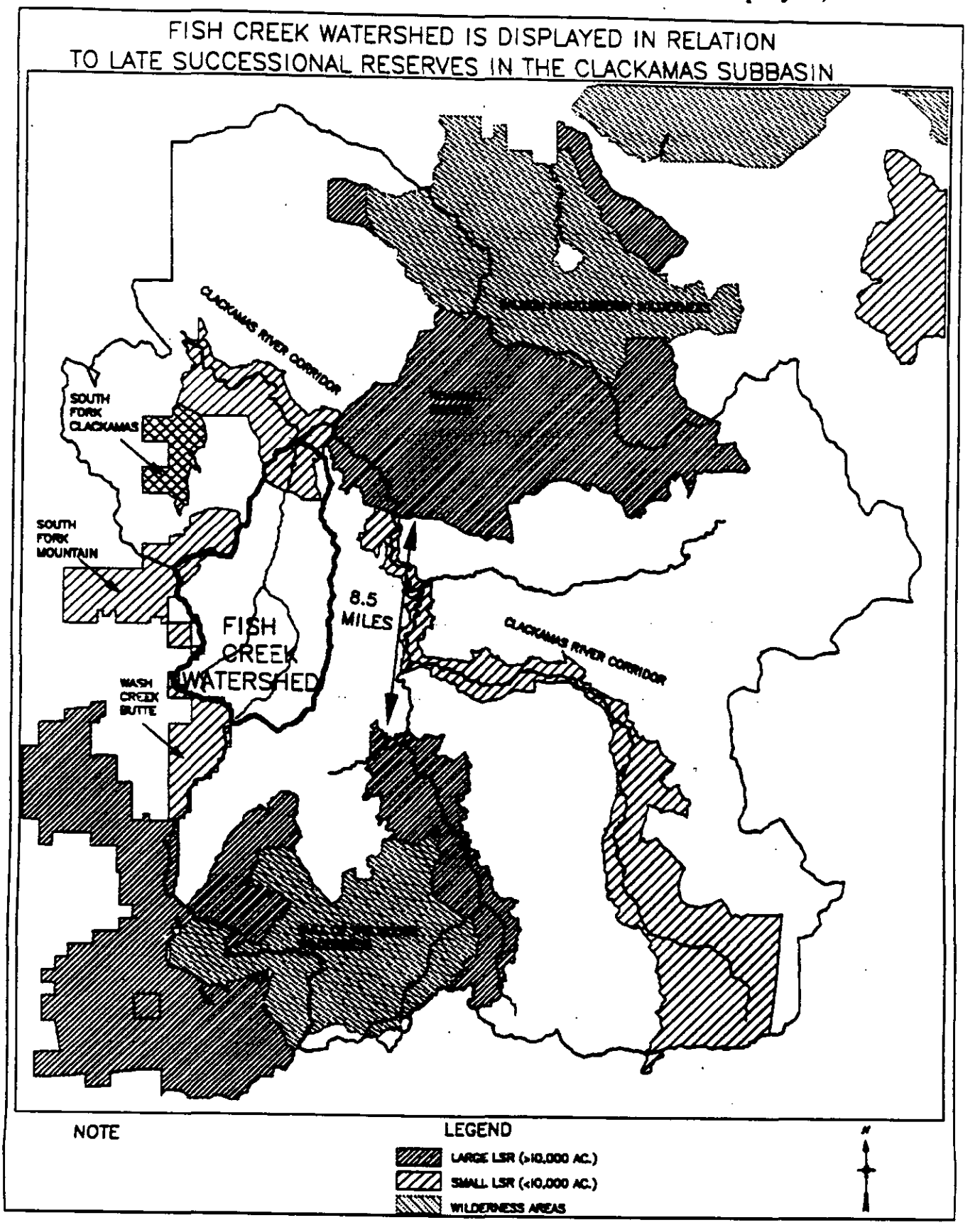
Map 4-6 Late Seral Habitat Currently Present in Fish Creek Watershed



Map 4-7. Late Seral Blocks and Interior Habitat Identified in Fish Creek



Map 4-8. Fish Creek Watershed is Displayed in Relation to Late Successional Reserves in the Clackamas Subbasin (Spotted Owl 100 Acre Unmapped LSRs are not displayed)



Although the vegetation of the watershed is quite heavily fragmented by timber harvest activities, several relatively large blocks of significant late seral (LS) habitat persist today (see Appendix A, Terrestrial). These current late seral blocks (Map 4-7) serve as important links in the existing "functional and interconnected old growth ecosystem" (ROD p.5) and may be important in assuring this objective of ecosystem management is met in the future. LS blocks displayed in Map 4-7 are subjective aggregations of existing LS habitat interspersed with other seral stages. These aggregations are centered around the largest remaining stands of LS habitat.

Late seral blocks often include stands recognized as interior habitat, i.e. the portion of the LS habitat least affected by edges and associated edge processes (e.g. wind patterns and temperature). See Appendix A and Analysis File. Late seral interior habitat has been dramatically reduced from the late 19th century era; however, some interior habitat still exists (Map 4-7).

Current management direction characterizes Fish Creek in the future as having a limited direct role in the Late Successional Reserves (LSRs) system in terms of land allocations within the watershed (Map 4-8). However, Fish Creek occupies an important location in assuring that dispersal habitat for late seral species moving among designated LSRs is provided and maintained through time. The ten spotted owl 100 acre core "unmanaged LSRs" are not displayed in Map 4-8 due to the sensitive nature of these data. Further discussion regarding the current condition of these LSRs is in Appendix A. Maps of these LSRs, held at the Estacada Ranger District, are not available for general distribution.

Riparian reserves, managed primarily for late seral habitat in the future, should contribute substantially to dispersal of late seral associated species, e.g. northern spotted owl. However, existing riparian habitat conditions are largely early and mid seral habitat in some areas (see Riparian discussion) and provide only discontinuous late seral connectivity between LSRs.

Wildlife

The 237 terrestrial vertebrate and aquatic amphibian species believed to inhabit Fish Creek were grouped into "life history guilds" based on their response to landscape patterns and their association with special habitat conditions (Mellen, et al. 1994). Existing habitat acreage for each life history guild was estimated on Forest-wide, Clackamas Subbasin and Fish Creek Watershed scales (see Appendix A and Analysis File). Estimates of habitat acreage available for these guilds historically has not been completed.

Special habitats play a major role in supporting wildlife in the watershed. Cliffs, caves and headwall-seeps and springs are of particular importance.

Ninety wildlife species associated with snag habitat are recognized as inhabitants of the watershed. Most of these species are generalists; however, 3 groupings of species are of particular interest due to their relatively specialized snag use patterns:

- primary cavity nesters requiring snags in late seral habitat.
- secondary cavity nesters requiring snags in early seral habitat.
- secondary cavity nesters using snags in late seral habitat.

Snags in late seral forest habitat have declined markedly within the watershed in the last century - largely due to clearcut and salvage harvesting of late seral forests. Most of the early seral stands (Map 4-1) in Fish Creek are nearly void of snag habitat (see Appendix A).

Analyses sufficient to support conclusions regarding species viability for any of the species in the 3 groups listed above are not available; however, a conclusion that these species are not serving fully functional roles in the Fish Creek ecosystem is reasonable. Examples of species included in these groupings are pileated woodpecker (a predator of Douglas-fir bark beetle) and western and mountain bluebird (primary predators of spruce bud worm).

Nine of the wildlife snag associates are also associated with lake or riverine riparian habitat. Existing habitat for these species has been depleted compared to historic levels due to timber harvest and control of fire within riparian zones.

Habitat conditions for wildlife members of the ecosystem, recognized as sensitive to human presence, were analyzed (see Appendix A). Sensitivity was interpreted as likelihood of displacement. Four of these species are currently on lists recognizing them as particularly at risk for maintaining viability, i.e. peregrine falcon (endangered) and California wolverine, harlequin duck and Townsend's big-eared bat (sensitive).

Fish Creek watershed plays a key role in the recovery and conservation of several imperiled species, i.e. peregrine falcon, northern spotted owl, Townsend's big-eared bat, and perhaps western pond turtle. The key role for spotted owl is providing dispersal habitat in a highly fragmented portion of the Forest. The key role for spotted owl is providing dispersal habitat in a highly fragmented portion of the Forest.

Although the entire watershed is not completely surveyed, ten spotted owl activity centers are recognized. Five of the ten are presently below "take" thresholds set by USDI-Fish and Wildlife Service, i.e. these owls are recognized as not having enough existing high quality habitat within their home range to sustain a viable, successfully reproducing pair (see Appendix A and Analysis File). Most of the higher elevations of Fish Creek Ridge are within a Critical Habitat Unit - as designated by the USDI-Fish and Wildlife Service under the Endangered Species Act (see Analysis File map).

Fish Creek Watershed's role in providing dispersal habitat for spotted owl was analyzed. Spotted owl dispersal success is recognized as a measure of "interconnectedness" in achieving the ROD objective (p.5) to *"provide for a functional and interconnected old growth ecosystem"*. The watershed lies between two large LSRs (i.e. >10,000 acres); the following conditions are considered pertinent to analyzing adequacy of dispersal habitat (see Appendix A):

- the 2 large LSRs are approximately 8.5 miles apart (Map 4-8).
- 46% of the watershed is currently in late seral habitat.
- 52% of the watershed has stands comprised of trees at least 11 inches in diameter and with canopy closures of at least 40%.

Five B5 Pileated Woodpecker/Pine Marten management areas were allocated within Fish Creek Watershed by the Mt. Hood Forest Plan. Three of these locations were included in land allocations which will retain adequate habitat for these management indicator species in the President's Plan. The other two B5 areas are in locations recognized as important for maintaining late seral habitat connectivity across the landscape.

Disturbance

Fire

Fire is the dominant landscape pattern-forming disturbance in this portion of the Cascades. Fire suppression in the Fish Creek drainage began in the early 1900's. Earliest recorded suppression activities occurred in 1910, on a 75 acre fire near Dead Horse Butte. Since that time an average of seven fire starts per decade have been suppressed within the drainage, both person and lightning-caused. All of these fires remained small. The most recent fire in the drainage was the Wash Creek fire in 1991, which burned a plantation and into adjoining unmanaged stands. Effective fire suppression, coupled with timber harvest pattern, has led to a reduction in the size of early seral patches within the drainage, as well as a change in the pattern of distribution, compared to what would be expected under the natural disturbance regime.

The last major fire events in Fish Creek occurred during the period between 1850 and 1900. Map (4-6) is a reconstruction of the Fish Creek landscape at the turn of the century, prior to the advent of fire suppression. In 1900, approximately 13% of the watershed was in an early seral condition, 1% in mid, and 86% in late seral. (See Appendix A for more information about the reconstructed 1900 landscape).

These fires (between 1850 and 1900) were predominantly mid-sized stand replacement fires which extended over the ridges, outside of the Fish Creek drainage. These fires show patterns where many residual trees and snags remained. There were large "fingers and blobs" of areas that either remained unburned, or only underburned. Significant remnants were found primarily in drainages and also around some of the rock outcrops.

Most of the Fish Creek watershed has a stand year of origin between 1650 and 1750, indicating major stand replacement fire events at this time.

There is no information available concerning the amount of underburning in the drainages that occurred under the natural fire regime.

Insects, Disease, and Windthrow

There are currently eight relatively small insect activity centers within the drainage (see Appendix D). Mapped activity centers are primarily bark beetles found in noble fir stands.

Damaging winds in the Fish Creek drainage usually come from either the east or the southwest. Most of the windthrow areas in the drainage are immediately adjacent to clearcut units. Most of the windthrow occurs in the lower portion of Fish Creek, on the east side of the drainage.

Landscape Pattern

Since timber management began in the Fish Creek drainage during the 1940's, the trend in the landscape pattern has been:

- Increase in the amount of edge (more edge habitat, less interior habitat, more risk of windthrow). Edge contrast is high, with abrupt transitions between early and late successional vegetation.

- Fragmentation of the mature forest matrix, loss of connectivity and isolation of mature forest blocks.

- Increasing patchiness. Patches are smaller and more uniformly sized than what would be expected under the natural disturbance regime.

- Open patches are more evenly distributed throughout the landscape and are beginning to coalesce.

(See Appendix A for FRAGSTATS analysis of spatial pattern.)

Aquatic System (including Hillslope and Hydrologic Processes)

Hillslope Processes

Geology

Throughout the Fish Creek Watershed, mass wasting has played an important role in shaping hillslopes. Currently, shallow landslides are the dominant mass wasting process. Steep slope gradients in combination water saturated soil layers overlying the bedrock interface drive the shallow mass wasting processes.

Evidence of ancient, deep-seated landslides is also found in the watershed in the form of large, bench-forming deposits. These landslides are thought to have been triggered by large magnitude earthquakes during a wetter climate. While this climate persisted, portions of the deposits that were rich in clay probably behaved like earthflows and continued to move. Most of these deposits in the Fish Creek Watershed are now believed to be stable.

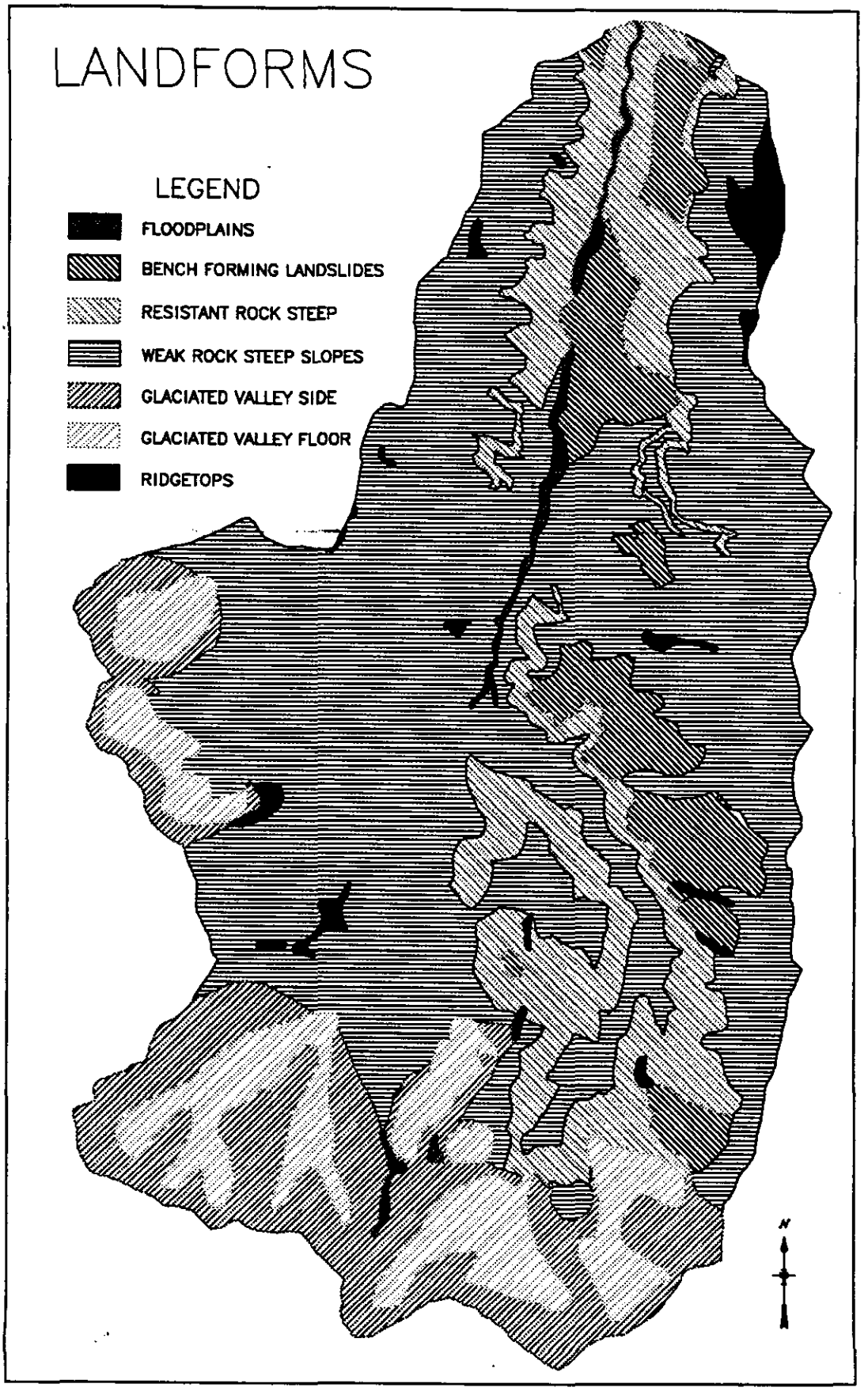
During the most recent glacial advance, small mountain glaciers formed in the upper reaches of Fish, Wash, Pick, Shovel and Music drainages. Glaciation has smoothed valley sides and widened valley floors in these subwatersheds.

In addition to mass movements other important hillslope forming processes that deliver sediment to streams in Fish Creek include soil creep and surface erosion.

Landform

The terrain in Fish Creek has been delineated into seven broad scale landform units that represent factors of geologic type, slope gradient and position, surface drainage and terrain texture. These factors impart a similar potential for mass wasting for the defined landform units. Table A-9 in the Appendix A displays the characteristics for landform units in Fish Creek. The distribution and location of landform units is presented in Map 4-9.

Map 4-9. Landform Units in Fish Creek



Landslides and Surface Erosion

A landslide inventory was conducted by examining a minimum of five sets of aerial photographs taken between the years 1946 and 1989. Four areas of the watershed thought to represent the seven landform types were examined. For information on the measured frequency of mass wasting occurrence for landform types in Fish Creek refer to the Fish Creek Analysis File.

Results from the landslide inventory indicates that highest rates of mass wasting are associated with steep slopes in resistant and weak rock geologic types (WRSS or RRSS). In naturally occurring forest and non-forest areas debris flow and debris slide type events were inventoried from aerial photographs. Debris slides were the most prevalent kind of mass wasting event, followed by debris flows. Together these two landslide types accounted for 94 percent of inventoried landslides (see Appendix A, Table A-11).

Timber harvest and road construction have increased rates of mass wasting in areas selected for survey in the watershed. Measured as the number of events over a 43 year period, rates of landslides originating from harvested areas and road locations are approximately three times natural levels (see Table A-11, Appendix A). In managed terrain, debris slides were roughly twice as common as debris flows. In contrast, debris flows were more than three times as common as debris slides in unmanaged terrain.

Recent landslides were not detected in harvested areas where recovery processes of plant succession and increased root strength had been ongoing for 20 years or more. It is not clear if this means the disturbed area has recovered or if landslides are now simply concealed by vegetation.

A consequence of increased mass movement frequencies has been greater delivery of sediment to stream systems in Fish Creek. In considering sediment delivery, debris flows were treated separately from other types of landslides because debris flows tend to alter a significantly larger portion of the stream channel. The highest rates of sediment delivery from debris flows were associated with landform types that were steeply sloping and consisted of either weak or resistant rock types. For debris flows, landform types with steep slopes that consist of either weak or resistant rock received a "High" sediment delivery rating. A "Medium" rating was given to large, bench-forming landslides and glaciated valley side slopes. Table A-10 in Appendix A displays the qualitative rating for sediment delivery for both debris flow and other landslide types (non-debris flow mass wasting events) for all landforms in Fish Creek.

Subwatershed Context

Table 4-2, in which debris flows and other landslides are combined, lists the number of acres in each relative sediment delivery class for each subwatershed. Sediment delivery is determined from the broadly defined landform types.

Table 4-2. Acres of Relative Sediment Delivery Risk Class in Subwatersheds

Subwatershed	Relative Sediment Delivery Rating						
	High	%	Medium	%	Low	%	Total
Lower Fish Creek	6903	82	1029	12	522	6	8454
Third Creek	1527	94	86	5	9	1	1622
Upper Fish Creek	5244	57	2369	26	1515	17	9128
Pick and Shovel Creek	1485	72	338	17	233	11	2056
Fall Creek	1135	95			64	5	1199
Wash Creek	2580	45	1116	20	2005	35	5701
Music Creek	1008	62	282	17	332	21	1622
Total	19,882	67	5,220	17	4,680	16	29,782

The aerial photo inventory of selected areas in the watershed noted that large debris flows impacted the upper reaches of Pick and Shovel Creeks. Since 1946 approximately 1.5 miles of Pick Creek has been scoured by one or more debris flow events. Debris flow events were also described for several tributary streams to Wash Creek.

A survey of damage resulting from the large storm event in December of 1964 revealed that many land damaging events were related to clear cut harvest areas and road development. The extent of damage from these events varied from onsite impacts to scouring of entire drainages down to the mainstem of Fish Creek.

Thirty-one separate events attributed to the storm were inventoried in Fish Creek drainage. Seven of those resulted in stream scour or damage in undisturbed areas. Thirteen of the forty streams surveyed had experienced debris flows. In five of the streams impacted the area of origin was not disturbed. Music Creek was damaged along nearly its entire length. First, Second and Third Creeks also received notable impacts from slides.

Other management activities in the watershed that may be contributing sediment to the aquatic systems are surface disturbances occurring due to timber harvest and site preparation treatments. For the entire watershed 75 percent or more of the basin has a severe or moderate erosion hazard. On severely erosive soils annual natural rates of soil erosion are estimated to be .024 to .026 cubic yards per acre (Swanson and Grant, 1982). Timber harvest disturbances result in increased erosion rates that may exceed ten times the natural rates (Swanson and Grant, 1982).

Following disturbances from logging and broadcast burning natural recovery occurs as vegetation re-establishes on disturbed soil surfaces. In most instances a stable soil surface condition occurs 5 years following soil disturbance. For the slopes occurring in Fish Creek 200 feet of natural canopy condition and ground vegetation protection was considered adequate to impede delivery of sediment from upland sources.

In the last 5 years several acres of harvest has occurred adjacent to streams or upslope from streams. Erosion on disturbed areas within 200 feet of stream channel on steep slopes has the potential to deliver sediment.

Highest acreages of harvest have occurred in Lower Fish and Wash Creek subwatersheds on severe and moderate erosion hazard lands. These acres have the capability to deliver sediment to stream channels.

Roads

Roads create disturbances on the landscape that are not replicated by natural factors operating in forest ecosystems. The impacts roads have depends on road construction techniques, topographic characteristics, the underlying geologic material and the subsurface flow of water downslope under the influence of gravity. In general roads cause steep slopes to be less stable, contribute sediment to stream systems from road surface and cutslope surfaces and interrupt the surface and subsurface flow of water to stream channels, affecting baseflow and peakflow characteristics of a watershed.

Road construction has initiated debris flows in Fish Creek predominantly within landform units characterized by either weak or resistant rocks on steep slopes. Using the miles of road located within landform types which have a high relative sediment delivery rating for debris flows or debris slides, (WRSS or RRSS), as an indicator of possible sediment delivery from road related mass wasting, Lower and Upper Fish Creek subwatersheds have the greatest degree of concern for road related mass movements delivering sediment to streams (Table A-15, Appendix A). Pick Creek and Wash Creek subwatersheds have fewer road miles on high risk landforms, however, because these two subwatersheds are smaller in area, impacts from mass wasting can be equally impacting.

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

A matrix was used to describe the relative capability of a road segment to deliver sediment to stream channels depending on cutslope erosion risk and road surface characteristics at stream crossings and roads located adjacent to streams. A description of the process and assumptions in developing the matrix are presented in the analysis file for Fish Creek.

There is a higher efficiency of sediment delivery at stream crossings via ditchline flow compared to delivery from culvert outflow occurring on vegetated slopes. Native surface roads have a greater susceptibility to erode than aggregate rock surfaced roads. Miles of roads by relative sediment delivery capability class is presented below in Table 4-3.

Table 4-3. Miles of Road by Sediment Delivery Capability in Subwatersheds of Fish Creek

	Sediment Delivery Capability					
Subwatershed	**High**	**Moderate**	**Low**	**Very Low**	**Total**	**Total Roads Subwatershed**
Lower Fish Creek	8.4	5.9	1.0	1.6	16.9	48
Third Creek	.9	1.0	.1	0	2.0	5
Upper Fish Creek	11.3	1.9	3.9	.3	17.4	47
Pick Creek	1.8	1.5	.4	.1	3.8	9
Fall Creek	.3	.2	.2	0	.7	4
Wash Creek	6.8	2.1	1.2	.1	10.2	24
Music Creek	1.0	.5	.1	0	1.6	6
Total	30.5	13.1	6.91	2.1	52.6	143

Approximately 53 miles of road in Fish Creek have the capability to deliver some level of sediment to streams (Table 4-3). Total road miles in the watershed is 143. More than 30 miles of road are in the high sediment delivery class.

There are approximately 359 crossings of streams by roads in Fish Creek watershed (Stream Crossing Map, Analysis File). Due to the high erosion susceptibility of soils derived from pyroclastic material over half of the stream crossings in the drainage are believed to have a high capability to provide material to be transported down ditchlines to stream channels.

Dispersed recreational sites adjacent to streams are a minor source of sediment to streams. These areas are less than 1/4 acre in size and total four acres in the watershed.

Hydrologic Processes

Stream Flow

A limited amount of streamflow information is available from a gauging station in operation since 1989 and located about 0.7 mile upstream from the confluence with the Clackamas River. For the period of record, the average annual water yield for the Fish Creek watershed is estimated to be in excess of 133,900 acre-feet per year. Over 50 percent of the annual flow comes in the months of November though February. Monthly mean flows range from a low of around 13 cubic feet per second (cfs), occurring in late summer, to a high in excess of 350 cfs during typical winter months. Maximum monthly flows generally occur during the months of December, January, and February, with a second peak (associated with spring snowmelt) occurring in April. Extreme flows for the period of record range from a low of 6 cfs (Sept. 1-2, 1992) to a high of 3,830 cfs (Dec. 6, 1991).

Peakflow

Significant flood events have occurred historically on a fairly regular basis in Fish Creek drainage. The February 1927 flood is likely to have triggered debris slides and channel scouring within the Fish Creek watershed, as evidenced by revegetated scars observed on 1946 series aerial photographs.

The most dramatic and well-documented flood event in the recent past occurred on December 22, 1964. Approaching the estimated 100-year frequency, this event caused extensive damage.in the Fish Creek watershed. This was followed by a somewhat lesser magnitude flood in January 1965.

Fish Creek flood events (see Appendix A for historical data) are similar to other documented floods in the Cascades. These peakflow events occur during the rainy season, following a rapid and substantial depletion of the snowpack during a prolonged rain-on-snow period in the "transient snow zone".

Approximately 77 percent of the watershed lies within the "transient snow zone" (Christner and Harr, 1982). The Fish Creek transient snow zone is estimated to occur between 2,400 feet and 4,800 feet elevation.

Approximately 41 percent of the watershed has undergone clearcut timber harvest with harvest areas in varying states of hydrologic recovery. The majority of harvest has occurred within the transient snow zone. Melting snow, which accumulates to greater depths in harvest areas and roads, increases the magnitude of peakflows during rain-on-snow events. The resulting higher flows may scour, downcut, or widen stream channels.

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

Roads also encroach on stream channels, riparian areas, and floodplains, continuing and straightening channels and "capturing" streams during flood events. This was observed along the mainstem of Fish Creek following the 1964 Flood, where the main access road (54) encroaches on the floodplain (between mile 3 and 4).

An analysis of streamflows (Hydrologic Change Module, Analysis Files) indicates that peakflows for the 2, 5, 10, 25, 50, and 100-year return intervals have all increased from 2 to 14 percent for Fish Creek and its principal tributaries during the period of management within the watershed (Table 4-4). Since the error associated with streamflow measurements is generally around 5 to 10 percent, only peakflow figures for the 2-year and 5-year events are significant in this analysis.

However, the other values indicate an overall trend of increased peakflows, especially where road contributions are considered - a factor not adequately addressed in the hydrologic change analysis methodology.

Table 4-4. Changes in Peak Flows

Fish Creek		Flow (CFS)*			
Recurrence Interval	Storm Intensity	F/BR Gage Predicted	USGS Eq. Adjusted	USGS Adjusted	Percent Increase
2	Average	3846	2094	2217	6
2	Unusual	3846	2094	2394	14
5	Average	4923	3193	3326	4
5	Unusual	4923	3193	3559	11
10	Average	5514	3932	4078	4
10	Unusual	5514	3932	4227	8
25	Average	6151	4950	5105	3
25	Unusual	6151	4950	5391	9
50	Average	6639	5759	5924	3
50	Unusual	6639	5759	6105	6
100	Average	6937	6593	6767	3
100	Unusual	6937	6593	7091	8

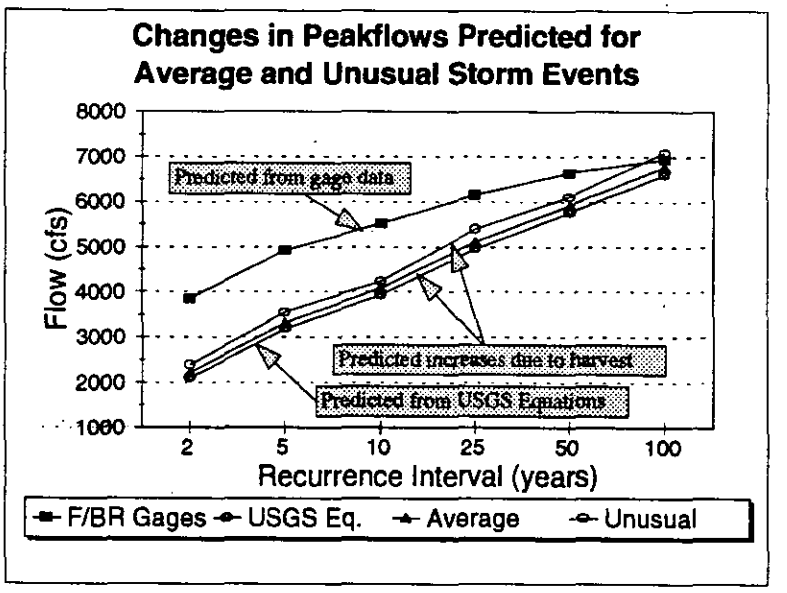
Flow (USGS) - From prediction equations published in Harris, D.D., Hubbard, L.L. and L.E. Hubbard, Magnitude and Frequency of Floods in Western Oregon US Geological Survey Open File Report 79-553.

Flow (F/BR) - Fish Creek predicted peakflows estimated from Mainstem Bull Run peakflows using relationship developed with Water Year 1990-1993 Fish Creek and Mainstem Bull Run mean daily flows.

NOTE: The mainstem Bull Run was selected for comparison since the watershed area above the gauging station approximates the Fish Creek Watershed in several regards: similar size, similar elevation, and unregulated. Bull Run is also the closest currently operating station on an unregulated stream.

Application of correlation analysis techniques (see Appendix A for details) indicates predicted peakflows (Figure 4-4) for Fish Creek are substantially greater for all return periods as compared to peakflows calculated from the USGS regional equations (USGS, 1979). Data presented in Table 4-4 and Figure 4-4 suggests that actual peakflows may be much greater than values predicted by available models.

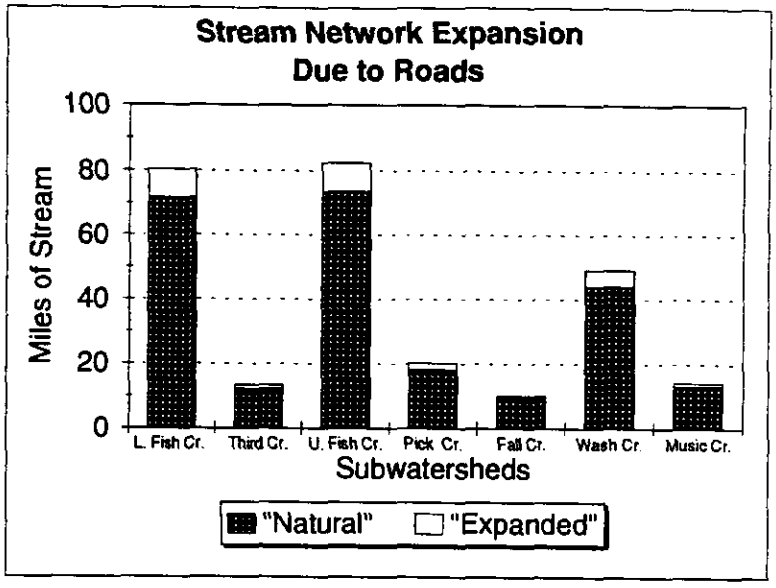
Figure 4-4 Predicted Peak Flows for Fish Creek



Analysis of roads and stream crossings with regard to the expansion of the channel network indicates that channel lengths and stream drainage densities appear to have increased by at least as 11 percent overall within the Fish Creek watershed (Figure 4-5). Assumptions for deriving the factor of stream expansion are discussed in Appendix A. This suggests that apparent increases in peakflows (discussed previously) are partially attributable to increased road density and expansion of the drainage network. Moreover, actual increases in peakflow may be substantially greater than values displayed in Table 4-4.

There is reason to conclude that channel-forming peakflows (2-year, 5-year, 10-year events) have been increased over natural levels in Fish Creek, the implications of which are discussed in sections which follow. It is also reasonable to infer that less frequent, longer return interval floods (25-year, 50-year, 100-year, etc.) are less affected by management and are more reflective of the specific climatic event causing or contributing to the stream discharge.

Figure 4-5. Channel Network Expansion Due to Roads



Baseflow

No long-term records of baseflow are available. Low flows ranging between 6 cfs and 13 cfs have been recorded at the USGS gage near the mouth of Fish Creek, representing recent drought years.

Evaluation of baseflow for Fish Creek involves correlation methods, described in Appendix A, to Fir Creek an unmanaged watershed with recorded baseflow. Minimum recorded flows at Fish Creek approximated 10 cfs or 0.192 cfs per square mile (csm) of watershed area, while the unmanaged comparison watershed, approximated 3 cfs or 0.576 csm. This data could indicate that land management activities within Fish Creek may have decreased baseflows.

Recent research (Hicks, et al 1991) suggests that reductions in streamflow following timber harvest may be related to the regrowth of deciduous riparian species which transpire larger quantities of water than the natural conifer vegetation. Timber harvest in Fish Creek has resulted in approximately 36 percent of riparian reserves being converted to an early seral stage, largely dominated by deciduous species. This may partially account for the apparent decreased baseflow.

Apparent reduced baseflow in Fish Creek could also be related to channel scour, down-cutting, and abandonment of former floodplains as discussed elsewhere in this analysis.

Channel Morphology

Stream channel gradients are steep for Fish Creek and its numerous tributaries, generally exceeding 5 percent, except for the lower 3.7 miles where gradients average 2 percent. Fish Creek mainstem has a boulder and cobble substrate contributing to a predominantly riffle environment. Wash Creek and upper Fish Creek have steeper, more incised, narrow channels with a predominantly cobble and gravel substrate.

Historically, the dominant sediment sources are landslide processes including debris slides and debris flows, associated with steep slopes, geologic contacts, and high gradient stream channels; and smaller earth slumps and landslides occurring within and along the margins of the large ancient landslide features (see Hillslope Processes section for discussion by subwatershed).

A comparison of the 1959 and 1965 (Oregon Fish Commission) surveys revealed that relatively little change occurred in the bottom composition of the lower 4.5 miles of Fish Creek (Lower Fish Creek), with slight increases indicated in the boulder category and corresponding decreases in the small gravel and cobble categories. The same comparison revealed major changes in substrate composition in the upper reaches of Fish Creek (Upper Fish Creek subwatershed) and Wash Creek (in reaches accessible to anadromous fish), with the greatest changes occurring in the boulder and bedrock categories. In both subwatersheds the proportion of bedrock was greatly reduced and the proportion of cobble substrate greatly increased. The large quantity of cobbles, boulders, and other coarse sediments are attributable to debris slide and debris flow contributions and channel erosion in high gradient tributary streams, which aggraded the former bedrock reaches. Due to generally steep gradients, fine sediments are apparently flushed through the system, and comprise a relatively small percentage of channel substrate throughout the watershed.

Water Quality

An examination of water quality encompasses several elements including temperature, clarity, chemistry, and microbiology. Water temperature and riparian canopy shade interrelationships are discussed elsewhere in this chapter of the analysis.

Sediment and Water Clarity

Water clarity of Fish Creek is generally extremely high. Streamflow is clear most of the year, except during early winter storms which tend to "flush" accumulated channel debris, and during major winter storms which may contribute sediment from bank erosion, slides, or surface erosion from disturbed unvegetated areas (including roads, dispersed recreation sites, etc.). Relatively high stream gradients and stream velocities tend to transport fine sediments rapidly out of the watershed, allowing rapid clearing of water.

Recent monitoring of streambed substrate in the lower gradient transport and response reaches was carried out during the summer of 1993. A discussion of inventory methodologies is presented in Appendix A.

Results revealed that fine sediments are not abundant in the streambed substrate of Fish Creek and stream channel aggradation is not extensive. To the contrary, stream surveys and monitoring suggest that degradation, or the downcutting of channels, may be occurring (Estacada District monitoring records, 1993).

Water Chemistry

All available information and data on water chemistry within the Fish Creek watershed comes form project-specific monitoring of aerial forest fertilization activities occurring in 1990 and 1991. The available data indicates that total nitrogen, nitrate-nitrite nitrogen, and ammonia nitrogen are present in relatively low quantities. Measurements of pH remain relatively constant within the various subwatersheds, ranging from pH 7.2 to pH 7.6. All measured parameters are well-within the tolerance limits which research has established for aquatic organisms.

Microbiology

Concern over the potential for introduction of pathogenic micro-organisms has arisen in recent years, due in part to the increased human use associated with unmanaged, dispersed camping and recreation occurring in riparian areas adjacent to Fish Creek. Evidence of unsanitary disposal of human fecal matter in close proximity to streams and other water bodies is common, particularly along the mainstem of Fish Creek. The extent and effects of microbial contamination are unknown.

Riparian Canopy Disturbance and Stream Water Temperature

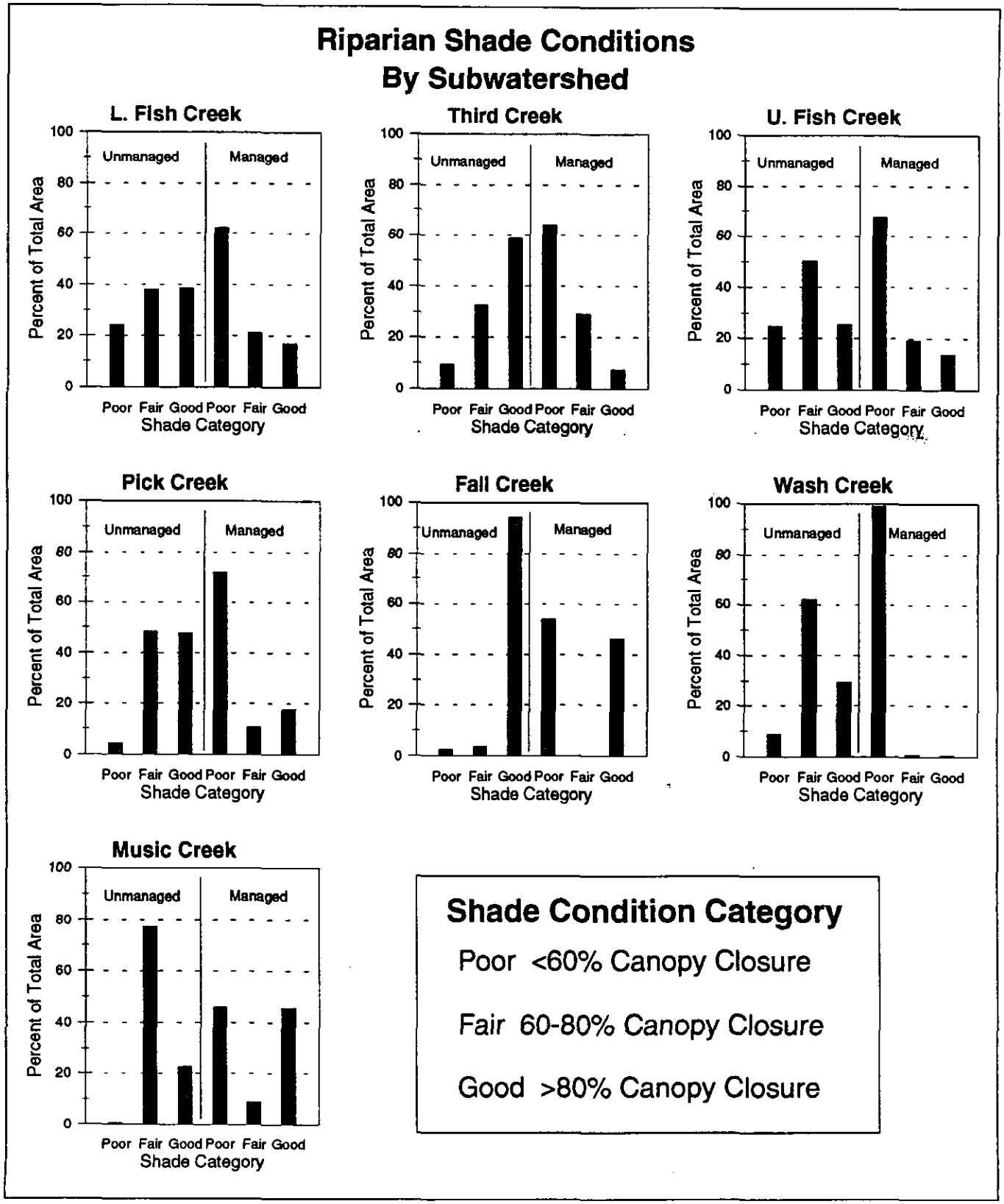
Direct solar radiation is a principal factor in raising stream temperatures and largely affected by the quality and quantity of shade producing vegetation. Natural disturbance agents such as fire, windthrow, and storm-induced channel scour, and human activities such as timber harvest, road construction, and riparian-based recreation have the potential to influence stream temperature by altering streamside vegetation and channel form.

Prior to the mid-1940s riparian areas along the mainstem of Fish Creek and elsewhere throughout the watershed were well-vegetated with mature old growth Douglas-fir, cedar, and hardwoods. Evidence (1946 aerial photography) of natural disturbance to riparian areas prior to timber management was not extensive. Several first and second order streams scattered throughout the drainage exhibited younger deciduous vegetation associated with debris flow impacts, possibly from the 1927 flood.

Removal of riparian vegetation along Fish Creek and Dog Creek began with the earliest logging in the drainage. Removal of streamside vegetation during timber harvesting was a common practice throughout the Fish Creek watershed from the date of timber harvest entry into the watershed (1940s) through the 1980s. Consequently, many perennial streams and most intermittent streams associated with harvest areas throughout the watershed lack the necessary shading to maintain cool stream temperatures during summer months. Along many of these affected streams, hardwood riparian vegetation has re-established and now provides sufficient shading. However, several of these affected streams, especially at the higher elevations, still lack adequate shading from riparian vegetation.

Based on an assessment of canopy closure from the 1994 Base Vegetation Database, Figure 4-6 illustrates the reduction in riparian shade quality between managed and unmanaged stands in the principal Fish Creek subwatersheds.

Figure 4-6. Riparian Shade Condition by Sub-watershed



Note the higher proportions of managed riparian reserves in the poor and fair categories, reflecting extensive timber harvesting in the various sub-watersheds.

Figure 4-7 displays average maximum temperatures for major streams within the Clackamas Subbasin, illustrating that Fish Creek temperatures are highest among streams monitored.

Figure 4-8 illustrates the average seven day temperature maximums for Fish Creek, near its mouth, for years for which data is available. Similarly, Figure 4-9 illustrates average seven day maximum temperatures for stations located on several tributary reaches in the Fish Creek watershed.

Critical high stream temperature periods occur mainly from June 1 through September 30. As Figures 4-8 and 4-9 illustrates, stream temperatures during this critical heating period have consistently exceeded the state water quality standard of 58 degrees Fahrenheit for the periods of available data during low summer flow conditions. Maximum stream temperatures are very close to biological thresholds for salmonid fishes (70 to 74 degrees Fahrenheit) (Figure 4-8). An analysis of stream temperature data collected near the mouth of Fish Creek from the period of 1991 through 1993 reveal both dramatic daily fluctuations and prolonged periods of daily departure from the state water quality standard (See reports on file).

Limited non-continuous stream temperature data, collected at the mouths of tributary streams during the low summer flow period during mid-day (1200 hours to 1600 hours), reveal temperatures in excess of 58 degrees Fahrenheit, the Oregon water quality standard). However, the magnitude and duration of these departures from the state of Oregon water quality standard are unknown.

Figure 4-7. Average Maximum Summer Temperatures for Major Streams Within the Clackamas Subbasin, 1993

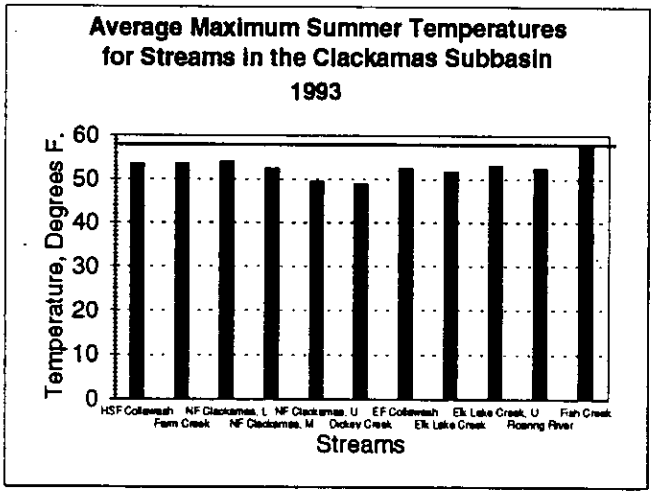


Figure 4-8. Seven Day Maximum Temperatures for Fish Creek, 1979-1993

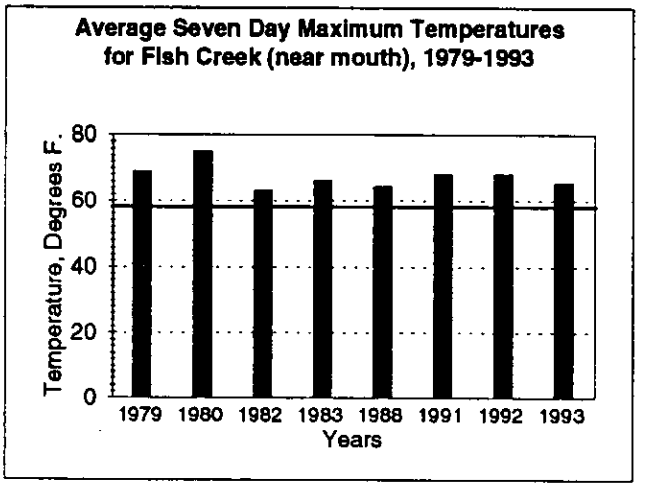
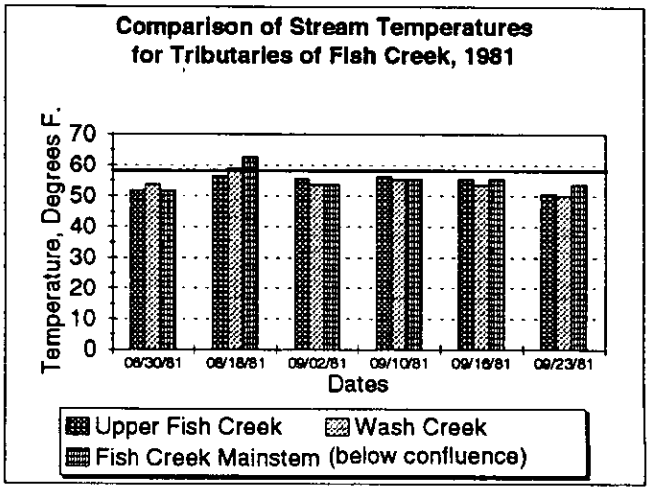


Figure 4-9. Comparison of Temperatures for Tributary Streams, 1981



Large Wood Supply Affecting the Aquatic Ecosystem

Large wood is delivered to stream channels naturally by landslides, by entry from adjacent riparian areas, and by transport from upstream areas. Large wood significantly influences channel morphology and is a major component affecting fish habitat.

Surveys of Fish Creek conducted in 1959 indicate that large wood was abundant and contributed to the formation of large jams and numerous deep pools. In 1959 pools comprised about 45 percent of the habitat in the range of anadromous salmonids. A resurvey of the watershed in 1965, following the flood of December 1964, indicated that pool habitat had been reduced to about 25 percent. Much of the large wood was apparently redistributed and transported downstream by the flood.

From 1965 until the early 1980s, much of the large wood was removed from the stream system through salvage logging. Surveys conducted from 1982 to 1985 concluded that the practice of removing large wood during the previous 10 to 15 years further reduced pool habitat to only 11 percent of total area.

Rehabilitation efforts over the past 10 years have focused on the re-introduction of large wood. Recent surveys indicate that pool habitat has returned to levels approximating those observed immediately following the 1964 flood. Conditions have yet to return to levels existing prior to the flood.

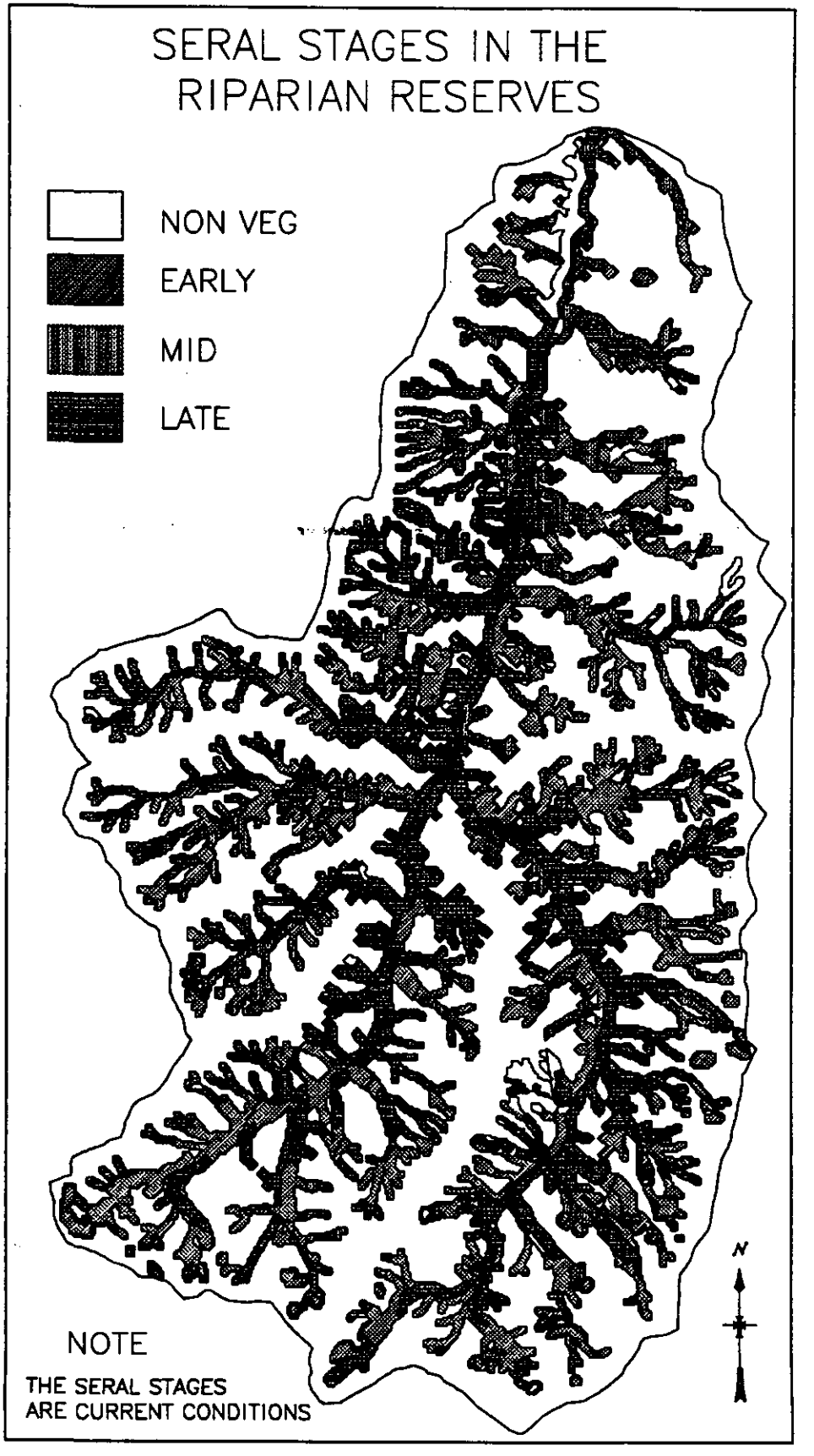
The range of natural condition (the expected range of variability within vegetation seral stages) for riparian areas in the Clackamas River Basin are show below.

Table 4-5. Range of Natural Conditions and Current Conditions of Riparian Reserves

Clackamas River	Early Seral 3 - 22%	Late Seral 36 - 78%
Current conditions are:		
• Fish Creek (all Riparian Reserves)	36%	51%
• Pacific Silver Fir Zone	50%	49%
• Western Hemlock Zone	29%	59%

These areas are shown on Map 4-10.

Map 4-10. Seral Stages in the Riparian Reserves



Projected large woody debris recruitment in the Fish Creek watershed in riparian reserves was modeled using the methodology outlined in the Washington Forest Practice Board methodology (p. D-12). Table 4-6 shows high, medium and low large woody debris recruitment potential by sub-watershed in acres.

Table 4-6. Potential Large Woody Debris Recruitment

Sub-Watershed	Current Recruitment Potential (acres)		
	Low	Medium	High
Lower Fish Creek	1267	1252	1082
Third Creek	276	83	180
Upper Fish Creek	1500	942	1575
Pick & Shovel Creek	297	191	346
Fall Creek	359	35	116
Wash Creek	1372	179	926
Music Creek	236	195	192
Total Acres	5309	2876	4417

Nearly 50 percent of the riparian reserve areas have low future large woody debris recruitment potential. These areas are mapped (see Appendix C).

Riparian areas, particularly those adjacent to high gradient source area tributaries, are potential sources for large wood recruitment to the stream system. However, with over 36 percent of riparian reserves currently in an early seral stage as a result of timber harvest, the potential supply of large wood has been seriously depleted in many areas. A more extensive discussion of Riparian Reserves, as defined by the President's Forest Plan, is Appendix A.

Aquatic Organisms

Fisheries and Aquatic Biology

Fisheries and aquatic biology are described in a historic context, followed by a summary of current condition and trends. Physical processes affecting fish, fish habitat and aquatic invertebrates are also examined. This section is outlined as follows:

- species present, distribution and population dynamics,
- habitat conditions, connectivity and habitat fragmentation,

- effects of physical processes on fish and aquatic insects, and
- lakes, springs and wetlands.

Fish Creek has an ongoing, ten year watershed wide fisheries research effort led by the Pacific Northwest Research Station in Corvallis, Oregon.

Species Present, Distribution and Trends

Fish

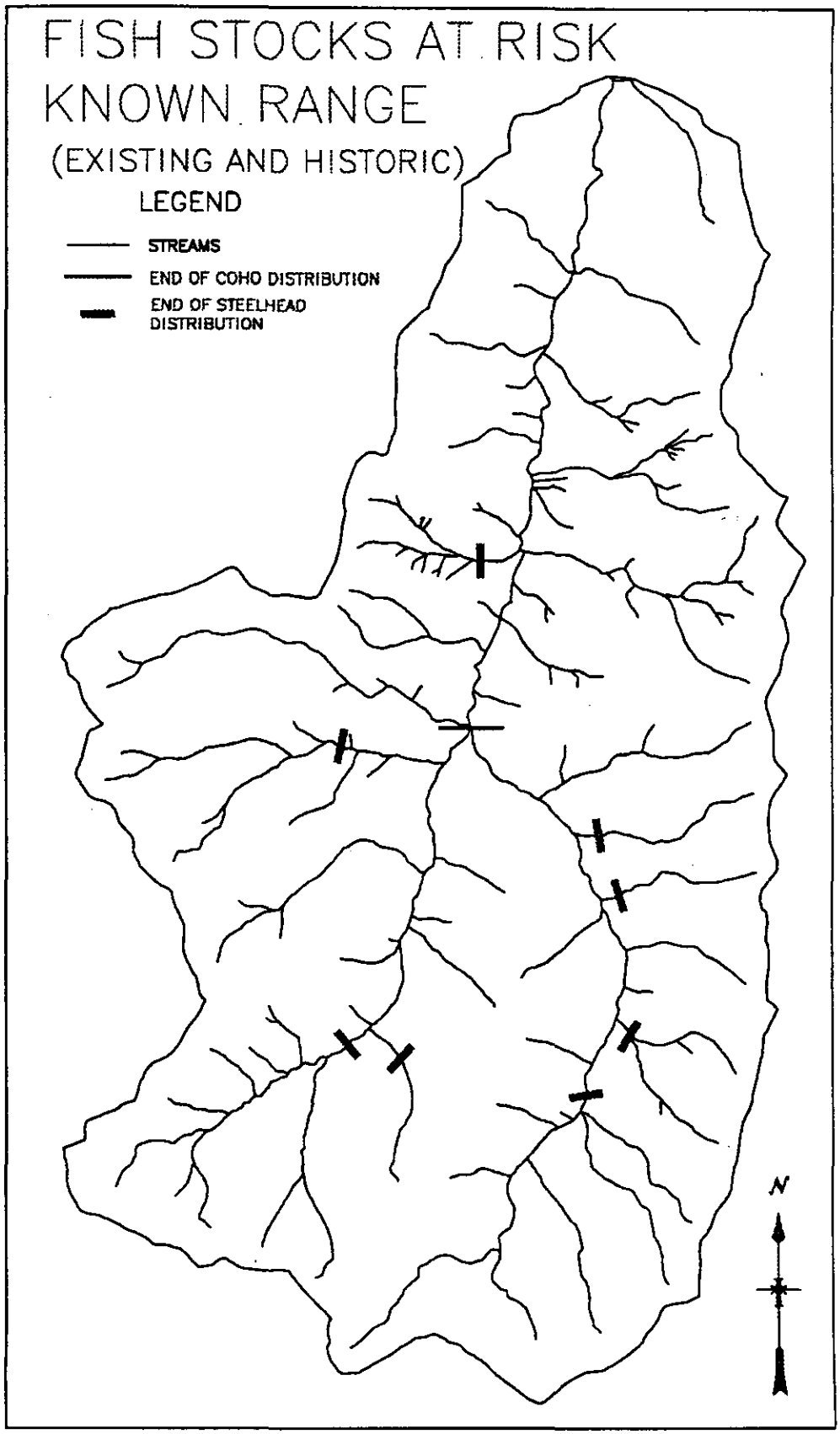
Prior to 1900, commercial fish harvest occurred near the mouth of the Clackamas River. Harvest estimates were as high as 12,000 spring chinook per year. Hatcheries were also built during this period, including one in the upper watershed of the Clackamas River used for the production of spring chinook. In 1904 Portland General Electric began construction of one of a series of dams on the Clackamas River. All dams were built with fish bypass facilities, however, in 1917 the ladder on Faraday Dam washed out and was not rebuilt until 1939. There was no upstream migration during this period. The existing fish populations are a combination of native Clackamas fishes that have naturally reseeded the upper basin, and introduced/non-native fishes.

Indigenous fish stocks found within the Clackamas River basin above River Mill Dam include spring chinook salmon, late run coho salmon, late winter steelhead, resident rainbow trout, and resident and searun coastal cutthroat trout. Introduced stocks include Willamette spring chinook, early run coho, Big Creek and Eagle Creek stocks of winter steelhead, and summer steelhead. Brook trout, brown trout and kokanee salmon have been introduced into high lakes and reservoirs in the upper Clackamas River basin.

Fish present in Fish Creek are spring chinook salmon, early and late run coho salmon, late winter and summer steelhead, rainbow trout, resident and searun coast cutthroat trout and brook trout. Other fish present in the Fish Creek watershed are sculpin, longnose dace, and mountain whitefish (Map 4-11.)

Life history characteristics of coho, steelhead and chinook are described in Appendix A.

Map 4-11. Fish Stocks at Risk Known Range Existing and Historic



In the early 1980's the Pacific Northwest Research Station (PNW) in Corvallis, Oregon began studying the effects of habitat restoration on physical characteristics and aspects of salmonid life history in Fish Creek. Results of these studies are found in a series of publications (see references in Appendix A). These reports document life history characteristics such as over-winter survival, total fish production, habitat use by juveniles and distribution in the watershed. There is a summary of their finding by species later in this document.

There are a total of 42.5 miles of fish bearing streams in Fish Creek. 16 miles of the 42.5 are anadromous. The lower portion of Fish Creek (from the confluence of Fish and Wash Creeks to the confluence with the Clackamas) is 2-5% gradient, and contains the only wide, flat reaches in the watershed.

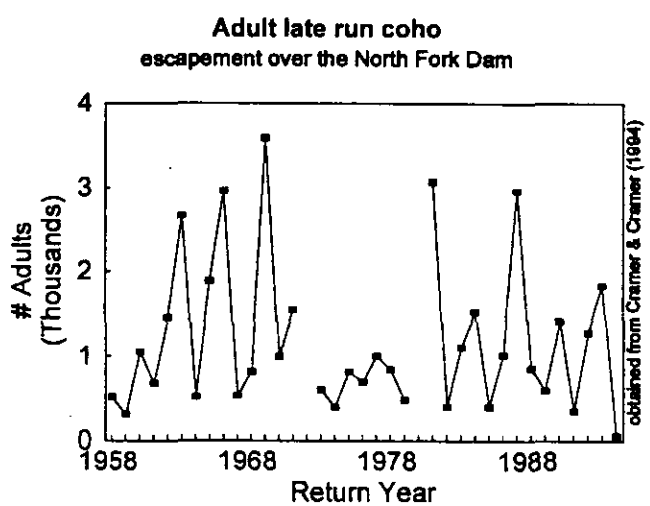
Coho

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

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

National Marine Fisheries Service is currently conducting a status review for the late run coho pursuant to the Endangered Species Act. Declines in the run are documented (Cramer and Cramer 1994), and modeling for the three brood years predicts extinction for one, possibly two of the brood years (Lee 1993, unpublished report). Figure 4-10 shows escapement over North Fork Dam of late run coho from 1958 to 1994.

Figure 4-10. Escapement Over North Fork Dam of Late Run Coho



It is unknown, but currently under investigation (Clackamas River Working Group 1994 work plan), what the contribution of Fish Creek late run coho is to the overall population in the Clackamas River. Based on Fish Creek's position in the watershed and known spawning activity (Cramer and Merritt 1992) it is thought to be a moderately to highly significant contributor of wild late-run coho to the overall subbasin population.

During four years (from 1985 to 1989) of published reporting, coho smolt production in Fish Creek has ranged from 2,371 to 3,831. The ponds on Fish Creek have contributed from 6% to 38% of the total production in the watershed. Knowing the high survival and production rates of the coho rearing ponds, fry from late winter coho were stocked in the ponds to establish a self-sustaining population. In the late 1980's the ponds were contaminated with Bacterial Kidney Disease (BKD), and have never returned to earlier production rates.

In the past decade PNW research has documented the following life history characteristics for coho specific to Fish Creek:

- There has been no direct correlation with habitat improvement projects and increases in numbers of juvenile coho. However, it appears there has been an upward shift of survival rates of juveniles - population peaks are higher, and mortality rates have decreased. Weights of outmigrating smolts appear to be increasing.

- Over winter survival of juveniles appears to be related to timing and magnitude of first storm events. Coho use large wood-boulder complexes located along stream margins. If a large winter storm occurs prior to when habitat is accessible (before rains in the fall have recharged winter baseflow) then mortality or movement out of the watershed would be high (Reeves et al 1990).

- Coho contribute to the Oregon troll fishery, and it is believed the Clackamas River stock moves south after entering the ocean at the mouth of the Columbia River (Reeves et al. 1990).

Winter and Summer Steelhead

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

During four years of published reporting, steelhead smolt production in Fish Creek has ranged from 3,100 in 1988 to 7,600 in 1987. Estimating contribution of Fish Creek steelhead stocks to overall numbers in the Clackamas River is difficult, similar to coho. The only numbers to compare are outmigrating smolt counts at North Fork dam. In 1991 and 1992 wild winter steelhead smolt counts averaged 42,800.

In the past decade research has documented the following life history characteristics for steelhead:

- There has been no direct correlation with habitat improvement projects and increases in numbers of juvenile steelhead. However, it appears there has been an upward shift of survival rates of steelhead - population peaks are higher, and mortality rates have decreased.

- Production of steelhead smolts appears to be highly variable.

- Summer low flows may be the "bottleneck" (Reeves et al in Meehan 1991) for steelhead production. There is a strong correlation between available rearing habitat during the summer low flow period during the previous year and estimated numbers of steelhead trout smolts the following year (Reeves et al 1990).

- The number of the 1+ population is strongly correlated to the next year outmigration of steelhead smolts (Reeves et al 1990). Over winter survival ranges from 40% to 92%, and appears to be dependent on timing and magnitude of winter flow events. If habitat is available during winter storm events (if flows are adequate to allow steelhead to enter substrate outside the thalweg prior to major events), then survival appears to be greater.

Spring chinook

In the early 1900's, the Clackamas River was considered one of the best wild spring chinook producers (ODFW 1991). Since then numbers of wild fish have dramatically declined. Distribution of returning adults is fairly uniform in the upper Clackamas River (above North Fork dam).

Distribution into Fish Creek is highly variable, and appears to be dependent on flow at the mouth. When late summer baseflows are low it appears chinook are unable to access Fish Creek during their spawning period. This has led to a highly variable production in the watershed. Estimates of juvenile chinook numbers range from 0 in 1988 to 6,290 in 1987. Due to this variability little additional information about spring chinook in Fish Creek is known.

Rainbow and Cutthroat trout

Endemic cutthroat and rainbow trout are found in Fish Creek. Coastal cutthroat trout are a State Sensitive Species (ODFW 1991). They have been infrequently found in Fish Creek in the last decade, but their numbers are thought to be variable and low.

Information on distribution of rainbow and cutthroat trout in the Fish Creek watershed is poorly documented. Fish biologists are continuing to conduct presence/absence surveys to determine distribution of rainbow and cutthroat (D. Shively, pers. comm.)

Other Fish Species

Information on other fish species is a by-product of investigations of salmonids. Information is poor, and inconsistently documented. Other fish species known to exist in Fish Creek are sculpin, longnose dace, and mountain whitefish.

Bull trout were known to inhabit the Upper Clackamas as recently as 1970. Anglers have reported past "Dolly Derbies", and other anecdotal information. They are currently thought to be extinct (Kamikawa and Eberl 1991). It is unknown if they historically occupied Fish Creek.

Aquatic Insects

In 1991 a biomonitoring program was begun on the Estacada Ranger District. Objectives were to provide baseline data for long-term trend analysis of aquatic biological integrity, and to augment the Mt. Hood National Forest stream database on invertebrate communities (Benthic Invertebrate Biomonitoring 1991).

Seven streams, including Fish Creek, were sampled on the Estacada Ranger District (see summary report on file at Estacada Ranger District). Data results for Fish Creek are based on a comparison between the seven streams, and regional Environmental Protection Agency Protocols.

Fish Creek taxa are typical of lower to mid-elevation montane streams of the Pacific Northwest. No sensitive species (TES) were found. Taxa present were indicative of fair to good water quality, and taxa representative of excellent water quality were present in low numbers.

Amphibians

Limited surveys have been conducted for amphibians in Fish Creek. Cope's salamanders were found in Pick Creek. Pacific Giant salamanders have been found during fish surveys. There are no exotic species, such as bullfrogs, known to occupy Fish Creek.

Population Dynamics

Management of fish populations is the responsibility of the Oregon Department of Fish and Wildlife (ODFW). ODFW's sub-basin plan for the Clackamas sub-basin includes a determination of the "biological potential" (numbers of fish supportable under current habitat conditions), and sets "escapement goals" (numeric goals for numbers of anadromous fish returning to spawn). These goals are developed by species in the upper subbasin (above North Fork reservoir). These goals are consistent with goals set forth by the Northwest Power Planning Council, and are as follows:

Table 4-7. Anadromous Fish Escapement Goals for the Clackamas River above North Fork Reservoir

Fish Species	Biological Potential	ODFW/NWPPC Plan Escapement Goals	90/91 Escapement Over North Fork Dam
Spring Chinook	3,700	2,900	3,514/3,059
~~Late-Run~~ Coho	4,500	3,000	342/1,259
Winter Steelhead	4,300-13,000	3,000	2,107/1,352

No searun cutthroat were counted in 1990 or 1991

Escapement levels for late-run coho and winter steelhead continue to fall short of minimum escapement goals. Long term population robustness is uncertain and of concern. Reasons for these declines are well documented in the Columbia Basin, and are a combination of fish harvest, impacts of hatchery stocks, reduced habitat quality and effects of hydroelectric facilities.

The Clackamas River Working Group of fish biologists made a preliminary estimate of which factors are most impacting fish stocks of concern on the Clackamas River (Information and Action Priorities for Managing and Restoring Clackamas River Salmonids 1993). Their findings were:

- Late-run coho are most impacted by commercial harvest levels.
- Steelhead are most impacted by hatchery effects, potential harvest of juveniles and overall declines in habitat quality.

Habitat Conditions, Connectivity and Fragmentation

Habitat conditions are described beginning with general historical information, and then comparing current habitat conditions to planning goals and desired conditions.

A variety of physical processes affect fish habitat. A few components important to species in Fish Creek are:

- Riparian vegetation and instream large woody material provide organic matter, shade, nutrient storage, low velocity areas, microhabitat, structure to scour pools and provide cover.

- Distribution of aquatic organisms is usually determined by habitat type. Side channels, ponds and low velocity riffles provide habitat for post-emergent fry. Pools provide habitat for salmon. In general, older age cutthroat trout are found in pools, and shallow riffles are occupied by young-of-year trout.

- Winter high flows often limit salmon production. Important winter habitat components are roughness elements such as boulders and large wood, and floodplains and other off-channel habitat areas. These provide low velocity and off channel habitats.

- Summer high temperatures can stress or kill fish.

An aerial photo analysis comparing historic (1946) photos against current (1992) photos in Fish Creek shows a simplification of channel sinuosity, and it appears downcutting in channels has decreased interaction of the stream channel with the historic floodplain (see discussion in Sediment and Water Clarity Section). This has resulted in a loss of fish habitat for overwintering fish during high flows. Since overwintering habitat is often a "bottleneck" for survival of juvenile salmonids, it could be limiting production (Reeves et al 1991).

Vigorous wood debris removal followed the 1964-65 floods to reduce hazards to bridges and culverts and improve access for adult salmon migration (a practice later determined to be detrimental to fish habitat). This resulted in further habitat simplification (Reeves et al 1990).

Aggressive restoration of habitat structure occurred in Fish Creek in the 1980's. By 1988 over 40% of the length of Fish Creek had been treated with some sort of habitat restoration. Some have met habitat restoration objectives (such as restoring pools to near pre-1964 conditions), and others, such as alcoves and cross channel boulder berms have not been as successful. These efforts are well documented in the PNW reports.

Current habitat conditions are measured by pools per mile and large woody debris per mile (Mt. Hood Forest Plan 1990 FW-095 and FW-094). Another regional guide, the Columbia River Policy Implementation Guide/Salmon Summit (PIG 1991), also sets goals for habitat conditions. Some of those relevant to aquatic ecosystems in Fish Creek are discussed in Table 4-8.

Table 4-8. Desired and Current Conditions for Aquatic Processes and Functions in Fish Creek

Parameter	Current Condition				
	Desired Condition	Fish Creek	Wash Creek	Pick Creek	Roaring River*
In-channel Large Woody Debris	minimum length 50'; 80 pieces/mi	252**	311**	166	68
Pools	minimum 28 primary pools/mi	12	8.2	N/A	7.7
Stream Temperature	not to exceed 58 degrees	70 - 74	59	N/A	53
Aquatic Insects	3 sediment sensitive species present	Appears not to meet.			

** Roaring River is an nearby unroaded watershed with somewhat similar characteristics as Fish Creek.*

*** Large woody debris dimensions do not correspond directly with Mt. Hood Forest Plan Standards and Guidelines.*

None of the sampled reaches in Fish Creek meet standards for pool depth or frequency. Large wood rates appear to meet standards in Pick Creek. Overall, habitat conditions in Fish Creek have been improving since the restoration project began in the 1980's but as yet do not meet standards and guidelines.

Stream surveys have not indicated an excessive amount of fine sediment. As noted in the hydrology report, as Fish Creek and feeder tributaries were subjected to debris flows or had large woody debris removed, storage capacity for fine sediments was reduced. As structure has been returned to Fish Creek there has been increases in retention of finer sediments. There do not appear to be any limiting factors regarding amount of spawning gravel availability.

Overall riparian connectivity is also an important component of fish habitat. Riparian habitat connectivity is discussed in Fish Creek for floodplains, localized disturbance (such as culverts), and connectivity of late seral stands. Downcutting and channel simplification in mainstem Fish Creek has decreased overall channel connectivity with floodplains (see channel morphology section). Culverts have been inventoried for fish passage, and on Third Creek and Pick Creek impassable culverts were replaced. There are other culverts blocking passage (such as on Music Creek and Rimrock Creek) that are decreasing riparian connectivity. Connectivity of late seral stands along the mainstem of Fish Creek is high on the west side of the stream, although the integrity of the riparian area is punctured by several clearcuts with boundaries next to the stream . The east side of Fish Creek is bordered by a road; and habitat fragmentation is high.

Effects of Physical Processes on Fish and Aquatic Insects

Physical processes discussions are restricted only to those that appear to be affecting aquatic habitat and populations. The management related debris flows described in the hillslope processes section have accelerated delivery rates of large wood, boulders and fines to stream channels. These debris flows have traveled 1/4 mile to 1 1/2 miles, many intersecting or traveling in fish bearing streams. In upper tributaries there are major deposits of large wood where these flows stopped. Channels altered by debris flows are often scoured to bedrock, and channel roughness has been simplified and have lost storage capacity of sediment and nutrients. Debris flows are also a source of large woody debris, but aggressive stream cleaning following the 1964-65 floods, left little in fish bearing streams. More localized debris flows have large debris jams still intact.

Peakflows continue to shape and modify channel geomorphology. The hydrology section discusses the probable increase in peakflows. This has a direct effect on fish in Fish Creek, since over winter survival appears to be directly linked with onset and magnitude of winter flows (Reeves et al 1990). Trends indicate peakflows have increased, and if these increases appear early in the winter storm season it has a direct negative affect on fish survival.

Large woody debris recruitment potential to streams has sharply declined since forest management began in the 1940's. This will continue to have a long term negative affect on fish habitat until existing stands reach a size to once again contribute a stable large wood supply.

Another effect of the intensive timber removal along streams has been the increase in temperatures. Water temperature is a determining factor in the composition and productivity of aquatic ecosystems. Of streams monitored in the Clackamas River subbasin, Fish Creek has highest average daily summer temperatures. It also has the greatest diurnal temperature fluctuations. Steelhead are probably the most sensitive to increased water temperatures. Summer low flow conditions are directly correlated with steelhead production (Reevest et al 1990).

Peak summer water temperatures appear to be affecting composition of aquatic macrointervebrate communities. It appears to be affecting community diversity, as a Trichoptera taxa is dominating community composition. Nutrient enrichment (from warm summer temperatures) and loss of retention of coarse organic matter may be changing functional feeding groups. Functional feeding groups appear to have shifted from shredders to collector-gatherers.

Low flows appear to be affecting stream carrying capacity of Fish Creek. With potentially decreased summer low flows, overall production has been reduced for steelhead. Access to margin microhabitat, a critical habitat need of juvenile coho, is also reduced during summer low flows. Low flows can also exacerbate stream temperature highs.

Low summer flows appear to be affecting the ability of migrating spring chinook to enter Fish Creek.

Changes in channel morphology and loss of floodplain connectivity would most affect overall channel complexity, and survival of fish during storm events.

Lakes, Springs and Wetlands

There are two lakes in the Fish Creek watershed, Surprise and Skookum. Skookum Lake is three acres in size, and is stocked with brook trout. Surprise Lake is five acres in size, and is stocked with brook trout. Both are popular recreation sites. Seeps, springs and wetlands are described in the "special habitat" section of the Terrestrial section. More detailed discussion of current conditions such as water chemistry for Surprise and Skookum Lakes is found in Appendix A.

Social

Prehistoric

Knowledge of prehistoric use within the Fish Creek drainage is somewhat limited. Several archaeological sites have been located within the watershed, but none have been evaluated to provide specific data on earliest occupancy. Other sites within the Clackamas Subbasin have been evaluated as dating back 7000- 8000 years.

Several prehistoric sites found within the watershed indicate that it was used by prehistoric peoples, especially the area along lower Fish Creek. These were likely places where native peoples stopped or camped for a limited time during their seasonal rounds. Key uses identified within the Fish Creek watershed include: gathering areas near the mouth of Fish Creek and at its confluence with Wash Creek (cedar bark was collected for clothing, storage containers and cordage, along with medicinal herbs), a fishing and camping corridor along lower Fish Creek, and a number of possible travel routes.

Heaviest use probably occurred near the mouth of Fish Creek at its confluence with a major anadromous fish bearing river, the Clackamas. The lower elevation and perhaps milder climate, along with the availability of resources may have contributed to stays of longer duration than in other parts of the watershed. Huckleberries were also an important dietary staple and are found at higher elevations within the Fish Creek drainage, although not in great abundance.

Historic

A 1916 Oregon National Forest map indicates a trail system already in place running in an east/west direction, crossing the watershed close to the confluence of Fish and Wash Creeks. This was part of a much larger trail system providing a travel route between the Willamette Valley and the upper Clackamas River and beyond. Trails were also in existence along the ridge systems bounding the drainage headwaters. Previous use of these ridge systems as travelways by native peoples is evidenced by sites located in scattered locations along their route.

Following the turn of the century and establishment of the National Forest system, fire protection and improved access to contain wildfires led to the establishment of remote "Ranger Stations" for fire and small work crews, along with fire lookouts on major peaks throughout the forest. Small work crews were needed for the development of a more extensive trail network and maintenance of telephone lines connecting the lookouts with the outside world. The lookouts which bordered the Fish Creek drainage were Fish Creek Mountain, existing from 1915 to 1963, Baty Butte 1914-1950, Thunder Mountain 1929-1967, and South Fork Mountain 1931-1960. There was also a Ranger Station at Baty Butte and one at Cold Springs on the ridge system between South Fork Mountain and Baty Butte.

Roads

Road construction in the Fish Creek drainage began in the mid 1940's. At that time roads were constructed into the lower reaches of the drainage near the confluence of Fish Creek and the Clackamas River, and then on to the broad upland benches occurring on the mid slope positions in the eastern portion of the watershed. The road entering the drainage traveled through and adjacent to Fish Creek, breaching the integrity of the established flood plain.

During the mid 1950's several new mainline roads, constructed as single lane aggregate surfaced features, were placed in the drainage. By 1960 the eastern portion of Fish Creek drainage had a well developed mainline system providing access to the headwaters of Fish Creek. The first roads were being placed on the west side of the drainage, providing access to the mid slope benches in that area.

Table 4-9. Road Development Through Time

Surface Type	1940 - 1960		1960 - 1980		1980 - 1994		
	New (miles)	Reconstruct (miles)	New (miles)	Reconstruct (miles)	New (miles)	Reconstruct Road (miles)	Current Roads
Native	1.9	0	11.1	0	.4	0	13.4
Aggregate	31.0	0	84.4	0	8.4	0	101.5
Paved	0	0	2.4	19.7	0	2.5	24.6
Total	32.9	0	97.9	19.7	8.8	2.5	139.5

The greatest level of road construction activity in the drainage occurred during the time period between 1960 and 1980. During this period an additional 53 miles of aggregate surface road had been constructed, providing access into the headwaters of Wash, Pick, and Fall Creeks, and the entire western part of Fish Creek drainage. New construction in this time period occurred on the steepest, unstable portions of the 5430 road.

By the end of the 1980's the road system in the watershed was extensive, with 130 total road miles creating a road density of 2.8 miles per square mile. Road densities in the watershed are not uniformly distributed. Highest road densities occur east of the main stem of Fish Creek.

Presently, there are 139.5 total existing road miles in the drainage with a road density of 3.1 miles per square mile. Miles of aggregate surface roads comprises 73 % of the total, while native surface roads comprise 10 % of the total road mileage.

Timber Harvest

The first timber harvest within the Fish Creek drainage began in 1944, to provide a quick source of lumber during World War II. The earliest harvest units were located near the mouth of Fish Creek and were sold to the Dwyer Lumber Company. Robert Dwyer established a small airstrip, at about the 1000 foot level southeast of the mouth of Fish Creek, to provide a landing area for his small airplane. By 1946 the Dwyer Lumber Company had established a logging camp with at least three large buildings slightly upstream from the mouth of Fish Creek.

The earliest harvest activities in the watershed were confined to the lower portions of the drainage along Fish Creek and on the steeper valley sides. Harvest levels increased in the 1950's in the Upper and Lower Fish Creek subwatersheds, with timber removal located on the hummocky terrain of ancient landslide benches and on the steeper valley side walls of Fish Creek canyon. By the beginning of 1960, harvest on 2,000 acres had yielded approximately 133.2 MMBF of timber (Table 4-9).

Harvesting rates accelerated during the next 20 years, an additional 6,720 acres of harvest occurred from 1960 through 1980 in the drainage. During this twenty year period harvesting took place in all seven subwatersheds. Over 420.2 MMBF of volume was removed in this twenty year period.

Table 4-10. Historical Timber Harvest

	1940 - 1960	1960 - 1980	1980 - 1994	Total
Harvest (acres)	2,036	6,720	3,530	12,286
Estimated Volume (net MMBF)	133,238	420,222	204,278*	757,738

**Includes only the period from 1980 through 1989.*

Harvest levels remained high from 1980 through 1993, occurring mostly in the first decade of the period. From 1990 to the present approximately 430 acres of harvest occurred in the watershed. The remaining 3,100 acres of harvest for the most recent period occurred during the 1980's. Timber harvest, predominantly by clearcutting, has occurred over 41% of the watershed (12,200 out of 29,782 acres).

Special Forest Products

The history of special forest products use coincides with development of access into the Fish Creek drainage. Historically, there has been firewood collection, Christmas tree harvest and harvest of cedar for shakes and bolts.

In recent years there has been increased harvest of ditchside alder and vine maple for furniture and crafts, upland alder and vine maple, beargrass in higher elevations, and sites for bee hives. Overall, mushroom harvest activity has been low in the watershed.

Recreation Use

The general pattern of recreation in the Fish Creek watershed is based upon landscape characteristics and management direction. Fundamental factors include proximity to Portland and surrounding communities, low elevation, topography, management direction in the Forest Plan, and roaded access. Fish Creek is located in close proximity to the Forest boundary and is within a shorter driving time than watersheds further upriver and receives a comparatively high level of human use. Recreation activities in the watershed include dispersed camping, trails along the watershed divide, fishing and camping at backcountry lakes, hunting, pleasure driving, limited mountain bike activity, dispersed off highway vehicle activity, and limited environmental education.

The pattern of dispersed camping within the Fish Creek watershed is a reflection of the general pattern found within the larger Clackamas drainage. Flat areas near water with easy access are a preferred setting during the warm weather recreation season and a concentration of dispersed campsites are found along the Fish Creek corridor.

A 1993 study revealed 22 dispersed campsites along Fish Creek's mainstem from the confluence of the Clackamas River to the confluence of Wash Creek. An additional 6 sites are located at or near the Wash Creek confluence. While some changes in the distribution of sites has occurred since the 1977 data collection (due to agency blocking of sites with berms and boulders or site development) the number and pattern of sites is roughly consistent in 1994 A total of 4 acres are impacted by dispersed camping. In addition to the dispersed campsites, Wards Camp is a former industrial camp cleared by the Forest Service and now converted by users to a dispersed campground. Additional information on dispersed camping is in Appendix A.

Biological and physical recreation use are of concern. As noted earlier, compaction, vegetation and sensitive species (such as Harlequin ducks) disturbance, and degraded (and potentially harmful contamination) from human feces are a few of the concerns.

A limited amount of environmental education and interpretation occurs along the mainstem of Fish Creek. School classes and biologists visit a number of sites along the creek to view fish structures and monitoring sites. Three bulletin boards placed along the creek provide messages about fish and fish habitat.

Dispersed camping also occurs in the watershed at the backcountry lakes. Skookum and Surprise lakes offer fishing opportunities. The campsites at Surprise Lake have roaded access and are available to RVs. The designated campsite at Skookum Lake is a walk-in site but a fire ring also exists at the trailhead parking area. Surprise and Skookum Lakes could also be considered "special places" as defined in the Forest Plan.

During the fall hunting season, the pattern of use disperses more broadly throughout the watershed to upland sites along roads and timber sale landings. There are no reported "special place" hunting camps. Desired settings for fall hunting camps does not appear to be contingent upon a wooded or scenic setting but is dependent upon flat areas, roads, and open stands.

There is only one developed recreation facility in the watershed, the Fish Creek Barrier Free Fishing Pier. Located at the confluence of Fish Creek and the Clackamas River, the pier is visible from HWY 224 and serves as an attraction drawing visitors to the watershed. Constructed in 1990, the pier receives a high level of use and a comparatively low level of vandalism. The pier meets requirements of the American with Disability Act (1992). The pier parking lot also serves as the trailhead for the Clackamas River Trail and as a staging area for river events.

Four and one half miles of trail are either located in or accessed through the Fish Creek watershed. These include:

Trail 541	Fish Creek Mountain, 2.0 miles
Trail 542	Skookum Lake, 1.0 miles
Trail 543	Thunder Mountain, 1.0 miles
Trail 545	Baty Butte, 0.5 miles

The Clackamas River Trailhead is located at the Fish Creek Pier. The proposed Urban Link Trail would cross a portion of the watershed at its confluence with the Clackamas River.

The Fish Creek watershed has minimal current use by mountain bikes and has only marginal potential for development.

Off-highway vehicle (OHV) use occurs in Fish Creek. A study is underway to develop OHV sites, accessed through Fish Creek, near Whale's Head.

Hunting and Trapping

Current recreational trapping activities in the watershed are very low.

Deer, elk and ruffed grouse populations have increased over the last 4 decades due primarily to intensive timber harvest and broadcast burning. Recreational hunting pressure is long-standing and consistent in the watershed, but minor in relationship to other parts of the subbasin.

Cougar populations are relatively high and receive notable harvest pressure by hound hunters (see Appendix A).

Fishing

Prior to 1989 Fish Creek was open to sport angling. Closure to fishing was instituted in 1989 to decrease the effects of angling on the research project in mainstem Fish Creek and Wash Creek.

Lakes are still open to fishing. Both Surprise and Skookum Lakes are stocked with brook trout.

Chapter 5 – Condition Trends

Chapter 5 continues the discussion the trend in processes and conditions analyzed and discussed in Chapter 4, and then relates them to future land management actions. This chapter builds on the knowledge of management effects on processes and impact mechanisms discovered in Chapter 4 to predict likely future condition trends. The scenario for management actions in the watershed is derived from land allocation objectives and standard and guidelines provided in the Mt. Hood Forest Plan and the President's Plan. Based on land allocations in Table 1-1, future management emphasis in Fish Creek is envisioned to be:

- reduced levels of timber harvest with emphasis on thinning rather than regeneration harvest,
- an increase in levels of recreational use, and
- restoration will reduce the effects of roads on hydrologic and hillslope processes.

The impacts of past management, future management possibilities and restoration activities are considered in discussing rates of recovery for processes and ecosystem components in the watershed. A specific time frame has not been identified as a basis for discussion of recovery processes.

Terrestrial System

Vegetation and Landscape Pattern

The trend for vegetative changes over the last century and into the future is characterized by the shifts in quantity, quality, and distribution of seral stages. Table 5-1 characterizes the landscape pattern and role of late seral vegetation over three time periods:

- late 19th Century,
- late 20th Century (management created current condition), and
- late 21st Century (projected).

In the future, current management direction (The President's Forest Plan and the Mt. Hood Forest Plan) will lead to increased connectivity of mature forest throughout the watershed. Interim riparian reserves and late successional reserve areas make up 49% of the watershed. This does not include riparian reserves in unstable areas. Achievement of this late seral condition will take time. Currently, 36% of the interim riparian reserve system is in an early seral stage and a large proportion of the late successional reserves (especially Clackamas River Corridor LSR in lower Fish Creek) are early or mid seral.

Wildlife

Biological Diversity

Given the emphasis of current management direction toward ecosystem management, two observations are offered regarding trends of total species richness. The total number of native species is expected to stay stable or slightly increase, i.e. no species currently present are expected to be lost (the closest exception might be wolverine) and one or two species might successfully be re-established in the Fish Creek ecosystem, e.g. peregrine falcon, fisher, or western pond turtle. The total number of exotic species is expected to stay stable or increase; for example, the aggressive noxious weed prevention and control program envisioned for the future will likely limit or reduce numbers of individuals of a species, but will not likely successfully eradicate the species from the ecosystem. Some additional exotic invertebrates may be introduced as noxious weed control agents.

Table 5-1. Landscape Pattern Trends

	Late 19th Century	Late 20th Century	Late 21st Century*
Processes Affecting Landscape Pattern	• Fire infrequent (predom. stand replacement) • Small pockets of insects, disease, windthrow	• Aggressive clearcut timber harvest • Road construction • Fire suppression • Increased windthrow due to clearcut edges	• Reduced levels of regen. harvest • Reduced roading • Fire suppression • Managed fire • Less windthrow due to: less edge & no harvest in windthrow prone NE part of drainage
Landscape Pattern	• Younger forest on ridgetops • Late seral on lower and mid-slopes • Connectivity of mature forest • Snags and remnant green trees in openings	• Increased edge, with high contrast • Less interior habitat • Fragmentation of mature forest matrix, loss of connectivity and isolation of mature forest blocks • Incr. patchiness, patches smaller and more uniform • Early seral above RNC • Few snags or remnant trees in openings	• Late seral in riparian reserves and some ridgetops • Some larger openings on ridgetops and upper slopes • Younger forest interspersed between late seral network • Snags and remnant green trees in openings
Late Seral Role of Fish Creek	• Large block of late seral habitat within watershed	• Heavily fragmented late seral habitat (both within Fish Creek and the surrounding watersheds)	• Some surrounding watersheds with late seral in large blocks
Spotted Owl	• 100% of biological potential	• 10 activity centers 5 below "take" thresholds	• Dispersal habitat
Snags, Down Wood	• Plentiful • 100% of biological potential of dependent species	• Aggressive salvage • Substantially reduced	• Mitigation level • 60% of biological potential of dependent species

**NOTE: The projection to the latter decades of the 21st Century assumes complete implementation of Forest Plan/President's Plan with emphasis on timber production whenever possible.*

The standards and guidelines of the President's Plan ROD are projected to maintain the viability of riparian habitat associated T,E and S species in the future (see Chapter 3, Terrestrial). Habitat quality for these species is believed to presently be at a low point due to past timber harvest activities in the riparian zone. If the assumption is true that these species currently have adequate populations and distribution to maintain viability, habitat and viability should be on the incline in the future. The improvement should be slow but steady as riparian habitat is restored.

Of the wildlife life history guilds described in Appendix A and Analysis File, one (TSMM) is recognized as having no habitat available currently in the watershed. Two guilds (TMPE and TSME) currently have a very low quantity of habitat in the watershed. Habitat for TSMM (terrestrial, small home range, mosaic and mid-seral) is projected to increase in the near future due to implementation of current management direction. TMPE (terrestrial, moderate home range, patch, early seral) and TSME (terrestrial, small home range, mosaic and early seral) are projected to decrease even further in the near future due to decreased creation of early seral habitat by timber harvest activities.

One guild (TLML) associated with large home ranges and late seral habitat is projected to decline in the future within the watershed. This guild includes spotted owl, pileated woodpecker, northern goshawk, American marten, fisher, California wolverine, and barred owl. Although, habitat for the TLML guild will expectedly decline in the future within Fish Creek Watershed due to land allocations in the President's Plan, habitat for these species should markedly increase within designated LSRs. Dispersal habitat for this guild amongst LSRs is still a concern and warrants further analysis at the Subbasin scale.

Other late seral guilds (TMML and TSPL) should not be a concern regarding available landscape patterns, given current management direction. TMML (with a moderate home range size) should respond well to the LSRs, spotted owl areas (unmapped 100 acres LSRs), and riparian reserves. However, TMML (black-backed woodpecker and three-toed woodpecker) are also snag associates (primary cavity nesters) - a habitat structure that is currently in limited supply. Snags, currently in reduced numbers due to past timber management activities (see Appendix A) should gradually increase in availability within mid and late seral habitat. TSPL (with a small home range) may continue to experience a decline within non LSR or riparian reserve lands as the President's Plan is implemented. However, adequate habitat should be provided for this guild (including northern flying squirrel and red tree vole) via LSR and riparian reserve land allocations.

Conditions for guilds associated with wetlands and wet areas (e.g. headwall seeps and springs) should improve in the future; wet areas disturbed by timber harvest and road building should gradually recover and provide high quality habitat in the future. Special habitat values associated with rock outcrops, talus slopes, and waterfalls are expected to remain fairly stable and not undergo any significant change in the future. Highly limited special habitat conditions associated with bridges (especially log stringer bridges) will likely remain fairly stable, but gradually decline as abandoned bridge structures decay and deteriorate.

Coarse woody debris (CWD) obligate and associate species, typically generalists as a group, are projected to gradually recover from the current low point in available habitat (associated with the preponderance of early seral forest with minimal or no CWD present in the watershed). However, the 3 groupings of CWD associates with specialized habitat needs (see Appendix A, Biological Diversity discussion) are all projected to experience further declines in the future within the watershed:

- **Primary cavity nesters requiring snags in late seral habitat** should hold steady for awhile; when regeneration timber harvest is implemented outside of riparian reserves and LSRs habitat availability for this group of species will decline directly proportionate to the amount of timber harvest activities completed. Standards and guidelines for retaining CWD in harvest areas should help mitigate these projected impacts, however, habitat quantity and quality for this group of species will still decrease.

- **Secondary cavity nesters requiring snags in early seral habitat** are projected to continue at a substantially depressed level due to the high percentage of the watershed in early seral habitat with minimal snag habitat. As regeneration timber harvest occurs, if snag management prescriptions are successfully implemented, limited habitat may become available for these species.

- **Secondary cavity nesters using snags in late seral habitat** should follow a similar scenario as described above for primary cavity nesters requiring snags in late seral habitat.

Data and analyses, to determine if continued low quantities of habitat for some snag obligate species on localized portions of their respective ranges has an effect on the species or population viability, are not available. Therefore, the ecosystem processes risk identified here is not one of species or population viability for these species; the risk instead is one of these species not playing a fully functional role in the watershed ecosystem. For example, the invertebrate prey items (e.g. Douglas-fir bark beetle and spruce bud worm) of snag associated species do not have the "check and balance" benefit of the predator population. The consequence of this kind of missing piece in the ecosystem puzzle is not well understood, however, a risk to ecosystem processes should be expected. A possible trend (conjecture only) is for the prey items to locally increase populations (i.e. higher population peaks than would typically occur in inherently cyclic populations), and in the case of tree feeding species, kill more trees and create more snags which would then increase the population of the predator. Once the habitat was again available for the predator populations to re-establish, the prey population cycles would again be moderated. See Chapter 7, Information Needs.

Under current management direction and projected increased recreation demands on the Forest, habitat quality for most species sensitive to human presence is expected to continue to decline. Two species, perhaps more directly sensitive to human presence than others (i.e. grizzly bear and gray wolf), which were extirpated in the last century as members and processes of the ecosystem, are not expected to be re-established as pieces of the ecosystem puzzle. Trends associated with continued deterioration of habitat for species sensitive to human presence are two fold:

- decreased role of species as fully functioning members of the ecosystem, e.g. imbalances in the predator-prey relationships processes, and
- possible extirpation of species.

The greatest likelihood of the latter trend is the possibility of losing another carnivore from high in the food chain - wolverine.

Spotted Owl

Northern spotted owl habitat is expected to continue to decline within the watershed - both in nesting habitat quality and dispersal habitat quality. As current land allocation prescriptions are implemented and timber harvest occurs outside of LSRs (mapped and unmapped) and riparian reserves, nesting habitat will decline. Authorization for "incidental take" of spotted owl pairs from the USDI-Fish and Wildlife Service will be necessary. Dispersal habitat will decline associated with timber harvest of existing mid and late seral habitat; dispersal habitat will gradually increase in quality within existing early and mid seral habitat as forest stands grow. Recovery of forests within riparian reserves will gradually increase long term dispersal habitat (i.e. unlike upslope areas, riparian reserves will not undergo programmed timber harvest episodes in the future). The temporal and spatial distribution of decreases and increases in dispersal habitat quality for spotted owls will be directly related to timber harvest practices (currently an unknown).

Although the viability of each of the ten spotted owl pairs in the watershed is projected to decline in the future, these pairs are not considered necessary to assure continued viability of the species as a whole in the President's Forest Plan.

Pileated Woodpecker and Pine Marten

Habitat for Forest Plan management indicator species, pileated woodpecker and pine marten, will decline outside of LSRs and riparian reserves directly related to timber harvest practices. Habitat for these 2 species will gradually increase due to successional progression within existing early and late seral habitat. Dependent upon the rate at which timber harvest practices are implemented in the future, dispersal habitat for these species may become substantially weak in the southern portion of the watershed - particularly in the portions of the watershed where Forest Plan B5 management areas were located.

Late Seral

Given current management direction, the distribution and condition of late seral habitat will undergo substantial change in the future as described in Table 5-1. Late Seral (LS) habitat will be extensive throughout the watershed, but distributed as long slender corridors along streams - as compared to the large contiguous block of the late 19th century or the fragmented blocks of the current condition (see Chapter 4 and Appendix A, Terrestrial). Projections of trends assumes timber management activities will be practiced to the full extent allowed by current management direction.

Of the existing late seral habitat (13,219 acres, 46% of the watershed), approximately 7,300 acres (approximately 25% of the watershed) will be retained as late seral habitat, based on current land allocations. The land allocations provide for as much as approximately 14,200 acres (49% of the watershed) to be managed as late seral habitat in the future (whether or not they are currently in a late seral condition).

Each LS block (as described in Appendix A) will gradually undergo changes based on the current seral mix, the extent of riparian reserve or LSR present and the feasibility of timber harvest. See the Analysis file for estimates of each LS block (Map 4-6) which will remain as late seral habitat based on land allocations present. Table 5-2 is a generalized summary of which existing LS blocks will remain (or become) contiguous blocks of late seral habitat in the future.

Table 5-2. Existing late seral blocks (as described in Chapter 4 and Appendix A) which will be retained or not retained in the future, based on projected implementation of current land allocations.

LS Block	Land Allocation	Retained (Yes or No)*
1	LSR	Yes
2	B6	No
3	B6 & B8	No
4	B6	No
5	LSR & B6	Yes & No
6	B6	No
7	B6	No
8	B6	No
9	B6	No
10	B6	No
11	B6	No
12	B6	No
13	B6	No
14	B6	No
15	B6	No
16	B6	No
17	B6, B12 & A9	Mostly No

** Riparian Reserve corridors within LS blocks will be managed for a high percentage of late seral habitat conditions. See Analysis file for acreage estimates for each LS block.*

LSOGS

Given current land allocations in existing management direction, only a small portion of the inventoried Late Successional Old Growth (LSOG) stands identified within the watershed will be retained in the future (see Appendix A and the Analysis file for LSOG description and map). The small portions are those which are designated as Riparian Reserves or Late Successional Reserves (see Chapter 4 and Appendix A, Terrestrial).

Interior Habitat

It is difficult to predict future trends in the distribution of interior habitat within the drainage. See Map 4-6 for existing distribution of interior habitat. Over the long-term, the largest block of interior habitat will be found in the LSR in lower Fish Creek. There is currently very little interior habitat in this area. Portions of existing areas of interior habitat within the watershed will be retained in riparian reserves. However, the interior quality of many of these areas will be lost where harvest takes place in upslope areas between reserves.

Risk of Disturbance

Over the long-term, as the amount of edge in the watershed decreases there will be less risk of windthrow. The portion of the watershed most prone to windthrow is in the northeast portion of the drainage. Some of this area will be in a late successional reserve, where future lack of created openings will lead to a decrease in windthrow.

Future risk of fire in the drainage needs further assessment. A preliminary assessment of fire risk and fuel loadings can be found in the Analysis File. Fire suppression activities will continue in the drainage, and fire will be suppressed within the late successional reserves until fire management plans for the areas have been completed. There is possible risk of stand replacement fires in some plantations containing untreated fuels and in some blowdown areas within riparian reserves. These areas need further examination.

Aquatic System (including Hillslope and Hydrologic Processes)

Hillslope Processes

Sediment Delivery to the Aquatic System

Several sources and processes will continue to deliver sediment to streams in the Fish Creek drainage including:

- Natural slope forming processes of soil creep, surface erosion and mass wasting.
- Elevated rates of surface erosion and mass wasting from past management activities of timber harvest, road construction and recreational disturbances.
- Disturbances associated with future management activities.

Future management actions on the large ancient landslide deposits will not result in the initiation of earthflow processes.

Sediment delivered from logging disturbances within harvested areas in the last five years will diminish as vegetative recovery processes occur and ground cover is re-established. The most recent clearcut harvest units in Fish Creek have three years of recovery.

Disturbances at dispersed use recreational sites will continue to be a potential sediment source. Future increases in dispersed recreation use will create new disturbances with potential to deliver sediment. Restoration projects will be designed to treat areas that threaten water quality.

Within the sampled areas, for the period from 1980 through 1989, nineteen separate mass wasting events were noted. Material delivered to stream channel side slopes from these events may continue to ravel and deliver sediment to local streams in the future.

Vegetative succession in harvested areas will promote recovery of slope stability. Data collected with the aerial photo inventory indicated that, as harvested sites revegetate, mass wasting rates begin to return to natural levels. Although field verification is needed, after 20 years significant recovery has taken place on fully vegetated harvest areas. These areas may still be susceptible to the destabilizing forces associated with high intensity rain on snow type events. Over 580 acres of clearcut harvest on high risk lands for debris flow and other landslide events are less than 20 years of age.

The direction of current land management plans secondarily emphasizes timber harvest in Fish Creek drainage. Disturbances resulting from harvest activities will be significantly less than in the past. As a Key Watershed, road construction within Fish Creek will be expected to meet the requirements of the Aquatic Conservation Strategy. If new road construction is necessary roads will be designed to have a low sediment delivery potential and will not be located in landscape positions that have a high slope instability risk.

Site specific evaluations of slope stability factors and the determination of riparian reserve boundaries necessary to protect unstable lands will reduce the incidence of mass wasting associated with any future harvest.

Implementation of direction to reduce total road mileage in Key Watersheds, provide for erosion control and stabilize road drainage should result in lower sediment delivery rates from roads.

Hydrologic Function

Peakflow

Currently, peakflow events appear to be larger than what occurred naturally and historically, particularly for the 2-year and 5-year return interval events.

As vegetative succession occurs, and early seral stands grow to mid-seral stages there will be a reduction of peakflows associated with timber harvest. As forest stands reach 40 years of age the effects of clearcuts on peakflows are greatly reduced. Rates of recovery are dependent on site quality and species composition.

The effects of roads on peakflows will be more permanent. Roads have increased stream densities 11 to 28 percent in Fish Creek, increasing the efficiency of routing water into stream channels. As identified in the Aquatic Conservation Strategy there will be no net increases in road miles, so there are no expected additional increases in peakflows over current conditions. Reductions of effects of roads on peakflows will occur only when roads are decommissioned or "put to bed" and natural subsurface routing of water is resumed.

Baseflow

Baseflow appears to have been reduced as timber harvest removed old growth forests (late seral) from riparian areas, and these riparian stands were replaced with alder and other deciduous species. The magnitude of daily changes in summer baseflow between day and night appears to be correlated with large amount of deciduous streamside vegetation in the watershed. As more of these deciduous stands are converted to conifer stands there should be a slight increase in summer baseflows and a reduction in the magnitude of these diurnal fluctuations.

Reductions in summer baseflows appear also to have been influenced by a reduction in in-channel and floodplain detention storage, due to channel scour and floodplain abandonment. Introductions of large wood and restoration of the natural processes of large wood recruitment will result in localized aggradation of channel sediments and reconnection of floodplains. Most likely the current streambed elevation and location represent a relatively permanent change in channel morphology. In many locations former floodplains will remain separated from the stream channels and floodplain interactions will remain disrupted. Baseflows will approximate current conditions.

Water Quality (Clarity and Stream Temperature)

Water clarity for Fish Creek is high. As restoration activities proceed, water clarity should remain high. If roads begin to fail as a result of reduced maintenance, and road decommissioning is not implemented, chronic erosion, sediment, and water clarity problems would likely occur.

Recovery of stream temperature is dependent on revegetation of streambanks lacking adequate vegetation, decreasing stream width along the mainstem Fish Creek, and increasing the depth of pools. As stream width is decreased through placement of large wood and natural recruitment, and the thalweg (main channel) is deepened, solar input is reduced, thus reducing stream temperatures. This is important for the mainstem of Fish Creek, since the orientation of the stream maximizes the period of solar exposure.

With 3 percent of the riparian reserve area in lower Fish Creek impacted by dispersed recreation sites (camping, day use, etc.) the risk to water quality due to compaction, erosion, and sanitation will likely increase as a result of increased public use.

Channel Morphology and Structure

As the magnitude of peakflows in the two to five year return interval decrease, channel changes will be slower than previously observed. Scoured reaches would be expected to aggrade somewhat and some abandoned floodplains and side channels may be restored to former function during more natural peakflow regimes.

Structural inputs are from large wood and coarse and fine sediments. As riparian vegetation matures into mid- and late seral stages, there is a corresponding increase in potential inputs of large wood into stream channels. Although the change will be gradual, there will be a slow recovery of historic pool volume and frequency as large wood falls into stream channels.

Fine sediments may have a greater rate of retention as structure and roughness elements associated with large wood occurs.

Coarse sediment inputs are generated by mass wasting events. As the Aquatic Conservation Strategy is implemented, rates of mass wasting are predicted to gradually return toward pre-management levels. There should be a decrease in inputs of large cobbles, boulders and large wood associated with the events. Since large wood is an essential (and lacking) riparian structure in the Fish Creek landscape recovery of mid and late seral stages along streamsides is important.

Aquatic Biota

Fish

Two salmonid populations, late run winter coho and native winter steelhead, are in decline. One of the three brood years of the late run winter coho are modeled to go extinct in the next fifty years. The rate of decline for native winter steelhead populations is not known at this time.

Habitat carrying capacity for anadromous (sea going) fish is also expected to change. As hydrologic systems return towards the range of natural variability (i.e. 2-5 year peakflow frequency is reduced and summer low flows increase), there will be corresponding changes in fish habitat. The changes in peakflow should reduce stress and flood related mortality of juvenile, overwintering fish. As summer baseflows increase there should be an increase of carrying capacity for salmonids.

Recovery of riparian areas and potential large woody debris input will have a net benefit on fish habitat. As identified in the hillslope processes section, short term instability may still result in inputs of large wood and coarse and fine substrates. As large woody debris input and retention returns to natural ranges, finer substrates should be retained in aquatic systems. Habitat complexity will be increased. This indicates an improving trend of quality for fish, but response of fish populations will be slow.

Effects of the road system on aquatic resources will be reduced as restoration activities occur. It is difficult to predict long term effects of roads - successful rehabilitation is dependent on both our ability to meet objectives and the forces of Mother Nature (i.e. 1964 flood).

Predicted reductions in summer temperature peaks will positively impact salmonid communities. Temperature reductions may take years, even decades, so corresponding changes in fish populations are on the same time scale.

Cold water resident fish should also benefit from improved hydrologic and riparian conditions.

Aquatic Insects

As peakflow magnitudes and peak summer temperatures are reduced, aquatic insect populations will be more stable and shift to a more temperature intolerant community. It is expected that the functional feeding group composition will shift away from Collector-gathers and back towards Shredders. As riparian canopy vegetation transitions into coniferous types, the food base and aquatic insect community will also shift.

Amphibians

It would be expected that cold water dependent species such as tailed frogs would have improved habitat conditions as summer temperature peaks decrease.

Social Systems

Commodities

Timber production in Fish Creek will be lower than in the period of 1950-1990. Forty-one percent of the land base has already been clearcut harvested, and those historic levels are not sustainable. To meet objectives of B-6 Special Emphasis Watershed and the Aquatic Conservation Strategy there will be reductions in sustainable timber harvest as hydrologic functions are restored (see Chapter 7 - Management Recommendations).

Pre-commercial and commercial thinning opportunities exist on 12,285 acres of post-clearcut harvest stands. Commodity production may be a direct benefit as some stands are managed for maximum tree growth, or as a secondary benefit from stands managed for other values such as increasing biodiversity or riparian health.

Special forest products will continue to make small contributions to the local economy. Noble fir boughs and bear grass harvest will continue. Availability of other products such as poles, firewood, Christmas trees, and alder/vine maple ditchside brushing is opportunistic and is dependent on future road access.

Access and Travel Management

As described in the Aquatic Conservation Strategy there will be no net increase in road density. It is likely there will be a reduced number of road miles in the Fish Creek watershed for the following reasons:

- appropriated road maintenance dollars are declining and many roads are becoming impassable,
- to meet Mt. Hood Forest Plan objectives for road densities,
- traditional maintenance dollars collected from timber sales are rapidly declining,

- implementing restoration activities such as decommissioning or "storm proofing" roads (removing culverts, ripping road surface, removing unstable fills, configuring for long term drainage, i.e. outsloping & water barring, etc.).

Because of the topography of Fish Creek, there will be limited opportunities for changing hiking, equestrian and mountain bike access. There is a potential for the Boundary Trail tie-in.

Recreation Use

The Mt. Hood Forest Plan identifies the riparian corridor from the mouth of Fish Creek to Wash Creek as A-7, Special Old Growth. Management direction encourages interpretive trails, facilities and day use. Depending on compatibility with the Aquatic Conservation Strategy, these uses may increase. Overnight camping is not encouraged, but it will be difficult to change the traditional dispersed recreational camping along Fish Creek. Current use patterns appear to be incompatible.

Demand for hunting opportunities will continue, but with decreasing deer and elk, ruffed blue grouse and band-tailed pigeon populations, hunter frustration is expected to increase.

The fishing closure along mainstem Fish Creek is expected to continue. There will continue to be fishing opportunities in Fish Creek high mountain lakes.

There will be increasing demand for recreation sites near water (along streams and lakes).

Overall, pressures will increase for recreation opportunities in the Clackamas River corridor as the Portland metropolitan area population continues to grow.

Hunting and Trapping

Demands for trapping opportunities are expected to continue at present low levels into the future. However, opportunities for hunting in close proximity to the urban setting are projected to continue to increase as human population levels increase in the Portland metropolitan area. Deer and elk populations are expected to gradually decline as less high quality forage is produced in the future associated with clearcut and burn silvicultural techniques. Ruffed grouse populations will also gradually decrease as the prevalence of riparian red alder communities associated with landslides and peak streamflow disturbances decline. Blue grouse populations may hold steady or increase as existing early seral communities grow into mid seral forest habitat.

Chapter 6 – Desired Conditions and Trends

In Chapter 6 desired physical and biological conditions and trends related to key questions are developed. Where identified in existing management plans or resource management laws desired conditions are quantifiable and measurable. In many instances desired conditions remain broad in focus. Desired conditions and trends help to focus future restoration work.

Terrestrial System

Vegetation and Landscape Pattern

The desired trend for vegetation management in the watershed is provided, in part, by the Forest Plan and President's Plan land allocations and standards and guidelines. The desired trend is also an attempt (complementary to the management direction from the Plans) to closely approximate vegetative patterns that would be expected under the natural disturbance regime.

The Forest Plan B6 Special Emphasis Watershed land allocation allows for timber Management as a secondary goal, subservient to the primary watershed emphasis goal (Forest Plan p. 246). At least 82 percent of the watershed is to be maintained in a hydrologically recovered condition, i.e. forested with trees at least 8 inches in diameter and with a crown closure of at least 70 percent. The President's Plan continues the same emphasis, recognizing Fish Creek as a Tier 1 Key Watershed. In addition, the President's Plan established Riparian Reserves and Late Successional Reserves where later seral forest are expected to predominate in the future.

To approximate landscape patterns that would be expected under the natural disturbance regime, the desired trend is toward less fragmentation and increased connectivity of late seral forest. Patch sizes would be larger, both for late seral and early seral vegetation.

Outside of Riparian Reserves and Late Successional Reserves, the desired conditions for landscape patterns include:

- mimicking natural fire patterns in vegetation management along upper slopes and ridgetops,
- creating larger patch sizes, more consistent with natural disturbance patterns,
- aggregating existing plantations in highly fragmented upslope and ridgetop areas,
- retaining structural components for the future stand (live trees, snags and logs), as described in the Presidents Plan ROD.

These are long-term desired landscape pattern objectives. Risk to hydrologic function needs to be evaluated before each proposed activity.

The desired trend for early seral forest in the watershed is to stay within the estimated historic range of natural conditions (REAP) listed below. Until completion of a more detailed basin-wide disturbance assessment that examines desired future conditions of individual watersheds, the following estimates are offered:

Vegetation Zone	Range of Natural Conditions
Western hemlock	8 - 10%
Pacific silver fir	6 - 16%
Mountain hemlock	2 - 10%

These ranges are considered consistent with the existing management direction intent of B6 Special Emphasis Watershed and Tier 1 Key Watershed.

Late Seral Habitat

The desired condition is to provide for a functional and interconnected old growth ecosystem (ROD p.5) across the subbasin. The Fish Creek Watershed role is two fold:

- develop and maintain late seral habitat within LSRs and riparian reserves.

- assure functional dispersal habitat for late seral associated biota is maintained among LSRs.

Wildlife and Plants

The desired trend is to improve biological diversity by moving toward a species richness characteristic of natural levels (i.e. estimated based on the late 19th century subbasin ecosystem). This trend will include:

- Reducing undesirable non-native species (e.g. noxious weeds and European Starling). Precluding establishment of additional undesirable non-native species (e.g. bull frog).

- Re-establishing fully functional populations of species currently markedly reduced or extirpated from the ecosystem (e.g. peregrine falcon and fisher). Removing impacts to extremely localized species (e.g. Gorman's aster).

- Maintaining habitat to support all existing native members of the ecosystem as fully functioning components.

The desired condition includes maintenance of all special habitats within the ecosystem. Maintenance includes assuring the integrity of special habitat communities (e.g. wetlands, wet areas and talus slopes, see Appendix A) and providing fully functional special habitat structures, e.g. coarse woody debris (CWD), cliffs and caves.

Aquatic System (including Hillslope and Hydrologic Processes)

Hillslope Processes

Sediment Delivery to the Aquatic System

On harvested areas the desired trend is to allow vegetative succession to move rates of sediment delivery from mass wasting and surface erosion toward pre-management conditions. Because of the presence of roads, and the increased risk of mass movement and surface erosion, rates of delivered sediment will be slightly higher than natural conditions. Highest occurrence of sediment delivery will be associated with large storms where the impacts will be diluted.

The desired trend is to allow natural recovery processes to progress, design specific projects to have low impacts on sediment delivery and apply restoration techniques to disturbed sites.

Streamflow

The desired trend is to begin to return to natural streamflow patterns. Previously discussed analysis suggests timber harvest and road construction has increased peakflows. As identified problems such as expanded ditch line networks and inadequate culvert spacing are addressed, and restoration efforts such as road decommissioning occurs there will be a trend towards returning to natural streamflow patterns. There will always be some level of impact from any future road system.

A desired trend is the natural recovery that will occur as effects of harvest on peak and baseflow diminish as vegetation matures. Rates will occur at the pace of natural succession. Silvicultural treatments such as thinning may create short-term delays while increasing the overall rate of hydrologic recovery. Anticipated improvements in channel morphology related to floodplain function and detention storage should also contribute to the desired trend of decreasing the magnitude of peakflows and increasing summer baseflows.

Sediment and Water Clarity

While water clarity is generally observed to be very good, maintenance or improvement of current water clarity is the desired trend. As instability risk is reduced and exposed stream banks are vegetated impacts to water clarity should be reduced.

Riparian Canopy Disturbance and Stream Water Temperature

As discussed previously, peak summer water temperatures are high and of concern. The desired trend would be to return riparian canopy closure and the percentage of riparian late seral vegetation to levels within the range of natural variability. Increased shading of exposed stream channels would begin to reduce the cumulative effects seen in mainstem Fish Creek. Anticipated improvement of pool quality (primarily depth) and other elements of channel morphology (narrowing and deepening of channel thalweg) would contribute to the desired trend of reducing summer stream temperatures.

Large Wood Supply

Within riparian areas the desired trend is to accelerate re-establishment of large conifers and late seral stages within the range of natural variability for seral stages and community diversity.

Channel Morphology and Condition

Peakflows are an important process in Fish Creek establishing channel morphology. A desired trend is to reduce the magnitude of peakflows, particularly the 2-year and 5-year return interval "channel forming" events, through watershed restoration projects and vegetation growth. A further desired trend would be to restore channel morphology and condition to levels more closely approximating pre-management conditions through direct and indirect (long-term riparian management) introduction of large wood and other structural components.

Aquatic Species, Habitat and Distribution

The desired trend for the Fish Creek watershed is a functioning ecosystem, sustaining healthy populations of anadromous and resident salmonids, non-salmonid fishes and other aquatic organisms such as aquatic insects and amphibians. The quality of habitat and subsequent response of aquatic organisms is dependent on restoration of hillslope and aquatic processes in Fish Creek and management of anadromous populations beyond the borders of the Fish Creek watershed.

Aquatic systems on Federal lands may be disproportionately important for maintaining and restoring the natural processes and components of aquatic ecosystems in the Cascade Range. In other words, Fish Creek and other Clackamas River watersheds may have the only viable habitat and provide refugia for species that can no longer survive any where else.

A good example of this is the late-run winter coho. Potentially the only wild coho left in the Columbia River, conditions off the Mt. Hood National Forest are of lower value to this cold water dependent fish (due to stocking and habitat conditions).

Established habitat and biological parameters set goals for land management practices to meet desired trends (such as the Mt. Hood Forest Plan and Policy Implementation Guide). Some of those relevant to aquatic ecosystems in Fish Creek are discussed in Table 6-1.

Table 6-1. Desired Conditions for Aquatic Systems in Fish Creek

Parameter	Desired Condition
In-channel Large Woody Debris	Minimum length 50' >80 pieces/mi
Pools	>28 primary pools per mile
Stream Temperature	Not to exceed 58 degrees
Aquatic Insects	3 sediment sensitive species present

Overall, habitat conditions (based on predicted growth and input of large wood, declining stream temperatures and maintaining or improving water quality) in Fish Creek are expected to improve. With the projected reductions in timber harvest, and no net (and potentially decreasing) increases in roads, overall habitat conditions should stabilize and improve at a rate controlled by natural processes. Restoration efforts will contribute to improving conditions.

The Fish Creek watershed will be at some level of risk. One risk is currently built roads systems that cannot be rehabilitated or restored (such as the 5430 road). These now-permanent landscape features could potentially aggravate physical processes when natural events (such as the 1964 flood) occur.

Social

Commodities

The desired trend is a sustainable supply of timber harvest consistent with protection of other resource values and objectives of the Forest and President's Plan. The quantity of sustainable supply is currently unknown.

Special forest products use will be developed in accordance with Forest and President's plan guidelines. Forest products associated with mid and late seral stage vegetation will be emphasized.

Recreation

The desired trend for recreation, scenic, and related amenity values in Fish Creek is to manage projected increase in demand in a way which is compatible with the goals and objectives in the President's Forest Plan and the Mt. Hood Forest Plan. Dispersed recreation sites along the creeks such as Wards Camp, are to be managed as a functioning part of the riparian ecosystem as well as for the site characteristics important to recreationists like scenery protection, site cleanliness, and privacy. The desired trend for road closures and evaluating road closures for roads to trail conversion opportunities. The desired trend for scenic management encourages a more natural appearing landscape especially along existing recreation roads and in the viewshed of the eligible Wild and Scenic River segment of Fish Creek. Environmental education will continue as an important trend to promote ecological awareness and responsible recreation behavior.

Hunting and Trapping

The desired trend is to provide habitat sufficient to support sustainable population levels of species hunted and trapped, i.e. populations which are sustainable including annual or periodic harvest of individuals. Establishment of population (or herd) management objectives cooperatively with Oregon Department of Fish and Wildlife which reflect changes in forest management directed by the President's Plan is essential (Forest Plan Standard and Guideline FW-188).

Chapter 7 – Guidelines for Project-Level and Land Management Planning

This chapter focuses on guidance and recommendations for project-level planning and overall land management planning, based on the findings of watershed analysis presented and discussed in previous chapters. Specific guidance is offered for addressing watershed processes and ecosystem concerns at a project planning level. Recommendations are also provided for further consideration at the broader land management planning level.

These guidelines and recommendations are intentionally not site-specific, rather they focus on processes, features, and watershed stratification elements presented earlier. In general, further site-specific project level investigation is anticipated to verify and implement the guidance and recommendations presented in this chapter. This chapter is divided into eight main sections or subject area headings:

- Riparian Reserves
- Restoration Needs
- Transportation Planning
- Opportunities for Commodity Production
- Management Plan Recommendations
- Information Needs
- Monitoring
- Landscape Analysis and Design

Riparian Reserves

One of the four components of the Aquatic Conservation Strategy are Riparian Reserves (ROD B-12). Riparian Reserves are delineated through Watershed Analysis (another component of the Aquatic Conservation Strategy). Riparian Reserves are portions of watersheds where riparian-dependent resources receive primary emphasis and where special standards and guidelines apply. Through the Fish Creek Watershed Analysis critical hillslope, riparian and channel processes have been identified. These processes are the foundation from which Riparian Reserve width recommendations are made.

As described in the ROD, permanently flowing stream, Riparian Reserve boundaries, should approximate boundaries recommended in the ROD. Fish Creek Riparian Reserve boundary recommendations for permanently flowing streams are consistent with the ROD. The ROD also notes the high variability of hydrologic and other processes which affect intermittent streams (ROD B-13). Fish Creek Riparian Reserve boundary recommendations for intermittent and unstable and potentially unstable areas reflect the physical processes described in earlier chapters of this document.

These prescribed widths for Riparian Reserves apply to Fish Creek until further refinement through site-specific analysis is conducted and described, and the rationale for final Riparian Reserve boundaries is presented through the appropriate NEPA decision-making process (ROD B-13).

There are five categories of streams and water bodies which receive specific recommendations for Riparian Reserve widths (ROD B-14):

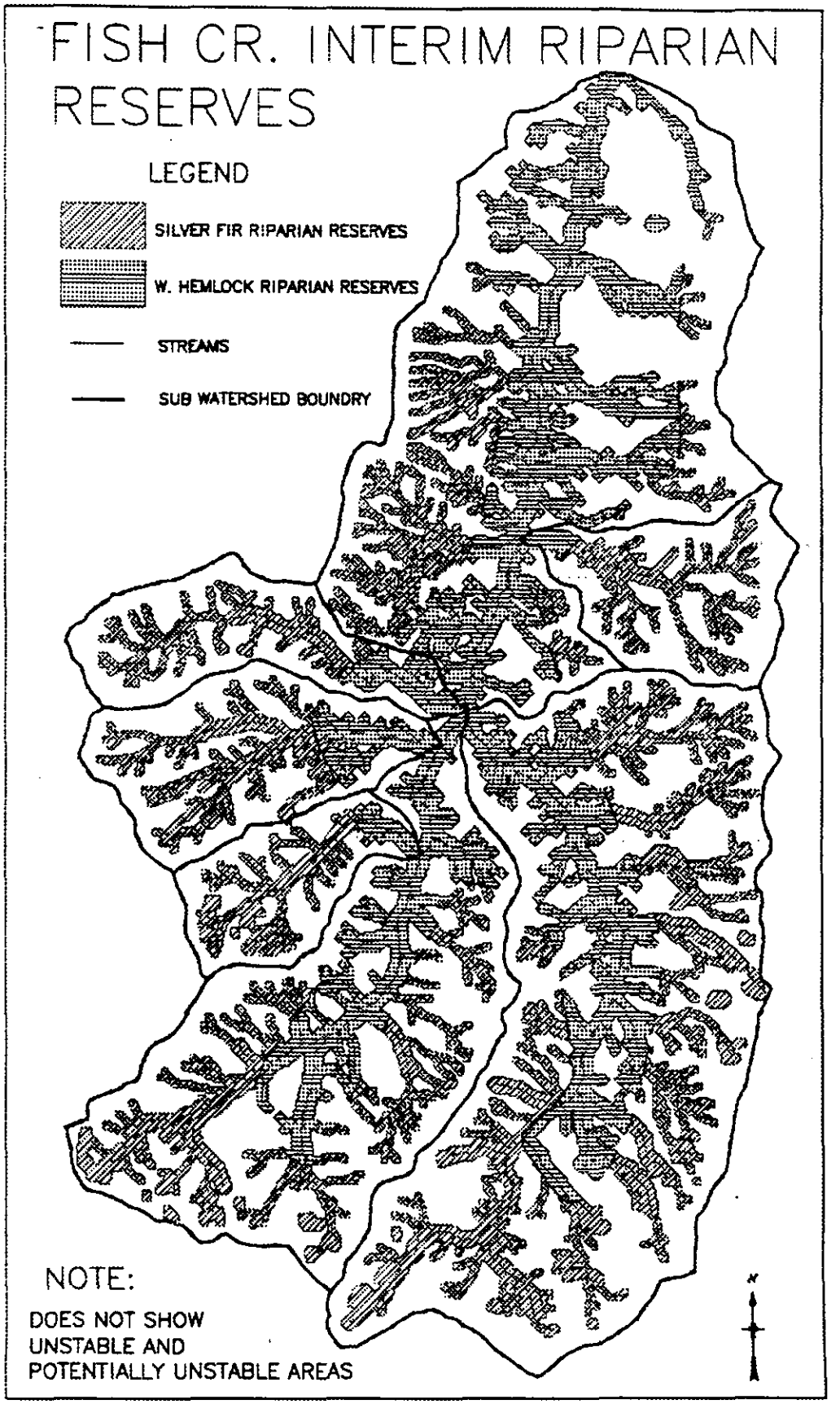
- fish bearing streams
- permanently flowing non-fish bearing streams
- constructed ponds and reservoirs, and wetlands greater than 1 acre
- lakes and natural ponds
- seasonally flowing or intermittent streams, wetlands less than 1 acre, and unstable and potentially unstable areas

The standards and guidelines of the ROD (C-30 & 31) provide guidelines for riparian reserve boundary recommendations. Final determination of Riparian Reserve boundaries is based on site specific planning where specifics such as the "inner gorge", "site potential tree height", or "100-year floodplain" can be determined.

General mapping for Fish Creek Watershed Analysis used site-potential tree height widths. A site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site class. The Mt. Hood ecology program had collected west-wide riparian plot data for site potential tree height for riparian areas. Their analysis determined Fish Creek site potential tree heights on the west side of the Mt. Hood National Forest are:

- 209' Western Hemlock Zone
- 158' Pacific Silver Fir/Mt. Hemlock Zone

Map 7-1 Fish Creek Interim Riparian Reserves



These two vegetation zones have been mapped on GIS, and as project level planning proceeds in Fish Creek, these maps will be useful to locate projects and determine the appropriate Riparian Reserve width. Note Fish Creek site potential tree heights are greater than the fixed heights (150') identified in the ROD (Map 7-1).

Based on findings of Fish Creek Watershed Analysis, Table 7-1 displays the recommendations for Riparian Reserves for the the five categories of streams and water bodies.

Table 7-1. Riparian Reserve With Recommendations

Category	Western Hemlock Zone	Pacific Silver Fir Zone
Fish Bearing Streams	418'	316'
Non-Fish Bearing Streams	209'	158'
Constructed Ponds, Reservoirs and Wetlands >1 Acre	209'	158'
Lakes and Ponds	418'	316'
Intermittent Streams**, Wetlands >1 Acre and Unstable/Potentially Unstable Areas	209'	158'

** *Seasonally flowing or intermittent streams, wetlands less than 1 acre, and unstable and potentially unstable areas are discussed separately to outline criteria considered important to address unique or important features found in Fish Creek. Expanded discussion of these findings is found in Chapter 4 and in Appendix A.*

Intermittent Streams and Ephemeral Channel Heads

Recommendation: Maintain ROD widths for intermittent streams and include ephemeral channel heads.

Definition: Ephemeral (identified in FEMAT IX-10 as those streams that only sporadically contain running water) were also identified as areas at risk in Fish Creek. Risk is seasonal, primarily during the rain-on-snow period, but based on previous analysis these are high risk for sediment delivery. Ephemeral channel heads of concern are those on slopes greater than 50% on the landform types weak rock steep slopes (WRSS) and resistant rock steep slopes (RRSS).

Rationale for recommendations:

- The majority of intermittent streams fall in the transient rain on snow zone.
- The identified risk of all slopes greater than 50% for surface erosion, and the large proportion of these slopes in Fish Creek.
- The risk of slope failure associated with plantations less than 20 years old.
- The amount of timber harvest and early seral conditions in intermittent streams.

Ponds, Wet Areas, Wetlands

Recommendation: Maintain ROD widths, and buffer all wet areas including Noble Fir and Sitka Alder wet areas (see Special Habitat Map 4-3).

Criteria for recommendation:

- Ponds, wet areas and wetlands were defined as "special habitats" during Fish Creek watershed analysis (see Chapter four). These were described by hydrophyllic vegetation, seeps/springs with shallow water tables and/or saturated with surface water. Noble Fir and Sitka Alder wet areas are generally located on the glaciated landform type. These are areas of high elevation, where snow accumulates within the glacial cirque.
- These cirques capture and retain moisture until late in the season and provide critical input to baseflow.
- If timber harvest were to occur, these areas would contribute to a disproportionate increase in peakflows and decrease in baseflow.

- These are areas of high biological diversity.

Ponds, wet areas and wetlands are mapped based on aerial photo interpretation and limited field reconnaissance. Project level planning will determine final boundaries. This recommendation includes all other ponds, red alder wetlands, wetlands and meadows outside the glaciated landform.

Unstable and Potentially Unstable Areas

Recommendation: Maintain ROD widths for unstable and potentially unstable areas.

Unstable lands can occur on the landscape in positions removed from riparian ecosystems yet these areas provide the important linkage mechanism for interaction of terrestrial uplands on the riparian and aquatic ecosystems. Mass movement events deliver large wood, sediment and nutrients to aquatic systems. The intent of developing riparian reserves for unstable and potentially unstable areas is to ensure the rate and distribution of sediment delivery does not alter stream channel forming processes or impair aquatic ecosystem functions.

Certain geologic conditions within Fish Creek Watershed are prone to produce instability. As discussed earlier (Chapter 3), Fish Creek has the largest proportion of area with potential for shallow mass wasting of any watershed on the Mt. Hood Forest. Unstable areas occur in many different landscape positions. Debris flows often originate in these areas and field investigations of length of travel of these debris flows will help define Riparian Reserve widths.

Unstable Geologic Factors

Field investigations are necessary to identify and assess conditions contributing to slope instability. Field investigations and professional judgment provide some details for identifying the spatial distribution of possible unstable areas. The following sites or conditions help to define slope-forming and geomorphic processes that may require the protection of riparian reserves. Additional information on location of unstable and potential unstable areas can be derived from the geology, landform and candidate land for unstable and potential unstable designation maps in the analysis file.

- Contacts between weak rock and resistant rock. Changes in permeability at these contacts often result in springs or shallow ground water tables. Altering the ground water conditions in these areas can trigger debris slides and debris flows. These types of contacts occur between:

  - Weak rock (WRSS) and resistant rock (RRSS) landform types on steep slopes.

  - The Rhododendron Formation (Tr) and Beds of Bull Creek Formation (Tbc)

  - The Older basalt (QTB) and Rhododendron Formation (Tr)

  - Lava-flow and pyroclastic rock types within the Rhododendron (Tr) and Beds of Bull Creek Formations (Tbc).

  - Lava-flow and interbed rock types within the Columbia River Basalt Formation (Twp and Tgr). The largest interbed and biggest problem site is between Twp and Tgr.

- Around the edges of intrusions. Intrusions are shown as Ti and Tipa on the geologic map (see Appendix D). The heat from these intrusions has often altered and weakened the immediately surrounding rock making it more prone to mass wasting.

- Along the margins of dikes. Many thin basalt dikes cut through the Rhododendron (Tr) and Beds of Bull Creek Formations (Tbc). Heat from the dikes has altered and weakened the immediately surrounding rock making it more prone to mass wasting. The dikes are not shown on the maps.

- On slopes >60% with shallow soils over impermeable materials. These are most likely to be areas within the landform units RRSS, GVSS, and GVF (glaciated valley floors); but could be within any landform or geologic units. These areas are prone to debris slides and debris flows.

- Along the toes of ancient landslides. Changes in ground water levels near the ancient landslide toes often trigger debris flows, debris slides, or slumps.

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

- Within the main bodies of the ancient landslides. Many of the ancient landslides are probably stable, but have smaller areas within the ancient landslide that are unstable or potentially unstable. These areas could occur almost anywhere within the ancient landslide. In general, the steeper the slope, the greater the risk. The larger ancient landslides are mapped on the geology map as Qls. Some smaller ancient landslides and debris flows were mapped within the sample areas of the watershed.

- Extremely steep channel heads that are water concentration areas for intermittent and ephemeral streams. The steep slopes typical of these landscape features and water table conditions promote shallow mass wasting. Occurs predominantly in WRSS and RRSS landform types.

The presence of these geologic conditions does not automatically mean that the area is unstable. Investigation of site specific factors critical to slope stability will occur during the planning phase of individual projects. Results from project investigations will provide the basis for determination of appropriate riparian reserve widths to maintain aquatic and riparian functions.

Restoration Needs

The objective for restoration in the Fish Creek watershed is to bring natural resource processes and ecosystem function towards desired conditions and trends. Restoration project opportunities, as presented in Table 7-2, are described in terms of altered processes, causal activities, resource effects, restoration objectives, project opportunities, and potential resource benefits. Restoration priorities are based on our current understanding of the key processes, functions, and resources interacting in the watershed, as described in previous sections of this document.

The Fish Creek watershed has been designated as a Tier 1 Key Watershed in the Record of Decision for Amendments to the Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (ROD 1994). Prioritization of restoration opportunities follow the Key Watershed principle of providing the greatest opportunity for maintaining, conserving or restoring existing populations and high quality habitat for riparian and aquatic beneficial uses. Within and downstream from the Fish Creek watershed, the legal mandates most affecting benefiting resources and beneficial uses include water quality (Clean Water Act), the quantity of water (Organic Act), threatened and endangered species (Endangered Species Act) and biodiversity (National Forest Management Act). Restoration opportunities address these resources needs and mandates.

Altered processes include altered sediment delivery and transport, altered hydrologic regime, altered riparian area function, altered aquatic habitat condition, altered forest structure and composition, and altered wildlife habitat condition and connectivity. Factors that would cause large-scale failure of process function are identified as priorities for restoration. In addition, the ROD recommends exploring opportunities to reduce the amount of existing system and nonsystem roads within Key Watersheds. To meet ROD and multiple resource restoration objectives, road de-commissioning projects are proposed for incorporation into priority restoration projects whenever possible.

Table 7-2 restoration opportunities denoted by a * bullet are those which are likely to yield the greatest immediate benefit in terms of favorable changes in watershed processes and resource effects. The restoration opportunities denoted by a ● bullet either provide delayed watershed benefits, benefits not specifically addressed in the ROD, or are component parts of another more inclusive project opportunity.

Table 7-2. Restoration projects that will move ecosystem processes and functions in Fish Creek toward desired conditions and trends. (page 1 of 6)

Altered Process	Causal Activity	Resource Effects
Altered Landscape Patterns	• Timber harvest	• Reduce patch size • Fragmentation • Increased edge habitat
	• Fire suppression	• Poor aesthetic quality in middle ground views from recreation areas
Altered Sediment Delivery and Transport Regime	• Road construction on high risk erosion and landslide lands	• Accelerated erosion and landslide failure
	• Inadequate road drainage system	• Concentration of runoff
	• Soil disturbance from timber harvest, dispersed recreational and OHV use	• Accelerated erosion
	• Compaction from road construction, harvest and recreational use	• Decreased infiltration, concentration of runoff
Altered Hydrologic Regime	• Intensive road building	• Reduced infiltration, concentration of runoff and extension of the channel network
	• Reduction of mid and late vegetation seral stages	• Snowpack accumulation and melt
Altered Riparian Area Function	• Timber harvest in riparian areas	• Loss of large woody debris (LWD) & nutrient recruitment • Loss of streamside shading
	• Road location in flood plains	• Loss of floodplain function
	• Dispersed recreation use	• Compaction • Loss of ground cover • Soil erosion

Table 7-2. Restoration projects that will move ecosystem processes and functions in Fish Creek toward desired conditions and trends. (page 2 of 6)

Restoration Objectives	Restoration Opportunities	Benefiting Resources
• Increase size of patches	• Aggregating existing plantations in fragmented upper slopes and ridgetops	• Visual quality
• Mimic natural fire patterns	• Create larger patch sizes • Create openings on upper slopes and ridges with high snag densities	• Some wildlife species • People (aesthetics and commodity production) • Diverse resilient landscape
• Decrease road failure and cut slope erosion	* Fill slope pull-back • Cut slope erosion control • Ditch relief before stream crossings • Reduce concentration of runoff to slide prone areas	• Improved water quality • Aquatic populations • Possible economic benefit to local economics, associated with project work.
• Disperse surface drainage	• Decrease culvert spacing • Outslope road surface • Improve road maintenance * Remove roads in riparian reserves	
• Reduce runoff and surface erosion	* Erosion control on disturbed areas (including dispersed sites) • Water barring and other structural applications	
• Increase infiltration	* Decommission roads • Subsoil tillage of road surface, compacted soils	
• Decrease road induced peakflow • Decrease channel/bank erosion • Restore channel morphology	* Decommission roads • Reduce/disperse surface runoff * Storm proof roads and stream crossings - correct size and spacing of culverts	• Aquatic populations - Higher fish survival - Improved pool quality - Higher fish carrying capacity
• Decrease magnitude of rain-on-snow events • Decrease channel bank erosion • Restore early to mid seral conditions	• Planting, precommercial thinning, etc.	
• Restore habitat complexity	• Species/structure diversification (thinning)	• Aquatic populations - Montane aquatic insect communities - Reduced fish stress -Harlequin ducks
• Regain side channels and floodplains function	* Riparian area plantings	• Riparian obligates and associates
• Reduce temperatures extremes	* Reconnect side channels and floodplains	
• Advance late seral development	* Dispersed recreation management plan	• Recreational experience and aesthetic quality
• Reduce runoff and surface erosion	• Ground cover restoration, erosion control	• Water quality

Table 7-2. Restoration projects that will move ecosystem processes and functions in Fish Creek toward desired conditions and trends. (page 3 of 6)

Altered Process	Causal Activity	Resource Effects
Altered Aquatic Habitat Condition	• Salvage of instream large wood	• Loss of stream channel complexity
	• Riparian canopy removal	• Impacts to fisheries habitat • Channel simplification
	• Culverts blocking fish passage	• Decrease habitat connectivity
Reduced Connectivity of Late Seral Systems (LS) Scale **- Basin & Subbasin Scale** **- Stand Scale**	• Land Allocations • Clearcuts • Salvage	• LS fragmentation and isolation • Reduced population numbers and viability of obligate species
Degraded Biological Diversity	• Extirpation or near extirpation of native species • Introduction of undesirable non-native species	• Degraded predator-prey relationships • Degraded natural selection processes • displacement and reduction in population viability of native species
	• Uniform spacing/monoculture in plantations	• Degraded stand-level species and structural diversity

Table 7-2. Restoration projects that will move ecosystem processes and functions in Fish Creek toward desired conditions and trends. (page 4 of 6)

Restoration Objectives	Restoration Opportunities	Benefiting Resources
• Restore instream energy dissipation	• Restore LWD	• Aquatic populations - Greater over winter survival - Improved habitat conditions -Improved passage
• Improve instream habitat	• Increase channel complexity	
• Restore side channel and floodplain function	* Reconnect side channels and floodplains	
• Restore aquatic habitat connectivity	* Removal/replacement of culverts	
• Establish a functional, interconnected LS habitat system	• Accelerate development of LS habitat characteristics in riparian reserves and LSRs	• LS habitat obligates and associates
• Assure functional dispersal habitat for LS obligate species	- thin stands to create patchiness and larger trees -create CWD -create mal-formed trees -underplant to expedite development of stand layering	• Aesthetics of watershed and recreational experience
• Re-establish selected wildlife species as successfully reproducing components of the ecosystem -peregrine falcon -fisher -western pond turtle	* Control human access near potential peregrine nesting sites and primary foraging areas	• Peregrine, fisher and western pond turtle
	• Improve peregrine nesting ledges	• Peregrine & fisher prey species
	• Improve peregrine prey populations by maintaining shrub communities and wetlands, and by planting fruit bearing shrubs and trees	
	• Physically import fisher and western pond turtle (ODFW jurisdiction)	• Improved food chain
	* Manage Fish Creek mainstem beaver ponds to include turtle and peregrine prey habitat	• Coho, by reducing aquatic vegetation in beaver ponds
• Control introduction of non-desirable non-native species; eradicate undesirable non-natives, e.g. noxious weeds	* Continue cooperative noxious weed control program with Oregon Dept. of Agriculture	• Native species
	• Restore native plant community at Fish Creek pier	• Social value of native species retention
• Minimize disturbance to Aster gormanii populations	* Close road; move back trailhead @ South Fork mountain	
	• Decommission roads for weed control	
• Restore habitat complexity in existing plantations	• Species/structural diversification (thinning)	• Terrestrial species diversity • Aesthetics

Table 7-2. Restoration projects that will move ecosystem processes and functions in Fish Creek toward desired conditions and trends. (page 5 of 6)

Altered Process	Causal Activity	Resource Effects
Reduced Snag and Log Habitat	• Timber harvest, clearcuts, salvage activities • Fire suppression	• Degraded predator - prey relationships • Reduced populations of primary and secondary cavity nesters • Decreased moderating affect on prey item populations, e.g. Douglas-fir bark beetle & spruce bud worm • Reduced amphibian habitat • Reduced habitat for some arthropod groups
Degraded Wildlife Security Habitat, i.e. Reduced Solitude	• Human presence in the forest (due to roads, trails, and other recreational and commercial pursuits)	• Reduced habitat available for wildlife species sensitive to human presence; displacement of individuals • Reduced population and species viability
Reduced Habitat Effectiveness for Deer and Elk	• Reduction in quantity & quality of forage created by timber harvesting and broadcast burning • High harassment potential due to high open road densities (particularly on winter range)	• Decreased recreational hunting opportunities • Decreased prey items for large carnivores, e.g. cougar, black bear & wolverine • Decreased deer & elk numbers

Table 7-2. Restoration projects that will move ecosystem processes and functions in Fish Creek toward desired conditions and trends. (page 6 of 6)

Restoration Objectives	Restoration Opportunities	Benefiting Resources
• Re-establish snags and logs as fully functioning structural components of the ecosystem - on every forested acre of the watershed (long term)	• Meet or exceed the quantities of coarse woody debris (CWD) prescribed by management direction on all new harvest areas * Create immediate and future snags and logs in deficient stands (short & long term) per S&Gs • Create high density snag patches with controlled fire (recognize role of insect infestations)	• Primary and secondary cavity nesters • All CWD obligate and associate species • Trees affected by insects (primary & secondary cavity nester prey items)
• Re-establish security habitat in selected areas	* Road closures • Limit off-highway vehicle (summer & winter) uses * Prohibit or restrict helicopter flights on Whales Head-Fish Creek ridge system from February thru July * Reduce human access to known Townsend's big-eared bat hibernaculum • Manage human presence along mainstem Fish Creek	• All species sensitive to human presence, e.g. peregrine falcon, wolverine, harlequin duck, Townsend's big-eared bat
• Improve habitat for deer & elk to help achieve ODFW herd management objectives • Assure sustainable deer & elk populations as fully functioning ecosystem components	• Reduce open road densities on winter range to 2.0 miles/section or less and 2.5 miles or less on summer range * Close all roads within highest potential winter range except primary haul routes (between 1 Dec & 31 Mar). See Analysis File map. • Discourage indiscriminate rifle shooting by establishing a designated shooting range in the subbasin * Establish long term high quality foraging areas on highest potential winter range (example: in conjunction with stand thinning and road decommissioning). See mapped locations in Analysis File.	• Recreation • Deer & elk • Large carnivores

Transportation Planning

The President's Forest Plan identified the primary objective of road management in key watersheds was reduction of existing system and nonsystem roads. In Fish Creek there are approximately 143 miles of roads. This section outlines access and travel management by discussing priorities for:

- *keeping roads open,*
- priorities for road closure and
- information for decision making on pertinent roads to close.

The goal of the access and travel management plan for Fish Creek is to reduce the impacts on water quality, hydrologic function (physical impacts), peregrine falcon nesting potential, and deer and elk winter range (biological impacts) while facilitating administrative, commodity and recreational uses. Because of hydrologic concerns, regeneration harvest is not envisioned in the watershed in the next 10 years (see management recommendations). Commercial thinning will likely occur. Access to artificially regenerated stands should be adequate. Thinning in natural stands may require additional road construction.

Roads to Keep Open

The following priorities are suggested in determining the importance of maintaining current roads in the transportation system. Referenced resource maps are available in the analysis file.

High — Roads with high watershed function impacts due to potential landsliding that demonstrate little opportunity for effective restoration techniques. An example is the 5430 road. (refer to maintenance level map)

High — Major traditional and recreational use - older (constructed from 1950 - 1960) roads important to recreational use, i.e. roads 5400 and 5420. (refer to road history map and recreational use map)

High — Tie through roads to adjacent watersheds. Evaluate at the subbasin level.

Moderate — Roads that access proposed commercial thinning stands with a low or moderate watershed impact. See discussion below. (refer to commercial thin map)

Low — Fire suppression (adequately addressed by high priority roads).

Low — Access for special products. (refer to special products map)

Roads to Close

Physical Factors

Roads with high impacts to watersheds contribute to channel network expansion and have a significant capability to contribute sediment to stream systems. The following physical characteristics are suggested for identifying roads that can be decommissioned or closed. Roads that have a combination of these features would have a high priority for restoration.

- Occur in the rain on snow zone (refer to the snow zone map).
- Occur on landform types with high sediment delivery risk for debris flows or debris slides, WRRS and RRSS landforms. (refer to landform map).
- Have a high cutslope erosion hazard (see Chapter 4 in appendix A).
- Have a native road surface.
- Located within Riparian Reserves or Late Successional Reserves.

Roads that are detrimentally affecting hillslope hydrology, either by channeling surface or subsurface water flow, are candidates for decommissioning type stabilization. Roads located in the rain on snow zone with a high density of road stream crossings and low landslide risk fall into this category of restoration. Roads that reduce the function and quality of riparian reserves are also candidates for decommissioning.

The relative sediment delivery capability of road segments in Fish Creek is presented in Map 7-2. This map is developed from sediment delivery factors discussed in Chapter 4, and is a visual display of information found in Table 4-3. Road segments in the high and moderate sediment delivery capability classes are potential areas for appropriate restoration projects.

Map 7-2. Relative Sediment Delivery Capability of Road Segments

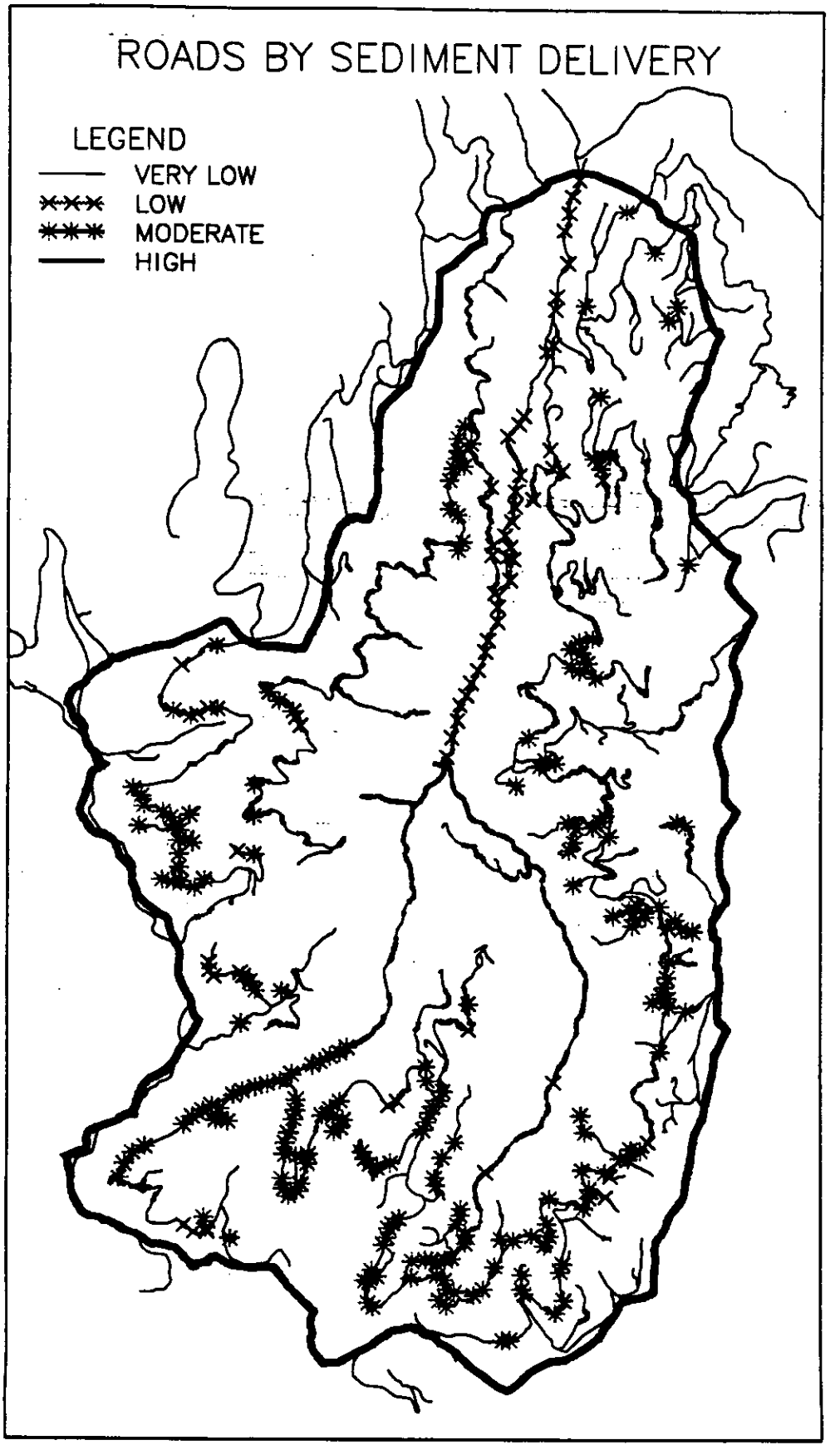


Table 7-3 is provided to assist in prioritizing restoration efforts addressing impacts of roads on hydrologic processes between subwatersheds in Fish Creek.

Table 7-3 Characteristics of Roads With Hydrologic Impacts for Subwatersheds in Fish Creek

Subwatershed	Road Density (mi/sq mi)	Road Stream Crossings	High Debris Flow Risk Landforms (road miles)	High Sediment Delivery Hazard (road miles)	Native Road Surface (miles)
Lower Fish Creek	3.8	115	33	8.4	3
Third Creek	2.0	16	4	.9	0
Upper Fish Creek	3.3	118	18	11.3	8
Pick Creek	2.8	26	6	1.8	0
Fall Creek	2.7	4	4	.3	0
Wash Creek	2.7	67	9	6.8	10
Music Creek	2.4	13	3	1.0	0

Information in Table 7-2 suggests road systems in Lower Fish Creek, Upper Fish Creek and Wash Creek have the highest risk factors for impacting aquatic ecosystems.

Availability of funds for completing maintenance operations on roads in Fish Creek is declining due to a decrease in revenue generating timber harvest. Several roads in Fish Creek have been closed and are currently not being monitored for possible drainage problems. In developing the restoration program in Fish Creek closed roads need to be inventoried and their ability to handle high energy storm runoff evaluated. All roads in the watershed could be inventoried for road surface drainage, adequacy of culverts to function during high energy storm events and potential to concentrate runoff onto unstable slope positions or heads of streams.

Biological Factors

The following biological considerations are criteria to consider in determining road closure needs in Fish Creek. The large ancient landslide deposits occurring on western aspects and midslope positions in Fish Creek watershed provide high quality winter range habitat potential for wildlife, particularly elk and deer. The habitat effectiveness of these winter range areas is substantially reduced by high road densities. Declining timber harvest in Fish Creek will limit opportunities to provide forage for elk and deer in the future. Reducing the level of harassment the animals are subjected to as result of open roads should increase the effectiveness of the forage that is available. A map of highest potential winter range is in the Analysis File.

Roads in close proximity to special habitats, e.g. cliffs (potentially used by peregrine falcons) and wetlands, reduce the quality of the habitat for associated and obligate species.

Opportunities for Commodity Production

Regeneration Harvest

In order to meet the objectives of the Aquatic Conservation Strategy for Tier 1 Watersheds (ROD pp B-13) no regeneration harvest is recommended for the next 10 year period in Fish Creek drainage. The high level of timber harvest in the previous decades left Fish Creek drainage in an unrecovered hydrologic condition. New harvest would also create additional acres of early seral stands moving the drainage further outside the range of natural conditions for early seral stands in the Clackamas subbasin.

Plantations resulting from harvest have not matured hydrologically and need greater time to recover. The Mt. Hood Forest Plan projects that 80 percent recovery (Forest Plan desired future condition) will take approximately 30 to 40 years. During the 10 year intervening period, future analysis on progress of the watershed toward hydrologic recovery needs to be conducted.

Long-term landscape objectives of establishing larger patches through regeneration harvest would be delay until hydrologic recovery is achieved.

Commercial Thinning

Over the next ten years there will be commodities produced through commercial thinning activities.

Riparian Enhancement

No thinning in unstable riparian reserves. Thinning in riparian areas adjacent to stream channels is possible if it meets the objectives of promoting vegetative structure for future wood input to streams or other riparian objectives. Material that is not necessary to meet riparian function needs, including down woody material, will be available as a commodity output. Opening up of riparian hardwood stands to accelerate conifer growth needs to be delayed until stream shading has recovered throughout the watershed.

Late Successional Reserves

Portions of the Clackamas Corridor LSR within Fish Creek are primarily in a mid seral stage. These are some of the oldest plantations in the watershed

and potentially ready for commercial thinning in the next decade. Precommercial thinning of these stands has created uniformly spaced stands. Commercial thinning in these stands is possible. Specific objectives of thinning prescriptions will be dependent on completion of LSR assessments. Other LSRs in the drainage have minimal opportunities for commercial thinning.

Matrix Lands

There will be opportunities in the next decade to commercially thin a number of the older plantations within the watershed, primarily to accelerate tree growth. Map 7-3 displays areas of potential thinning anticipated within the next 10 years within the watershed. Approximately 234 acres would be available for thinning during the first year.

Uneven-aged Management

There may be opportunities for uneven-aged management (group selection or single tree selection) on matrix lands. It is not precluded as an option, although suitable areas have not been identified in this analysis. No new road construction may be associated with these harvest activities. Harvest activities must be consistent with the standards and guides for B6 Management Direction, and can have no detrimental effect on hydrologic recovery. Site specific analysis is needed to address:

- feasibility,
- silvicultural considerations, and
- instability concerns.

Salvage

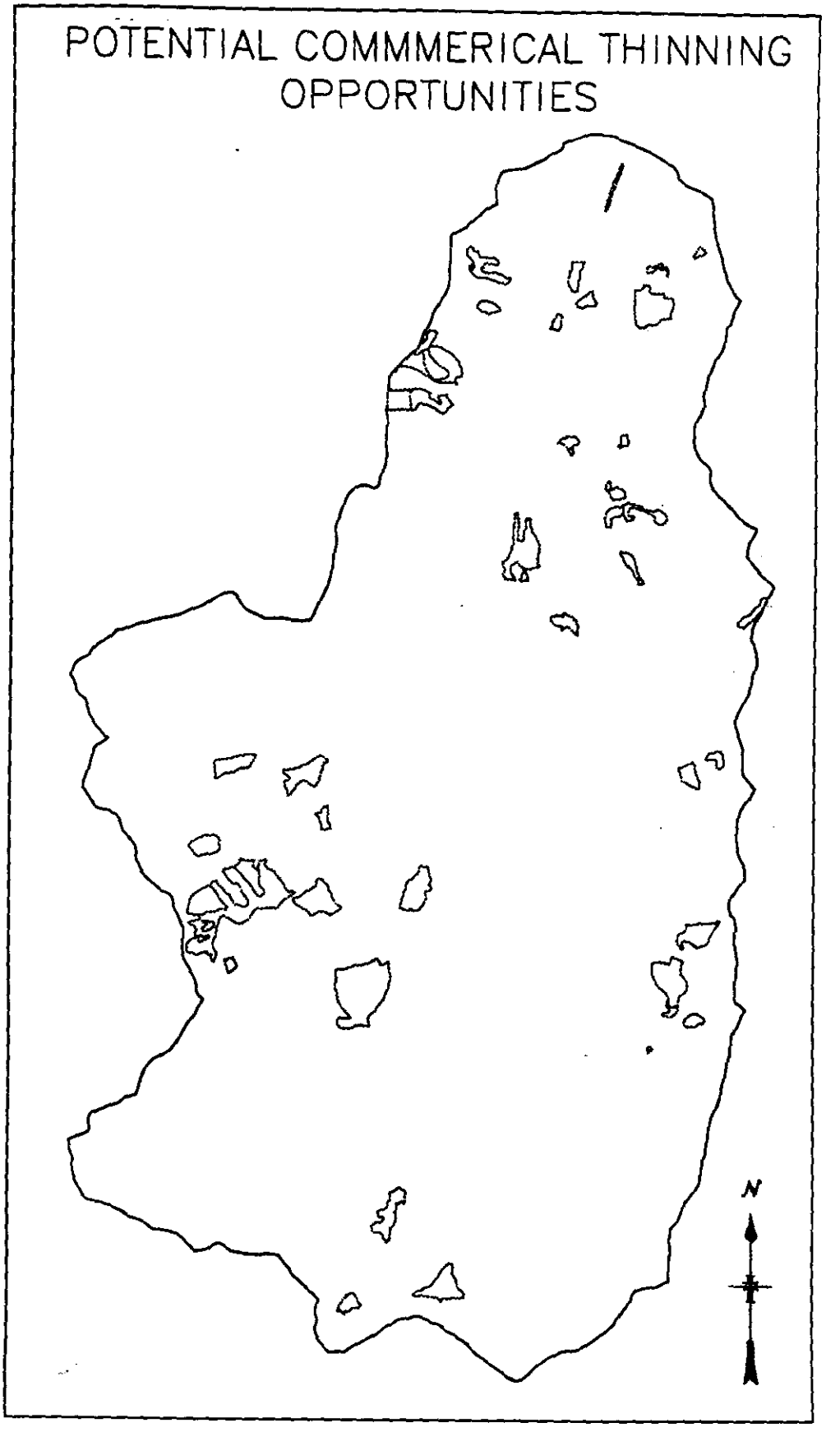
Salvage opportunities will be limited until current standards and guidelines for standing and down coarse woody debris guidelines are achieved. There may be exceptions for large scale catastrophic events such as windthrow and fire.

Special Forest Products

Harvest and collection of special forest products will continue within Fish Creek. Closure and decommissioning of roads may limit access to past collection sites. Utilization of products associated with early seral vegetation communities will decline in the next ten year period.

Mushroom harvest within LSRs will not occur unless LSR assessments determine mushroom removal to be compatible with LSR goals and objectives.

Map 7-3. Potential Commercial Thinning Opportunties in Fish Creek



Management Plan Recommendations

The objective of this portion of the chapter is to capture observations regarding existing land management direction resulting from Fish Creek watershed analyses. The observations address any inconsistencies or weaknesses recognized in assuring the current management direction provides for achieving the President's Plan mission of sound ecosystem management. Observations include instances where ongoing processes on the ground appear to be inconsistent with processes described in the current management direction. They also include recommendations for finalizing riparian reserve and late successional reserve boundaries. Rationale for recommendations are offered where appropriate. In some cases potential weaknesses in management direction are identified and further analyses to address the weaknesses are recommended.

These recommendations are not decisions. Any recommendations the Forest chooses to pursue will be undertaken consistent with the National Environmental Policy Act.

Terrestrial System

Late Successional Reserves

The following Late Successional Reserve (LSR) boundary adjustment recommendations are offered for consideration in preparation of LSR Management Assessments (ROD, p. C-11).

South Fork Mountain LSR

This LSR, on the western edge of the watershed, lies predominately within the Memaloose Creek Drainage and Dead Horse Canyon (a tributary to the North Fork Molalla River Drainage) on Bureau of Land Management (BLM) administered lands. A small portion of the LSR is within the Fish Creek Watershed near South Fork Mountain.

Recommended minor adjustments to the LSR boundary are depicted on an Analysis File map. The boundary adjustments serve to encompass a more recognizable and manageable late seral block. Adjustments to total acreage within the LSR are very minor.

Round Mountain and Miner's Butte

Portions of 3 quarter sections, administered by BLM, near Round Mountain an Miner's Butte are identified LSRs. Recommendations regarding boundary adjustments for these areas are deferred to Watershed Analyses completed by BLM which could more logically address the role of these small areas.

Wash Creek Butte LSR

This LSR lies within the headwaters of the Table Rock Fork of the Molalla River (largely on BLM lands); however, small portions are along the ridge tops in the headwaters of Wash Creek, Wear Creek and Fish Creek (Mt. Hood NF administered lands). These National Forest System (NFS) lands are included within recommended boundary adjustments for Riparian Reserves in Fish Creek. See Riparian Reserves section of Chapter 7.

Clackamas River Corridor LSR

This LSR encompasses the entire mainstem of the Clackamas River from its headwaters to where the river leaves NFS lands. The goal of the LSR (as identified in this document, see Appendix A) is to provide for late seral riverine habitat, spanning the elevational gradient of the Clackamas River Subbasin. The northern portion of the Fish Creek Watershed is included in this LSR.

A recommendation is offered to amend the LSR boundary by deleting areas not currently characterized by late seral habitat. Portions of the LSR on both the east and west sides of Fish Creek are recommended for inclusion in the deletion (see Analysis File map). The portion east of Fish Creek is located on an ancient landslide (see Landform map, Chapter 4) that was clearcut harvested in the 1940s. The portion west of Fish Creek is heavily fragmented and impacted by clearcut harvesting; it offers very little existing value as late seral habitat. Neither area offers much opportunity to provide late seral riverine habitat.

"Functional and Interconnected Old Growth Ecosystem" ROD p. 5

The old growth (or late seral) forest ecosystem in the Clackamas Subbasin is heavily fragmented both within the subbasin and within Fish Creek Watershed (see Chapter 4 and Appendix A, Terrestrial). The function and interconnection of the late seral ecosystem in the future will rely heavily on the LSR network across the subbasin and adjacent subbasins (see Chapter 5, Terrestrial). Currently, some LSRs contain limited late seral forest habitat; portions of the large LSRs are mostly mid seral forest - particularly the Roaring River area immediately northeast of Fish Creek Watershed (Map 4-7).

Although the Fish Creek Watershed is currently quite heavily fragmented, some relatively large late seral blocks persist and have been identified and described (see Chapter 4 and Appendix A, Terrestrial). Three late seral blocks are recognized as significant in assuring a functional and interconnected late seral ecosystem is maintained; these blocks are identified in Chapter 4 and Appendix A as LS blocks 4, 9 and 12 (see Map 4-6).

A recommendation is offered to delay any regeneration or clearcut timber harvest in late seral blocks 4, 9 and 12 to mitigate losses in connectivity of the late seral ecosystem until:

- all LSR Assessments in the Clackamas and Mollala Subbasins are completed,
- the Clackamas Subbasin Watershed Analysis and the Willamette Province Plan are completed,
- an analysis is completed addressing dispersal of management indicator species in this part of the Cascade Range (i.e. pileated woodpecker, pine marten and northern spotted owl), and
- adjacent LSRs achieve quantities and distribution of late seral habitat determined adequate by subbasin analyses and provincial plans (i.e. adequate to assure functional, interconnected old growth ecosystems are maintained).

Townsend's Big-eared Bat

One of two known Townsend's big-eared bat hibernacula on the Forest is present in the Fish Creek Watershed. The bat is heavily associated with prey items from the Lepidoptera family for reproduction.

A recommendation is offered to not apply any pesticide used to control members of the Lepidoptera family within the watershed until a Conservation Strategy for Townsend's big-eared bat is completed and embraced by all pertinent agencies, e.g. Oregon Department of Fish and Wildlife. This recommendation would take the form of a watershed-wide or subbasin-wide Forest Plan standard and guideline.

Coarse Woody Debris

Snag habitat is currently substantially reduced from historic levels (see Chapter 4 and Appendix A, Terrestrial). Timber harvest activities have not been successful in achieving management direction for retaining snags within harvest units in the past (see Mt. Hood Forest Plan Monitoring Reports 1991, 1992 and 1993). Wildlife species dependent upon this habitat structure are believed to not be contributing as fully functional members of the ecosystem (see Chapter 5, Terrestrial).

A recommendation is offered to defer any salvage of coarse woody debris (standing and down) within the watershed until current standards and guidelines are achieved. This recommendation would take the form of a watershed-wide Forest Plan standard and guideline. The environmental analysis process for this decision should address possible exceptions for very large scale windthrow events, fire, or insect infestations, etc.

Aquatic System

Riparian Reserves

See Riparian Reserves section of this chapter regarding recommended adjustments to the Riparian Reserves boundaries.

Regeneration Timber Harvest

In order to achieve the goals, desired future conditions and standards and guidelines of B6 Special Emphasis Watershed and the objectives of the Aquatic Conservation Strategy for Tier 1 Watersheds (ROD, p. B-13), no regeneration timber harvest is recommended until the hydrologic regime has recovered. This recommended deferment of regeneration harvest will be for at least 1 decade, i.e. until prescribed thresholds are achieved. See Opportunities for Commodity Production, Chapter 7 for further rationale. This recommendation is a clarification of implementing existing direction, it is not a change in the Forest Plan.

A7 Special Old Growth

The A7 Special Old Growth land allocation established by the Forest Plan is completely engulfed by the Riparian Reserve land allocation of the President's Plan. The A7 goal to *". . . provide for a high degree of interaction between people and forests with old growth character"* is recognized as incompatible with the riparian reserve and Tier 1 Key Watershed management direction.

A recommendation to remove the A7 land allocation is offered. Preclusion of human presence is not the intent of this recommendation, rather a recognition that encouraging human interaction with old growth is not the appropriate primary goal of this portion of the ecosystem. This amendment to Forest Plan management direction is to be addressed in the President's Plan - Forest Plan Reconciliation Report (currently in development).

B8 Earthflow

The B8 Earthflow land allocation established by the Forest Plan is intended to apply to large masses of slowly moving land. The movement is based in deep seated physical processes of geology and hydrology. Although land masses experiencing these kinds of processes are prevalent in the subbasin, the "ancient landslides" described in Fish Creek (see Chapter 4, Hillslope Processes) do not appear to be experiencing these kinds of processes.

A recommendation is offered to further field verify the physical processes occurring within the B8 allocation in Fish Creek and determine the appropriateness of removing the B8 designation and treating these lands as B6 Special Emphasis Watershed. If further analysis determines the change is warranted, this recommendation would take the form of a Forest Plan amendment.

Social

Off-highway Vehicles

Forest Plan standards and guidelines give management direction that helps address the use of off-highway vehicles in Fish Creek Watershed:

B6-003 and B6-004

The development of new or expansion of existing recreation sites, facilities and trails (hiking and cross-country skiing) may occur, but should avoid or protect sensitive watershed lands.

The President's Plan stipulates that no additions to total road mileage in key watersheds is to occur. With regard to resource impacts, off-highway vehicle trails and uses are recognized as part of the road mileage in the watershed. This type of recreational activity is difficult to manage and control; funds to administer off-highway developments are typically not available or very limited across the Forest. Unmanaged and uncontrolled off-high vehicle use in the watershed is not seen as compatible with the Aquatic Conservation Strategy and B6 management direction.

A recommendation is offered to prohibit off-highway vehicle use within Key Watersheds. This recommendation would take the form of a Forest-wide standard and guideline.

Roads

New road construction on the landform unit characterized by weak pyroclastic rocks on steep slopes is not recommended. The environmental impacts, including increased landslide risk, sediment delivery and altered surface and subsurface water flow associated with road construction on this landform unit is contrary to management objectives in Key Watersheds.

Information Needs

Table 7-4 in this section displays additional information or analysis needs that would have strengthened the analysis for Fish Creek. In certain instances available information relegated discussion and conclusions presented in the analysis to inferential levels. The additional information identified in Table 7-4 would allow more conclusive discussion of relationships between management activities and changes in functioning of ecosystem components. Development of new information could also require additional analysis work to identify relationships. Additional information needs are also related to key questions that were excluded from the analysis because data was not available in a format that could be developed into useful information.

Table 7-4. Information Needs.

Process	Data Needs	Analysis Needs	Research Needs
Flow Regime - Peakflow	• Long-term flow records to validate modeling assumptions	• Existing models do not address contribution of roads or role or stand thinning on peakflow • Assess changes in channel substrate associated with altered peakflows	• Effects of thinning on peakflow response
Flow Regime - Baseflow	• Long-term baseflow records, lack data for tributary streams		• Effect of riparian species composition on baseflow
Water Quality - Temperature	• Continuous data for key tributaries or critical reaches of mainstem to assess temperature • Information on riparian species composition, structure, canopy closure for assessing shade/temperature relationships	• Run Shadow module to assess stream temperatures at specific points or reaches	
Channel Morphology - Bank Stability	• Information on stream bank stability • Effects of landslide deposition on stream channel characteristics		
Aquatic/Riparian LWD Recruitment Potential	• Information on vegetative composition or structure in riparian areas		
Aquatic Habitat - Pool Quality	• Data on pool depth, substrate particle size distribution		

Process	Data Needs	Analysis Needs	Research Needs
Aquatic - Hillslope Processes	• Quantitative information on sediment delivery rates for mass movement events, including field validation • Quantitative information on sediment delivery from/to aquatic systems	• Sediment contributions to aquatic systems from mass wasting • Sediment contribution of roads to aquatic system	
Terrestrial - Vegetation/ Disturbance	• Effects of management activities on soil productivity • Cryptogam species distribution, including President's Plan survey and manage species • Current fire risk within the drainage, emphasis on riparian buffer strips where blowdown has occurred and on the LSR's. • Stand productivity, time until canopy closure and shifts in seral stages	• Loss of growth potential and site capability • Subbasin plan for managing within the RNC for seral stages	• Fire history, including amount of historic underburning (watershed and subbasin scale)
Terrestrial - Vegetation/Seral Condition	• Role of Fish Creek in the functional & interconnected old growth ecosystem, historically • Mapping of sites considered unsuitable for timber management • Current seral stage condition of LSRs adjacent to Fish Creek • Wildlife life history guild habitat data on BLM and private lands	• Effect of moisture & weather gradients on range of natural conditions for mix of early, mid and late seral forests • Contribution of unsuitable TM sites to habitat connectivity for late seral & continuous canopy dependent species • Quantity, quality and distribution of late seral habitat within riparian reserves in the future • Projection of LSR capability for supporting and sustaining late seral habitat in the future • Habitat conditions historically and in the future for wildlife life history guilds	

Process	Data Needs	Analysis Needs	Research Needs
Terrestrial - Late Seral Wildlife Pops	• Complete spotted owl occurrence & reproduction data within and adjacent to the watershed • Mapping of lands not capable of providing dispersal habitat for spotted owl, e.g. 11-40 habitat • Population and life history data for late seral associated wildlife	• Determination of location, quantity & quality of suitable nesting, roosting & foraging habitat for spotted owl • Adequacy of dispersal habitat for spotted owl & other late seral associated species • Role of Fish Creek in supporting goshawk populations	• Capability of Clackamas R. corridor LSR for supporting spotted owl life history needs
Wildlife - Herptiles	• Herptile community, composition, species distribution, relative abundance and age class data	• Past and current conditions and effect of current mgmt. direction on these species	
Wildlife - Invertebrates	• Identification & understanding of invertebrate functional groups	• Past and current conditions and effect of current mgmt. direction on these species groups	
Wildlife - Bio Diversity	• Past and current populations of species in peril; Fish Creek habitat inventory • Historic range of western pond turtle; confirmed absence of bull frog in the watershed • Townsend's big-eared bat population status; hibernacula & roost sites; life history requisites in the watershed	• Watershed, subbasin and basin specific implementation strategies for existing recovery plans • Conservation strategies for species without recovery plans • Adequacy of Fish Creek beaver ponds for turtle population establishment • Effect of current mgmt. direction on this bat population	• Ecosystem effects of managing for minimum recovery populations levels versus fully functioning component levels

Process	Data Needs	Analysis Needs	Research Needs
Wildlife - Bio Diversity/CWD Levels	• Fish Creek specific coarse woody debris data in early, mid and late seral habitat • Population levels and trends of primary and secondary cavity users & their prey items	• Strategies for recovering from current highly reduced CWD levels	• Ecosystem effects of highly depressed CWD associated populations • Effect of depressed CWD associate populations on invertebrate populations that effect tree growth and mortality
Wildlife - Bio Diversity/Security Habitat	• Degree and extent of human presence in the watershed		• Tolerance of species to human activities
Huntable Populations	• Quantification of forage availability trends for deer-elk • Deer-elk population levels & use patterns in the watershed • Band-tailed pigeon reproduction & foraging activity in watershed	• Projections of forage produced in the future due to current mgmt. direction • Subbasin and Fish Creek role in achieving ODFW's North Santiam Unit herd management objectives • Conservation strategy	• Role of huntable populations in the ecosystem • Effect of hunting & trapping on species recognized as in peril, e.g. harlequin duck, band-tailed pigeon, marten and fisher
Human Use	• Impacts of dispersed sites on aquatic system (introduction of pathogens and sediment)		

Monitoring

Monitoring, as described in the Federal Agency Guide for Pilot Watershed Analysis, is used to evaluate environmental change. Fish Creek watershed analysis has displayed key processes and factors that are either unique or important. The following monitoring priorities are based on value of data for better understanding processes, and/or potential to show significant early changes.

Table 7-5. Monitoring Priorities

Process	Monitoring Objective	Parameters to Monitor
Connectivity and Interconnectedness of Late Seral (LS) Habitat Systems	Evaluate function of LS systems and processes	• LS habitat development within LSRs (both in and out of Fish Creek Watershed) • LS habitat development within Fish Creek Riparian Reserves • Spotted owl dispersal habitat quality (continuity of canopy closure, quantity of 11-40 habitat, % of watershed in LS habitat)
Biological Diversity (Species Richness)	Evaluate attainment of species richness conditions	• Re-establishment of extirpated and near extirpated native species (e.g. peregrine falcon, fisher, w. pond turtle) • Reduction of exotic species (e.g. noxious weeds)
Coarse Woody Debris Habitat	Evaluate trends of snag dependent species and processes	• Quantity and quality of snag habitat in early and late seral habitat • Population levels of primary and secondary cavity users and their prey populations (e.g. Douglas fir bark beetle)
Security Habitat	Evaluate effects of people presence on intolerant species and associated processes	• Degree and extent of human presence • Security of selected peregrine and Townsend's big-eared bat sites • Open road density • Population trends of dependent species, e.g. wolverine
Huntable Deer and Elk Populations	Evaluate trends in recreational hunting opportunities	• Quantity and quality of forage available • Road density (winter and non-winter range) • Contribution to ODFW Herd Management Objectives

Process	Monitoring Objective	Parameters to Monitor
Landscape Pattern and Vegetative Condition	Evaluate processes affecting landscape pattern and vegetative condition	• Insect and disease populations • Fire risk • Stand productivity, canopy closure • Seral stage shifts across the landscape, relationship to estimated range of natural condition • Effects of any selective harvest activities
Hillslope	Validate information on unstable areas and evaluate recovery of hillslope processes	Following 10 year storm events, evaluate debris flows and debris slides in the following areas: - <20 year old clearcut harvest units - potentially unstable Riparian Reserves - high debris flow hazard landslides
Water Quality	Evaluate source of sediment (management vs. natural)	• Inventory streams during storm events using source search methodology
Channel Geomorphology	Evaluate channel recovery	• Continue V* surveys, establish permanent photo point and cross-channel transects • Continue PNW monitoring
Peak and Baseflows	Evaluate hydrologic recovery	• Continue USGS gauging station
Stream Temperature	Evaluate temperature changes	Establish long term temperature stations at: - subwatersheds with greatest amount of early seral in Riparian Reserves (Pick Creek) - intermediate mainstem reaches - mouth of Fish Creek
Aquatic Insects	Evaluate effects of recovery of hydrologic processes on aquatic species	• Continue aquatic invertebrate monitoring in least impacted sub-watershed (Music or Fall Creek) and along intermediate mainstem reaches
Anadromous Salmonids	Population increases or decreases	• Continue to support PNW population and habitat research
Human Use	Evaluate patterns and effect of use	• Effect of dispersed sites

Other Monitoring/Research Needs

There is a lack of understanding of how debris slides have affected "high energy" tributaries in Fish Creek and overall impacts to channels. Questions to answer are particle size moved, affects on channel morphology and location of impacts.

We encourage continuing the relationship with the Pacific Northwest Research Station. Watershed Analysis has determined some potential impacts of upslope processes on aquatic biota, and future research could be strengthened by evaluating links between aquatic habitat and hillslope processes, i.e. "how has pool quality been affected by debris flows?" It is also important to maintain the long term data set of habitat and population surveys.

The C-3 table of the ROD lists species in the "survey and manage" category. See Analysis File for lists of species from table C-3 believed to inhabit the Fish Creek Watershed. A basin, subbasin or Forest level strategy for addressing these needs is not available; the Fish Creek watershed role in any such strategy is yet to be determined.

Landscape Analysis and Design

A landscape analysis and design was completed for the Fish Creek watershed, to answer the key question: "What landscape pattern would best meet ecological objectives and social expectations for the watershed over time?". The results of the watershed analysis procedure were used in the 8-step Forest Landscape Analysis and Design process (Diaz and Apostol 1992).

The process included: identification of current landscape structures; mapping of flows across the landscape; analysis of the relationship between structures, patterns, and flows within the watershed; description of natural disturbances and successional processes within the watershed; description of functional linkages between the Fish Creek watershed and adjacent areas; determination of existing landscape pattern objectives from the Mt. Hood Forest Plan and the President's Plan; and the development of narrative landscape pattern objectives. Using the above information, coupled with landform analysis and spatial design techniques, a conceptual design of the desired landscape pattern was developed for the Fish Creek watershed.

(Copies of the Fish Creek landscape analysis and design summary and of the concept design will be available soon.)

Appendix A

(included in separate document)

United States
Department
of Agriculture

Forest Service

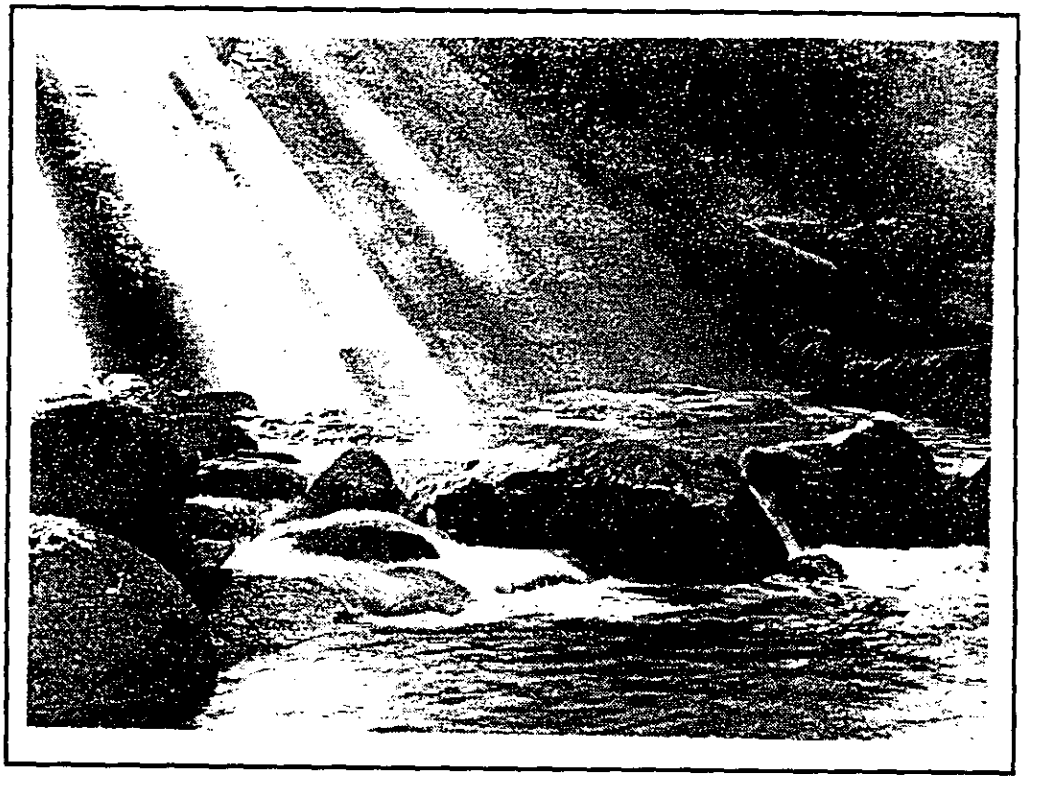
Pacific
Northwest
Region

1994

Appendix A

Watershed Analysis

Fish Creek Watershed



Mt. Hood National Forest

September 1994

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Appendix A – Technical Documentation for Fish Creek Watershed Analysis, Chapter 4 (Past and Current Condition)

Terrestrial Ecosystem

Vegetation

Existing Vegetation

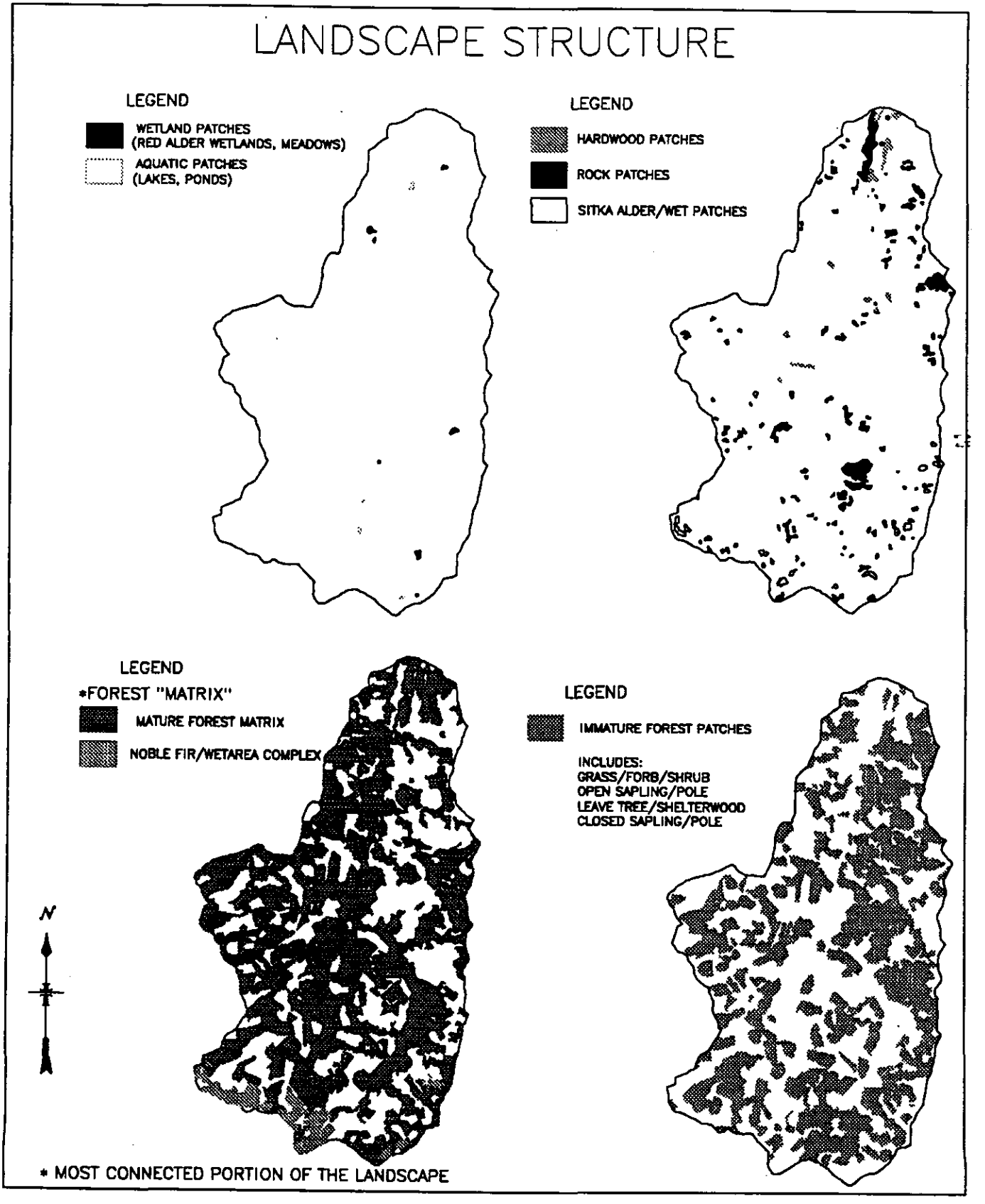
A new vegetation database for Fish Creek was created by combining information from MOMS (Mature and Overmature database), TRI, SCCA (Species and Communities Conservation Analysis database), stand exam information, Area 7 ecology plot data, and special habitats information (see Analysis File for more detailed information about the vegetation database).

Landscape Structure

Map A-1 is a landscape structure map which displays the current condition of the Fish Creek watershed. The structural elements of the Fish Creek landscape are divided into six broad categories:

- matrix (landscape ecology terms)
- hardwood patches,
- immature forest patches,

Map A-1. Current Landscape Structure



- wetland patches,
- aquatic patches, and
- rock patches.

The matrix within Fish Creek is defined as mature forest, a combination of large and small sawtimber. The "matrix", in landscape ecology terminology, is defined as the most connected portion of the landscape, the vegetation type that exerts the most control over landscape dynamics (Forman and Godron 1986, Diaz and Apostol 1992). [Note the difference between use of the word "matrix" here and the President's Forest Plan matrix.] Although Fish Creek is quite fragmented, mature forest is still the most connected forest type.

The predominant tree species within the forest matrix are Douglas-fir (Pseudotsuga menziesii), western hemlock (Tsuga heterophylla), Pacific silver fir (Abies amabilis), noble fir (Abies procera), mountain hemlock (Tsuga mertensiana), red alder (Alnus rubra), and bigleaf maple (Acer macrophyllum). Understory species include vine maple (Acer circinatum), rhododendron (Rhododendron macrophyllum), swordfern (Polystichum munitum), salal (Gaultheria shallon), Alaska huckleberry (Vaccinium alaskaense), beargrass (Xerophyllum tenax), and numerous forbs and grasses. The small sawtimber matrix areas within Fish Creek are primarily mid seral stands, although some are late successional stands on poorer, high elevation sites. Complexes of noble fir and Sitka alder (Alnus sinuata) wet areas, found in the headwalls of Fish and Wash Creeks, are also part of the mature forest matrix.

Immature forest patches include the following structural classes: grass/forb/shrub, open sapling pole, closed sapling pole, Sitka alder shrub patches, and leave tree and shelterwood stands.

Other landscape patch types identified within the Fish Creek watershed are:

- hardwood patches (both mixed red alder-conifer stands and stands of pure red alder or bigleaf maple);
- wetland patches (shrub-graminoid meadows and red alder swamps);
- aquatic patches (lakes and ponds); and
- rock patches (rock outcrops, talus slopes, and quarries).

Special Habitats

Map A-2 shows the wetland areas that were identified in Fish Creek. There are 5 red alder wetlands, 2 small meadows, and 4 lakes or ponds.

Also shown on the wet areas map are additional areas that were identified as special habitats. These are areas, found primarily at the southern end of the watershed in the glaciated headwaters of Fish and Wash Creeks, which contain numerous scattered seeps and springs. These areas were identified based on vegetative characteristics, combined with local knowledge, and need further ground-truthing. They have been divided into two categories:

- Sitka alder patches with numerous seeps and springs, and
- noble fir/Sitka alder complexes with scattered seeps and springs.

They are very unique areas and provide a great deal of diversity to the watershed. Two of the areas identified have been previously harvested. (See Analysis File for USFWS wetland classification for Fish Creek).

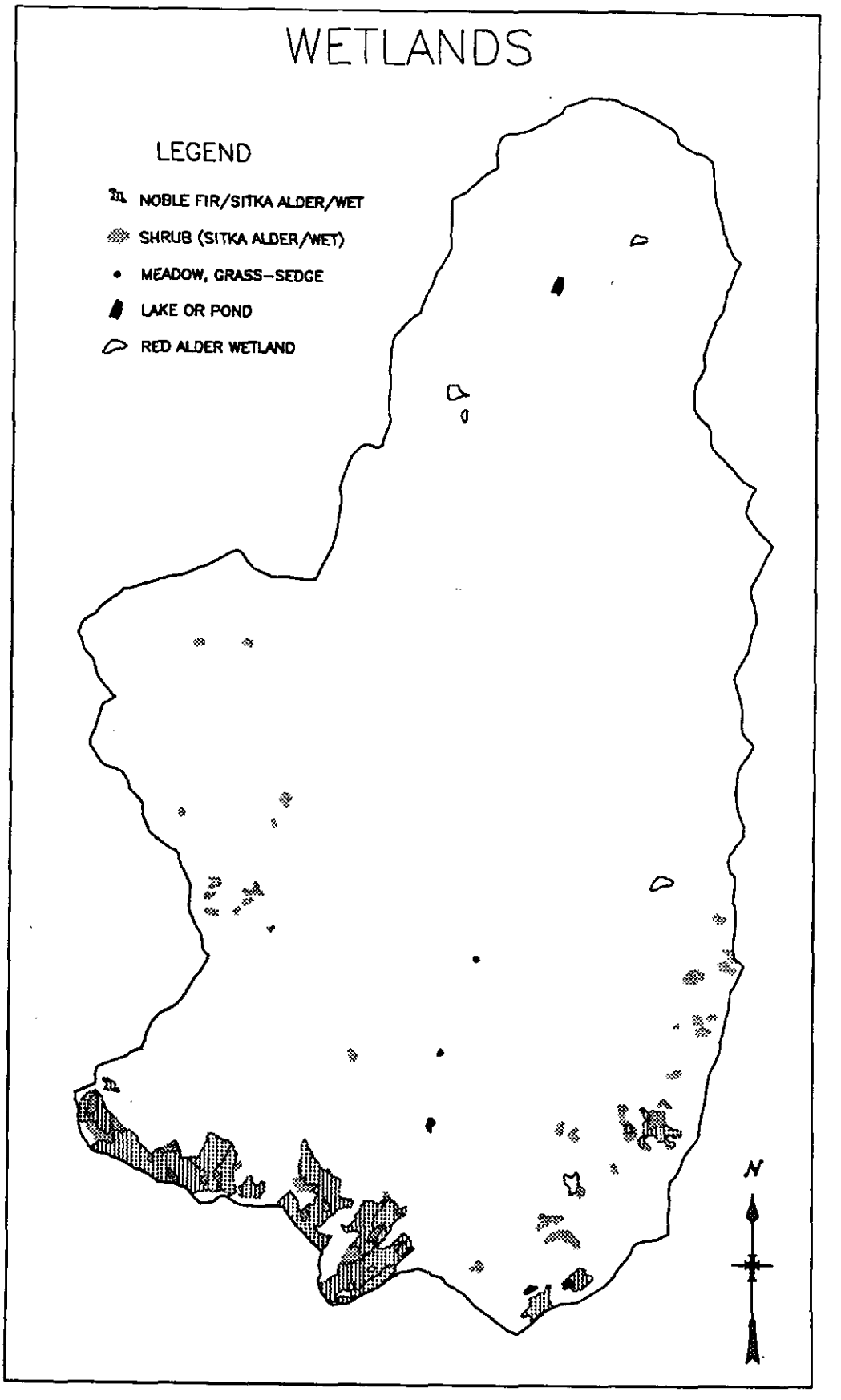
Rock/talus natural openings were also identified as part of the special habitats mapping (see Map File, "Rock/Talus"). Rock outcrops and talus slopes were categorized based on type and cover of vegetation present. Classification was based on presence of tree or shrub cover, it is recognized that lichens and mosses are also important members of the vegetative community on many of these sites.

A map showing hardwood and mixed hardwood stands within the Fish Creek watershed is also available in the Map File. All of the special habitats described above are important contributors to habitat and species diversity within the watershed.

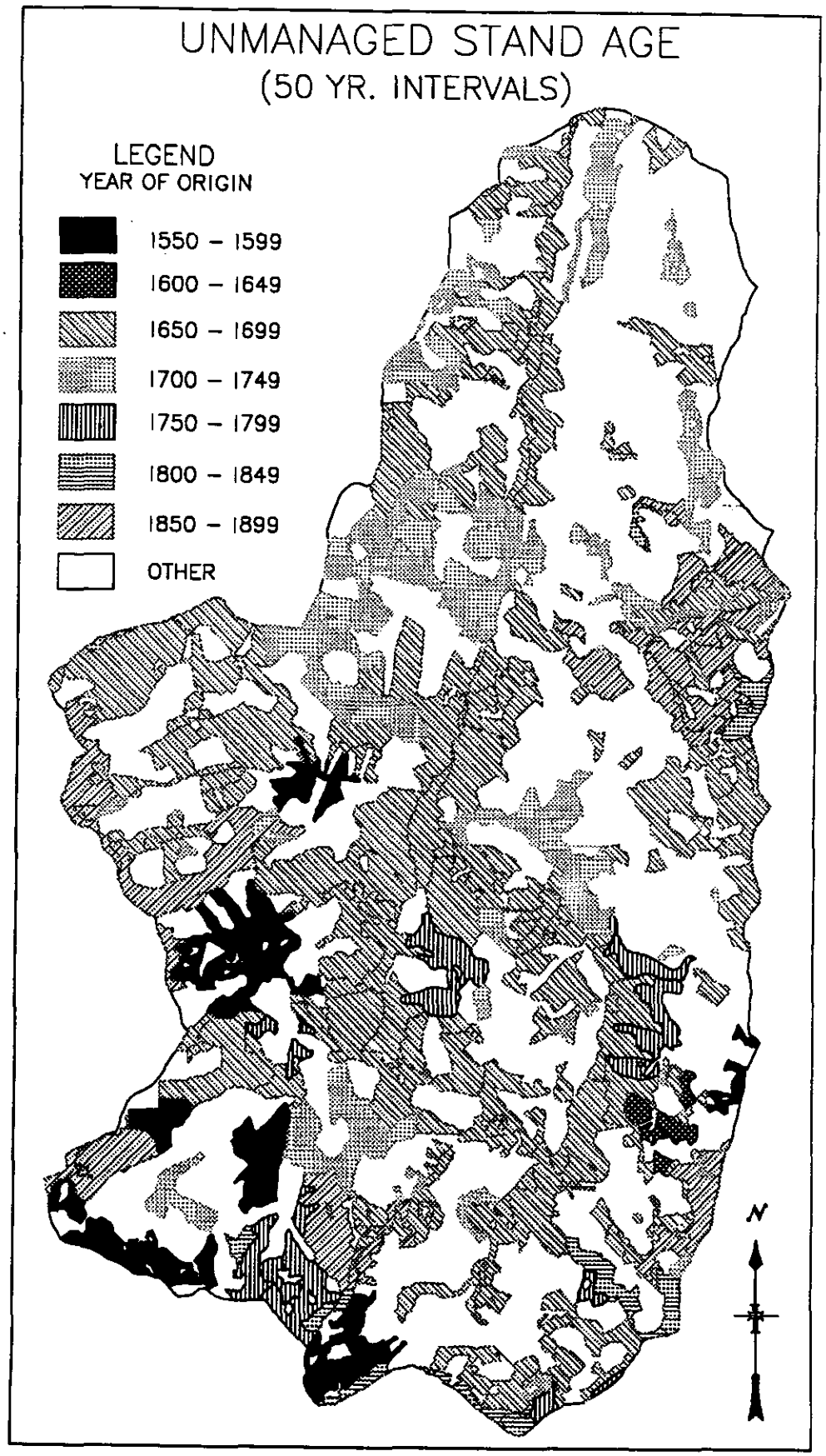
Age Distribution

Map A-3 shows the ages of unmanaged stands within Fish Creek, by 50 year increments. The oldest stands in the watershed are between 395 and 444 years old. These stands are located primarily in the southwestern quarter of the watershed. Most of the unmanaged stands in the watershed are between 245 and 344 years old. The younger natural stands are found primarily along the ridges.

Map A-2. Special Habitats: Wet Areas



Map A-3. Stand Age



Seral Stages

Thirty-seven percent of the vegetated acres in the Fish Creek drainage are in an early seral condition, 17% in mid seral, and 46% in late (Map A-4). The early seral stands in Fish Creek were created almost entirely through clear-cutting. The only exceptions are a very few small burned areas, such as the recent Wash Creek fire in upper Wash Creek. Mid seral stands within the Fish Creek watershed include both older managed stands (harvest began in the mid 1940's) and some areas where mid-size stand replacement fires occurred around the turn of the century (for more information see Disturbance section).

For this analysis, seral stages were defined according to stand structure rather than stand age. Late seral stands were defined as stands dominated by conifers at least 21 inches in diameter at breast height (these stands are generally older than 80 years). The mid seral category included closed sapling pole stands (average stand diameter less than 8 inches, dense canopy) and small sawtimber (stands dominated by conifer trees ranging from 8-21 inches in diameter). A problem with this definition is that some late successional stands on poorer, high elevation sites are included in the mid seral category. The early seral category consists of grass/forb/shrub stands, shelterwood and leave tree stands, and open sapling pole stands (conifers greater than 10 feet tall, less than 60% canopy cover).

Figure A-1 shows the percentage of each subwatershed in early, mid, and late seral. The only subwatershed that really stands out is Third Creek, with 54% of the subwatershed in mid seral and only 14% in late seral. This is because most of the subwatershed burned just prior to 1900.

Map A-4. Seral Stages - Present.

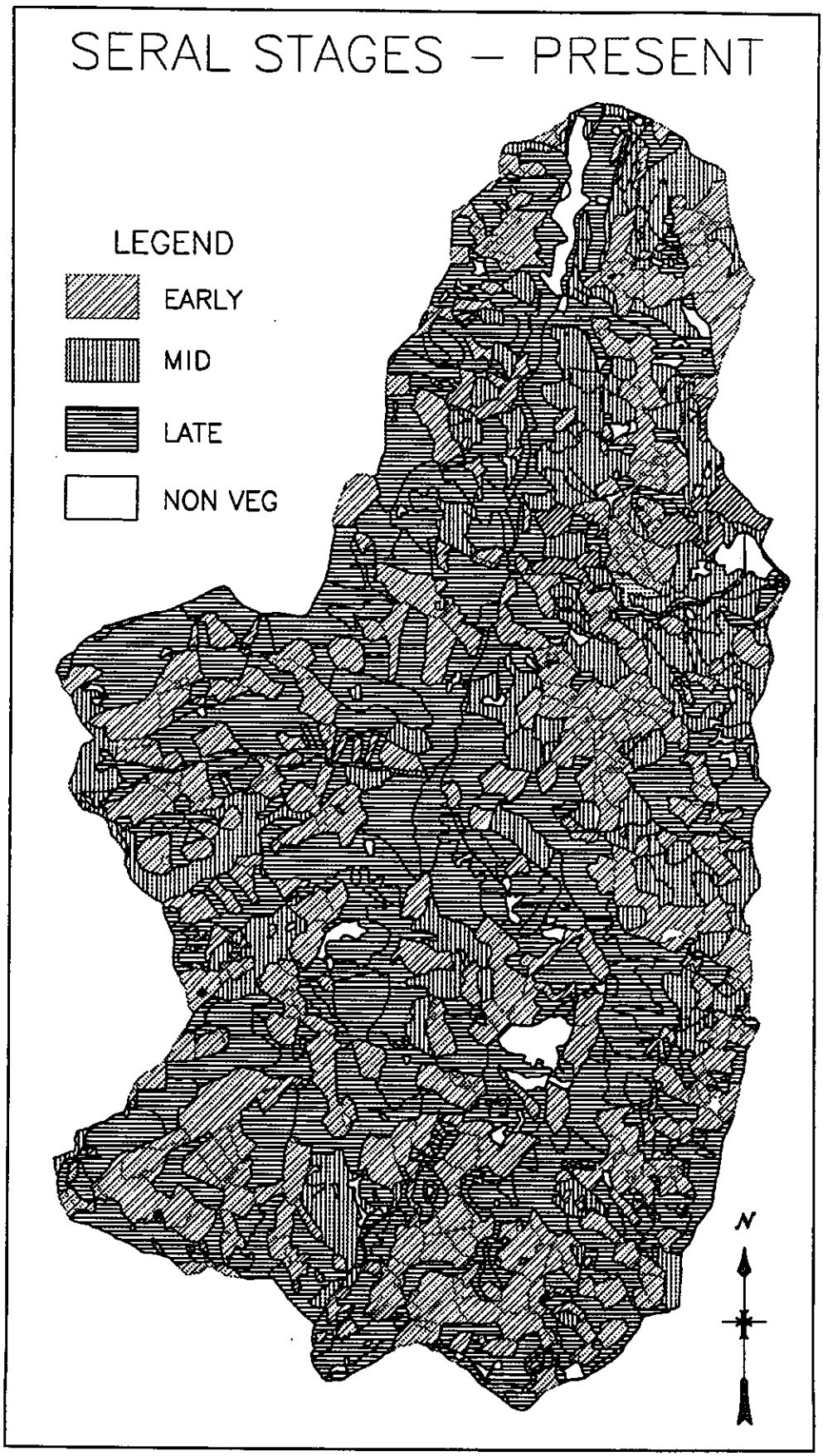


Figure A-1. Seral stage by subwatershed. Values shown are percentage of each subwatershed in early, mid and late seral stage.

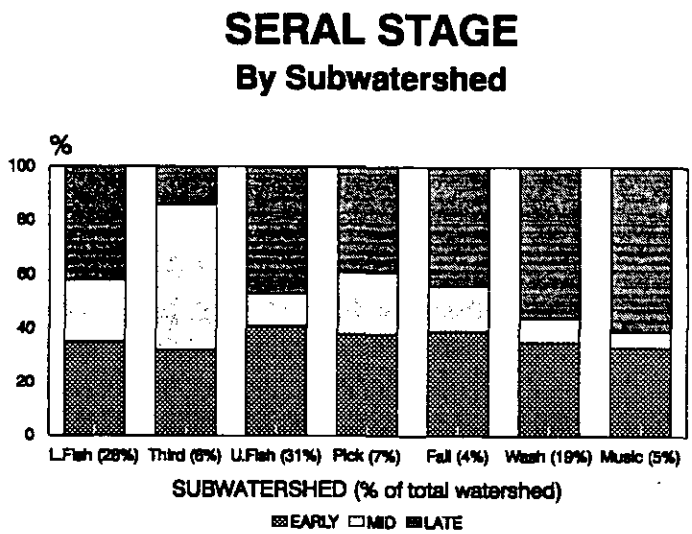
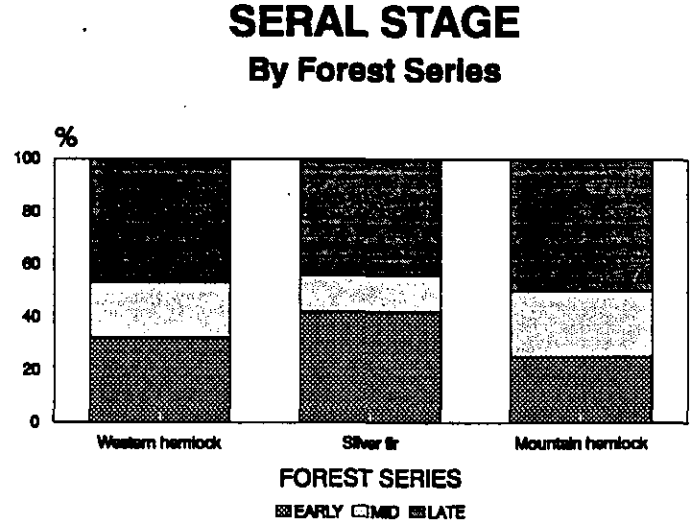


Figure A-2 shows the percentage of each forest series (or vegetation zone) within the various seral stages. Fish Creek drainage is roughly half in the Pacific silver fir zone and half in the western hemlock zone. The mountain hemlock zone is a very minor component of the watershed (3% of the total area). Forty-two percent of the Pacific silver fir zone is in early seral, compared to 32% of the western hemlock and 25% of the mountain hemlock zone. The higher percentage of the Pacific silver fir zone in early seral is due to the fact that timber harvest in Fish Creek began in the more accessible western hemlock zone, and many of these earlier harvest areas have entered the mid seral stage.

Figure A-2. Seral stage by forest series. Values shown are percentage of each forest series in early, mid, and late seral stage.



Range of Natural Variability

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

In 1993, the Pacific Northwest Region undertook an assessment of the natural range of variability for a number of key ecosystem elements, elements that are believed to be key to ecosystem health and sustainability. This analysis was done at the subbasin scale and is referred to as REAP (Regional Ecological Assessment) (USDA, 1993).

Figures A-3 and A-4 show the relationship between the current condition of Fish Creek and the estimated natural range of variability in the Clackamas subbasin (from REAP) for two of the identified key ecosystem elements, amount of late and early seral vegetation. These numbers are expressed as percent of the total area (either watershed or sub-basin) within each forest series.

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

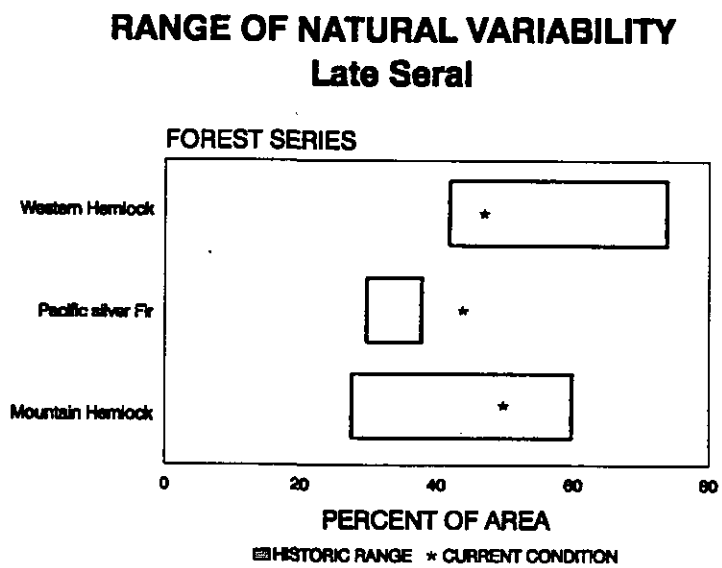


Figure A-4. Current condition compared to historic range of amount of early seral vegetation. Values shown are percentage of the total area within each forest series.

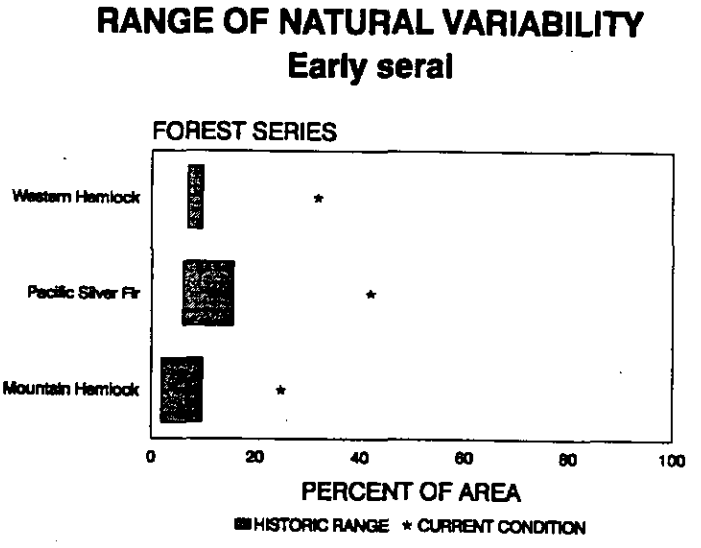


Figure A-3 shows that the amount of late seral vegetation in Fish Creek is within the range of natural variability in the mountain hemlock and western hemlock zones. The current condition within the western hemlock zone is at the lower end of the natural range. There is currently more late seral in the Pacific silver zone in the natural range. It is important to note that for the Clackamas subbasin the Pacific silver fir zone had a very narrow estimated range, compared to the other forest series.

All three forest series are outside of the natural range of variability in terms of amount of early seral vegetation (Figure A-4). There is currently 22% more of the western hemlock zone in early seral than would be expected under the natural disturbance regime, 26% more in the Pacific silver fir zone, and 15% more in the mountain hemlock zone. This is due almost entirely to timber harvest and some associated blowdown, there have been only minor areas impacted by fire in Fish Creek in the last 95 years.

It is important to note that overall percentage of area within various seral stages is not the only factor that has been altered by management, it has also greatly effected the pattern of the vegetation (see Landscape Pattern section). It is also important to note for Fish Creek that late seral does not mean "untouched" stands. Many of the stands classified as late seral have had salvage activities and some have been "pre-logged", where the mid-story western hemlock trees were harvested.

Potential Vegetation

Forest Series

There are three forest series found within the Fish Creek drainage: western hemlock, Pacific silver fir, and mountain hemlock (Halverson et al., 1986, Hemstrom et al., 1982)(see Map File, "Forest Series"). A forest series (or vegetation zone) is the area within which a particular tree species is dominant in the climax plant community. The western hemlock zone occurs at lower elevations within the drainage, occupying approximately 45% of the watershed. Fifty-two percent of the watershed is in the mid to higher elevation Pacific silver fir zone, and approximately 3% of the watershed is in the high elevation, mountain hemlock zone. The mountain hemlock zone is found primarily along the southern boundary of the watershed, with a few isolated, higher elevation areas along the eastern boundary (Whaleshead and Fish Creek Mtn.) and on Camelsback ridge.

Plant Associations

Plant associations are units that are used to classify plant communities. They are groupings of plant species recurring across the landscape within particular environments (Daubenmire, 1968). Plant associations describe the potential, or climax, plant community, the vegetation that would eventually occupy a site in the absence of disturbance. The group of species that eventually becomes dominant on a site is an indicator of environmental conditions. The classification of sites into plant association types allows us to make inferences about a wide range of ecosystem functions and responses, simply by examining the vegetation.

Fish Creek drainage supports a wide variety of plant associations. There are 15 western hemlock, 14 Pacific silver fir, and 3 mountain hemlock associations found within the watershed (see Map File for plant association maps).

Plant associations within the western hemlock zone include:

TSHE-PSME/HODI	Western hemlock (WH)-Douglas-fir/oceanspray
TSHE/POMU-OXOR	WH/swordfern-oxalis
TSHE/POMU	WH/swordfern
TSHE/ACTR	WH/vanillaleaf
TSHE/BENE-GASH	WH/Oregongrape-salal
TSHE/BENE	WH/Oregongrape

TSHE/BENE/POMU	WH/Oregongrape/swordfern
TSHE/ACCI/ACTR	WH/vine maple/vanillaleaf
TSHE/OPHO/SMST	WH/devil's club/ starry solomonseal
TSHE/VAAL/OXOR	WH/Alaska huckleberry/oxalis
TSHE/RHMA/XETE	WH/rhododendron/beargrass
TSHE/RHMA-VAAL/COCA	WH/rhod.-Alaska huck./ dogwood bunchberry
TSHE/RHMA-GASH	WH/rhododendron-salal
TSHE/RHMA-BENE	WH/rhododendron-Oregongrape
TSHE/VAAL/COCA	WH/Alaska huckleberry/ dogwood bunchberry

Plant associations within the Pacific silver fir zone include:

ABAM/BENE	Pacific silver fir (PSF)/ Oregongrape
ABAM/OPHO	PSF/devil's club
ABAM/TIUN	PSF/foamflower
ABAM/OXOR	PSF/oxalis
ABAM/ACCI/TIUN	PSF/vine maple/foamflower
ABAM/CLUN	PSF/queencup beadlilly
ABAM/MEFE	PSF/fool's huckleberry
ABAM-TSHE/RHMA-GASH	PSF-WH/rhododendron-salal
ABAM/RHMA-VAAL/COCA	PSF/rhod.-Alaska huck./ dogwood bunchberry
ABAM/RHMA-BENE	PSF/rhod.-Oregongrape
ABAM/RHMA/XETE	PSF/rhod./beargrasss

ABAM/VAAL/COCA	PSF/Alaska huck./ dogwood bunchberry
ABAM/VAAL-GASH	PSF/Alaska huck.-salal
ABAM/VAME/CLUN	PSF/big huckleberry/ queencup beadlilly

Plant associations within the mountain hemlock zone include:

TSME/VASC	Mountain hemlock (MH)/ grouse huckleberry
TSME/VAME/XETE	MH/big huckleberry/beargrass
TSME/RHAL	MH/rhododendron

Stratification

The drainage was stratified into 5 broad groups of plant associations:

Wet, Headwall Associations

The headwalls of Fish and Wash Creek are dominated by the wet, higher elevation Pacific silver fir/devil's club association. Other moist plant associations within the area include Pacific silver fir/foamflower, Pacific silver fir/fool's huckleberry, and Pacific silver fir/big huckleberry/queencup beadlilly. More exposed, drier microsites in the headwall area, such as on exposed ridges, support Pacific silver fir/Alaska huckleberry/dogwood bunchberry and Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry communities.

Dry, Cliff Associations

The basalt cliffs in lower Fish Creek support the dry Western hemlock-Douglas-fir/oceanspray association on the most exposed sites, along with the slightly less dry, but still droughty, Western hemlock/vine maple/vanillaleaf association.

Warm Associations

The dominant associations in the northern portion of the watershed (lower Fish Creek) are Western hemlock/swordfern-oxalis and Western hemlock/swordfern. These associations are not found anywhere else in the watershed. Other associations found in the area include Western hemlock/Oregongrape/swordfern, Western hemlock/vanillaleaf and some Western hemlock/Oregongrape-salal on the west side of Fish Creek. These are all relatively warm associations.

Rhododendron Associations

Associations containing rhododendron (Pacific silver fir/rhododendron/Oregongrape, Pacific silver fir/rhododendron/ beargrass, Pacific Silver fir/rhododendron-Alaska huckleberry/ dogwood bunchberry, Western hemlock/rhododendron-salal, Western hemlock/rhododendron-Oregongrape, Western hemlock/ rhododendron/ beargrass) dominate most of the remainder (mid-portion) of the watershed. The beargrass associations seem be to found primarily on Camelsback ridge and the west side of the drainage.

Moist Associations

Throughout the mid-portion of the drainage there are smaller groupings where moist site associations such as Pacific silver fir/oxalis, Pacific silver fir/foamflower, and Pacific silver fir/vine maple/foamflower predominate. Drainage patterns and aspect are determinants of these areas.

Plant Species of Concern

Threatened, Endangered, and Sensitive Species

There are no known federally Threatened or Endangered plant species found in the Fish Creek watershed or on the Mt. Hood National Forest. There are four documented locations of the Sensitive species Aster gormanii within the watershed, and five sites just outside the watershed boundary. Aster gormanii is a candidate species for federal listing as Threatened and is classified as Threatened throughout its range by the Oregon Natural Heritage Program. There are no other documented Sensitive plant species locations. There are several other Sensitive vascular plant species that have potential to be found within the watershed (see species list below). Highest probability habitat is found in riparian and rocky areas (see Map File, "Special Habitats").

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

Tall agoseris	Agoseris elata	2E
Gorman's aster	Aster gormanii	1Th, X
Moonwort	Botrychium minganense (B. lunaria)	2Th
Cold-water corydalis	Corydalis aquae-gelidae	1Th, X
Fir club-moss	Huperzia occidentalis	2Th
Adder's tongue	Ophioglossum vulgatum	2E

Loose flowered bluegrass	Poa laxiflora	3
Pale blue eyed grass	Sisyrinchium sarmentosum	1Th, X
Lance-leaved grape-fern	Botrychium lanceolatum	2Th
Mountain grape-fern	Botrychium montanum	2E
Pinnate grape-fern	Botrychium pinnatum (B. boreale)	2Th
Pale sedge	Carex livida	2
Tall bugbane	Cimicifuga elata	3
Three leaf goldthread	Coptis trifolia	2
Fir club-moss	Lycopodium complanatum	2Th
Bog club-moss	Lycopodium inundatum	2Th
Scheuchzeria	Scheuchzeria palustris v.americana	2Th
Kruhsea	Streptopus streptopoides	2Th
Lesser bladderwort	Utricularia minor	2
Water-meal	Wolffia columbiana	2

X = Federal Candidate Species

Oregon Status:

1 = Endangered or Threatened throughout range.
2 = Endangered or Threatened in Oregon but more common or stable elsewhere.
3 = Limited in abundance throughout range but currently stable.

E = Endangered.
Th = Threatened.

All known sensitive plant locations, and survey area boundaries and dates are mapped and on file at the Mt. Hood NF Supervisor's Office and Estacada Ranger District (these maps are not available for general distribution). Sites mapped on the TES map layer include all known historic sites. Documented sites in the Fish Creek watershed date to circa 1979. None of these known sites have been "impacted". (See Analysis File for more information pertaining to sensitive plant survey locations and for sources of information used in this assessment).

Noxious Weeds/Non-native Vegetation

Noxious weed species occurring within the Fish Creek watershed include: St. Johnswort (Hypericum perforatum), tansy ragwort (Senecio jacobaea), Canada thistle (Cirsium arvense), and scotch broom (Cytisus scoparius). These species are found throughout the watershed, in areas associated with roads, timber harvest activities and recreational use (see Map File, "Noxious Weeds"). Other non-native invasive species are found in the same kinds of locations. The only other significant area within Fish Creek where human activities have altered the native vegetation and introduced non-native species is at the Fish Creek pier site.

Plant Species Diversity

Fish Creek was found to be one of two watersheds on the Mt. Hood NF with the lowest total vascular plant species diversity. This analysis was based on potential habitat, not on actual species presence. Fish Creek was found to contain potential habitat for 450 plant species, as compared to the most diverse watershed on the Mt. Hood which contained habitat for 1074 species. Fish Creek was also determined to contain potential habitat for 47 introduced plant species, and 7 sensitive species. (See Analysis File for a list of potential vascular plant species within Fish Creek, and a list of potential species associated with special habitats within the watershed).

Lichens, Bryophytes, and Fungi

The President's Forest Plan calls for the survey and management of numerous species of fungi, lichens, bryophytes, and vascular plants. Information on these species within the Fish Creek drainage, especially non-vascular plants, is lacking. Fish Creek does contain potential habitat for many of these species (see Analysis File).

Existing information concerning lichens, bryophytes, and fungi is incomplete. See Analysis File for the best available compilation of species lists including:

- Sensitive cryptogam species known to exist on the Mt. Hood NF, and
- various lichen, bryophyte and fungi species lists assembled for the west side of the Forest.

Wildlife

Late Seral Habitat

The overriding process affecting distribution, quantity and quality of late seral (LS) habitat is the human political process, specifically, establishment of land management direction (e.g. late seral or old growth land allocations) and the objective of providing timber volume to the local economy wherever management direction allows.

Subbasin Context

In the late 19th century approximately 86% of the Fish Creek watershed was in a LS forest condition (see Landscape Structure section, Appendix A). Although some other watersheds in the Clackamas Subbasin apparently had similar magnitudes of LS forest, much of the subbasin was characterized by higher percentages of early and mid seral habitat due to higher frequencies of large scale fires, e.g. North Fork Clackamas and Roaring River Watersheds. The distribution of large blocks of LS habitat is believed to be important to many dependent biota.

As a part of the Gang-of-Four event (Johnson, et al 1991), Late Successional Old Growth (LSOG) areas were inventoried throughout the range of the northern spotted owl. Within the Clackamas Subbasin significant blocks and corridors of late seral and potential late seral habitat were identified (see map in the Analysis File). Fish Creek watershed was recognized as containing a portion of 2 LSOGs that lie predominantly outside the watershed and 1 that lies largely within the watershed. All 3 were identified with the classification of LSOG-1, i.e. the "most significant" classification. The 2 LSOGs mostly outside the watershed are the Clackamas River corridor (paralleling the river and stretching from the headwaters to the Forest Boundary) and the Memaloose Lake/South Fork Mountain area (shared with BLM). The LSOG within the watershed also paralleled the stream system, stretching from the lower elevations encompassing the lower mainstem of Fish Creek canyon, through the confluence of Fish Creek and Wash Creek, and extending to the headwaters of Wash Creek (including some BLM acreage). Much of the west aspect of upper Fish Creek canyon was also included in the LSOG.

The President's Forest Plan ROD established Late Successional Reserves (LSRs), therefore, determining the distribution of large blocks of LS habitat in the future. The large LSRs (i.e. >10,000 acres) provide population centers for late seral associated wildlife, e.g. northern spotted owl and pileated woodpecker. The viability of these species is dependent upon 2 longterm factors:

- Maintenance of late seral habitat within LSRs.
- Providing habitat adequate for these species to disperse among the LSRs.

Map A-5 and Table A-1 display all of the LSRs (other than unmapped spotted owl activity centers, see Wildlife section of Appendix A) in the Clackamas Subbasin. The Fish Creek Watershed is displayed in relation to these LSRs (Map A-5).

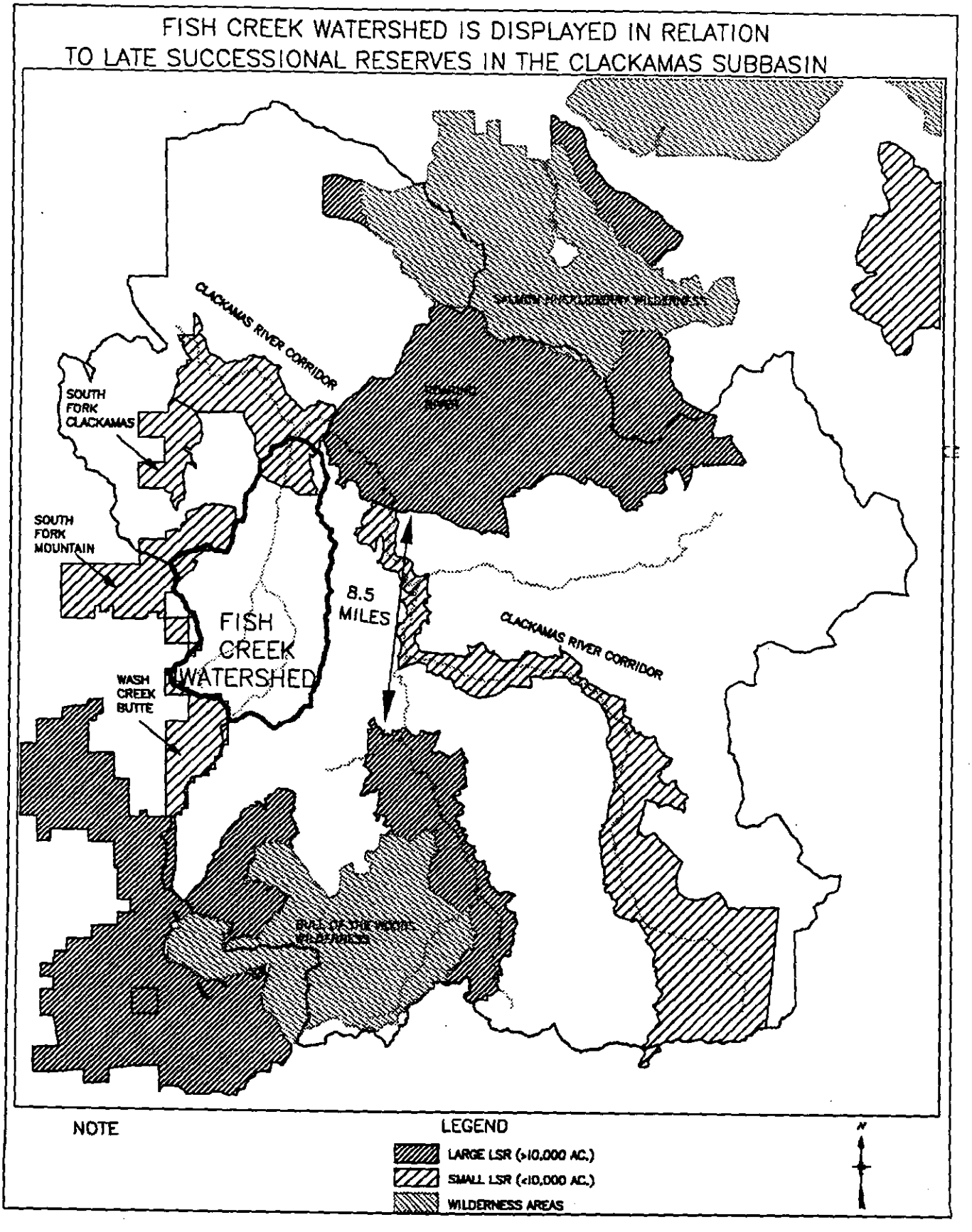
Table A-1. Late Successional Reserves Associated with Fish Creek Watershed are Described

LSR*	Goal**	Acreage	Ownership
Roaring River/Salmon Huckleberry Wilderness Complex	• Terrestrial LS habitat • Spotted owl population center	> 10,000 ac	NFS (MTH)
Bull of the Woods/ Collawash/Bagby Complex	• Terrestrial LS habitat • Spotted owl population center	> 10,000 ac	NFS (MTH & WIL) & BLM
Table Rock Wilderness Complex	• Terrestrial LS habitat • spotted owl population center	> 10,000 ac	BLM
Clackamas River Corridor	• Riverine LS habitat		NFS (MTH)
South Fork Mountain	• Spotted owl pairs & dispersal	< 10,000 ac	NFS (MTH) & BLM
Wash Creek Butte	• Spotted owl pairs & dispersal	< 10,000 ac	NFS (MTH) & BLM
South Fork Clackamas	• Spotted owl pairs & dispersal • Low elevation LS	< 10,000 ac	NFS (MTH)

** Geographic names are provided; wilderness areas are included as part of large LSR "complexes".*

***** General goals are provided for descriptive purposes. LSR-specific goals are not established by the ROD and should be developed as part of Basin or Subbasin watershed analysis.***

Map A-5. Fish Creek Watershed is Displayed in Relation to Late Successional Reserves in the Clackamas Subbasin



The role of Fish Creek Watershed in providing for a functional and "interconnected old growth ecosystem" across the subbasin is inherently a reflection of the condition of the surrounding LSRs with respect to old growth or late seral habitat. Two measures of the current condition of the LSRs are quantity of late seral habitat present and population status of late seral associated species. Data regarding LSR percentages of early, mid and late seral conditions are available in the Analysis File. See Wildlife section of Appendix A regarding northern spotted owl populations in the large LSRs.

Watershed Context

Current management direction (i.e. the Mt. Hood Forest Plan, as amended by the President's Plan) has the following LS habitat expectations of Fish Creek Watershed. These expectations are considered Fish Creek's contribution to achieving the President's Plan ROD objective to "provide for a functional and interconnected old growth ecosystem" (ROD p.5) and to provide for spotted owl viability. See Wildlife section of Appendix A regarding spotted owl dispersal habitat as a measure of "interconnectedness".

- There are no large (i.e. >10,000 acres) LSRs essential for spotted owl viability in the watershed.

- Fish Creek plays an essential role in providing habitat for spotted owl dispersal among LSRs (i.e. this portion of the Forest and subbasin is currently highly fragmented habitat and the distance between large LSRs is quite high).

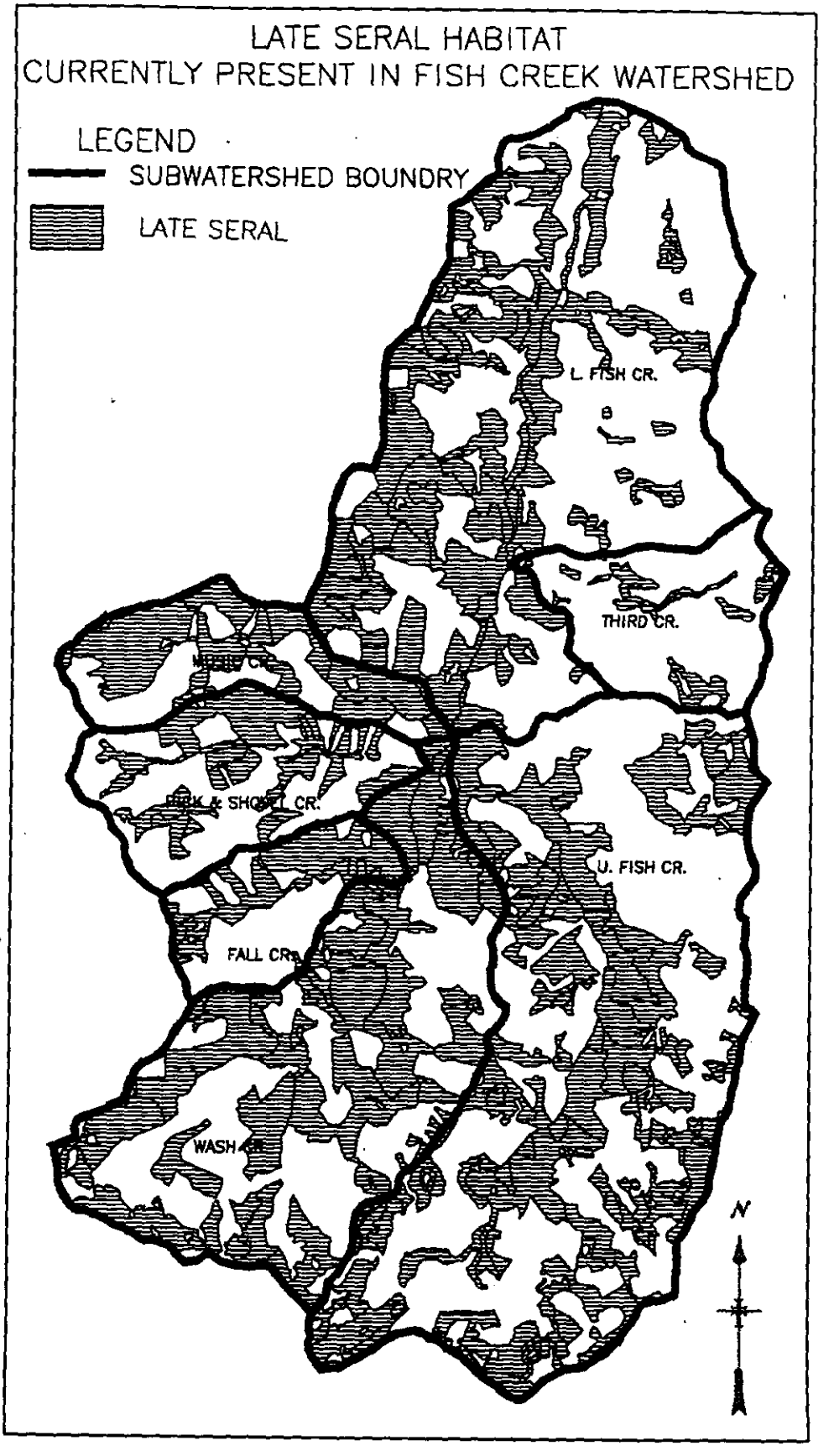
- Ten spotted owl activity centers are present in the watershed. One hundred acre core areas will be retained as LS habitat for each activity center.

- Riparian reserves, providing some linkage among LSRs, will be managed for a high percentage of LS habitat in the future.

- Other LSRs include some minor portions of their respective acreages within the watershed.

The 46% of the watershed in LS habitat is well represented in all 3 of the vegetation series present. Percentages for the western hemlock, silver fir and mountain hemlock are 47%, 44% and 50%, respectively. All 7 subwatersheds also have substantial LS habitat persisting, with the exception of Third Creek, which has only 14% LS habitat. See Analysis File tables for further data. Map A-6 displays the LS habitat currently present in the watershed (see Analysis File for maps stratifying by vegetation series).

Map A-6. Late Seral Habitat Currently Present in Fish Creek is Displayed With Subwatersheds Depicted



For analysis purposes existing LS habitat was lumped into descrete LS blocks. These LS blocks, displayed in Map A-7, are subjective aggregations of existing LS habitat interspersed with other seral stages. These aggregations are centered around the largest remaining stands of LS habitat. Attributes describing current habitat conditions and disturbance of the LS blocks are displayed in Table A-2. A subjective characterization of relative significance of each LS block is included in Table A-3.

A depiction of LS interior habitat is included in Map A-7. Interior habitat is the portion of the LS habitat least affected by edges and associated edge processes (e.g. wind patterns and temperature changes).

Map A-7. Late Seral Blocks and Interior Habitat Identified in Fish Creek are Depicted

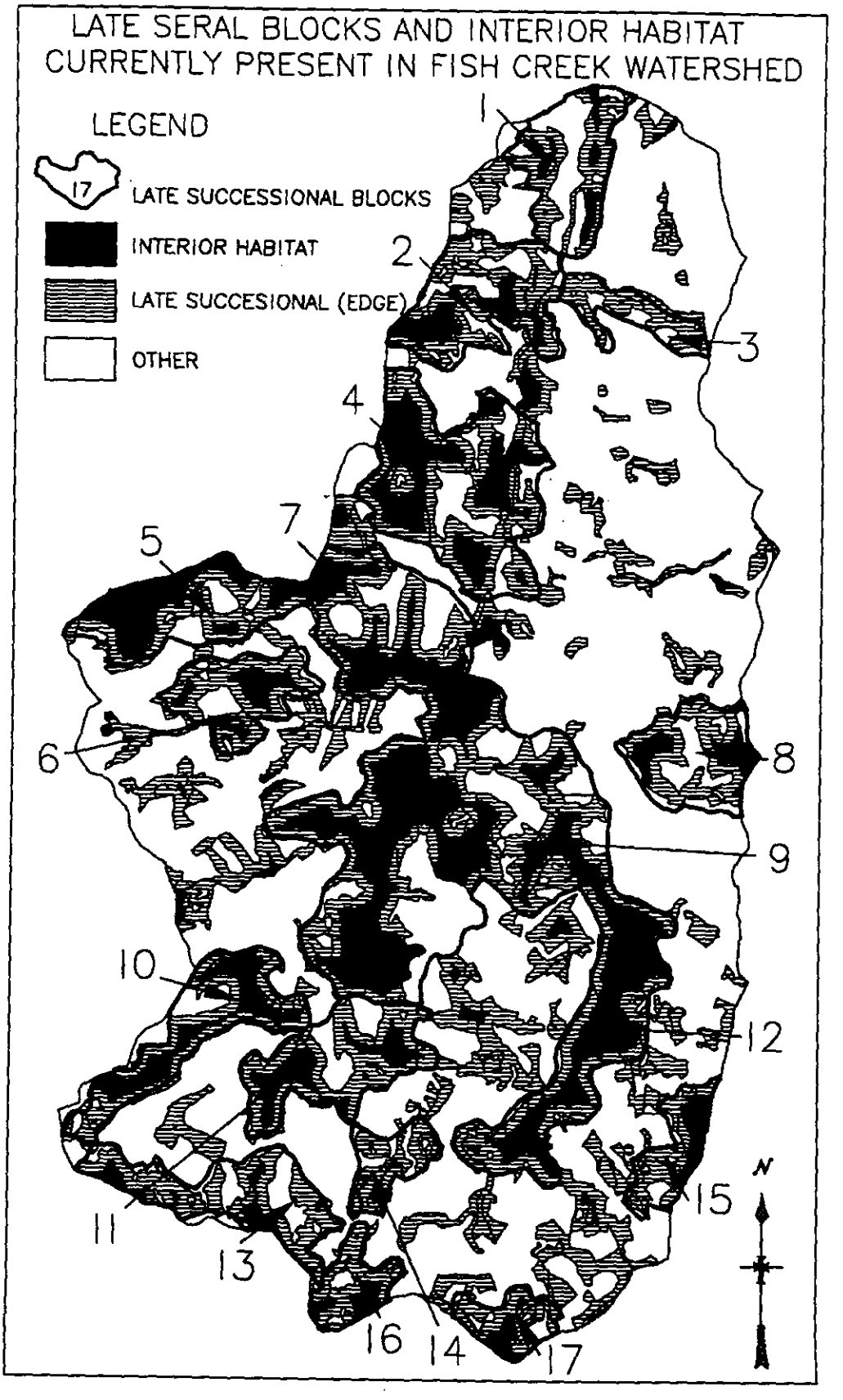


Table A-2. Attributes Describing Current Condition and Disturbance of Late Seral Blocks in Fish Creek Watershed are Displayed

Late Seral Block	Total Acres	Interior Habitat Acres & %	Range of LS Stand Age	Seral Stage %	CWD	Roads	Human Presence	Spotted Owl Activity Center
1	645	61 9.4%	250-350	E = 9.0 M = 13.2 L = 54.7	High	Med	W = M NW = L	No
2	804	158 19.7%	250-350	E = 13.1 M = 9.1 L = 72.1	Low	Med	W = H NW = M	Yes
3	264	1 0.3%	300-350	E = 18.2 M = 7.6 L = 65.9	Low	High	W = M NW = L	No
4	1394	459 32.9%	250-350	E = 11.1 M = 9.4 L = 79.0	Med	Med	W = H NW = M	Yes
5	712	311 43.7%	300-350	E = 16.7 M = 0.0 L = 82.7	Low	Med	W = H NW = M	No
6	481	92 19.1%	300-350	E = 20.8 M = 0.0 L = 78.4	High	Med	W = H NW = M	Yes
7	944	282 29.9%	250-350	E = 24.8 M = 1.9 L = 72.6	High	Med	W = H NW = H	No
8	559	102 18.2%	300-350	E = 25.9 M = 6.3 L = 65.7	High	Med	W = H NW = M	Yes
9	3138	1210 38.6%	200-450	E = 120 M = 11.4 L = 73.7	High	Med	W = H NW = M	Yes
10	650	208 32.0%	100-450	E = 13.8 M = 1.6 L = 84.6	High	Med	W = H NW = M	Yes
11	740	155 20.9%	250-450	E = 20.9 M = 0.5 L = 77.7	High	Med	W = H NW = M	Yes
12	1043	490 47.0	200-400	E = 5.8 M = 0.8 L = 92.6	High	High	W = H NW = H	Yes
13	656	70 10.7%	150-450	E = 30.2 M = 0.3 L = 69.5	High	Med	W = H NW = M	Yes
14	248	9 3.6%	100-350	E = 10.5 M = 11.3 L = 71.8	High	Med	W = H NW = M	No
15	294	71 24.1%	100-350	E = 15.6 M = 1.4 L = 83.0	High	High	W = H NW = H	No
16	255	52 20.4%	150-450	E = 11.4 M = 0.8 L = 83.5	High	High	W = H NW = H	No
17	241	42 17.4%	150-350	E = 16.2 M = 0.0 L = 78.4	Low	Med	W = H NW = M	No

Legend: (Table A-2)

Late Seral Block: Number 1-17 based on delineations on Map A-7.

Total Acres: Sum of early, mid and late seral within the late seral block, as well as non-vegetated.

Interior Habitat: Total acres of interior habitat within the LS block and percent of total block (roads and the Watershed boundary were not counted as edges).

Range of LS Stand Age: Summary of the various late seral age classes present in the LS block.

Seral Stage %: The percentage of the total LS block in E (early), M (mid) an L (late) seral forest; nonvegetated percentages are not shown.

CWD: A subjective comparison (high, medium, low) of the relative quantity of coarse woody debris present in the LS block - based on records of past timber harvest and salvage activities.

Roads: A subjective comparison (high, medium, low) of the quality of LS habitat due to lack of roads, e.g. high indicates high quality habitat due to very few roads.

Human Presence: Subjective comparison (high, medium, low) of the quality of LS habitat due to lack of people presence during the winter (W) and non-winter (NW) seasons. High indicates minimal impact from human presence.

Spotted Owl Activity Center: Presence of a spotted owl activity center within the LS block (yes or no).

Table A-3. A subjective indication of relative significance of late seral blocks in Fish Creek watershed is provided. Late seral blocks are numbered on Map A-7.

Late Seral Block	Relative Size	Relative Contiguity	Degree of Security	Contribution to Connectivity
1	M+	L	L	NA
2	M	M	M	L
3	L	L	L	L
4	H	H	M	M
5	M+	H+	M	NA
6	M	M	M	M
7	M+	M+	H	M
8	M+	L+	M	M
9	H	H	M	H
10	M	M	M	H
11	M	M	M	H
12	H	H	H	H
13	M	L	M	M
14	L	L	M	H
15	L+	L+	M	M
16	L+	L+	M	H
17	L+	L+	M	H

Legend:

H = High M = Moderate L = Low
(**Note:** A + is added to indicate that interior habitat is higher than estimated due to juxtaposition with LS habitat outside watershed.)

Relative Size: A comparison of magnitude relative to other LS blocks in the watershed.

Relative Contiguity: A measure of lack of fragmentation relative to other LS blocks in the watershed. A measure of quantity of interior habitat present.

Degree of Security: A measure of lack of human presence relative to other LS blocks in the watershed.

Contribution to Connectivity: A measure of relative location in contributing to an interconnected late seral system across the subbasin. Factors considered include: habitat in key location not currently protected by management direction and location of Forest Plan B5 Land Allocations. LS blocks currently in LSR's are indicated as NA.

Three LS blocks were given 2 or more high rankings for relative significance in Table A-3:

- #4 Wanderers Creek area,
- #9 Wash Creek and Fish Creek confluence area, and
- #12 Upper Fish Creek canyon area

Numbers 9 and 12, as well as the lower elevations of number 4, were also recognized as highly significant in the Gang-of-Four publication (Johnson, et al 1991). Number 5, in the South Fork Mountain area, also stands out for its relatively high quantity of interior habitat (311 acres); this area is currently included in an LSR land allocation.

Biological Diversity

Of the 307 terrestrial vertebrates and aquatic amphibians considered inhabitants of the Mt. Hood National Forest, 237 are believed to occupy (for at least some portion of the year) Fish Creek Watershed. See Analysis File for complete species lists. Data to field verify actual presence of these species in the watershed are not available. Data are also not available regarding species richness for the Clackamas Subbasin or Willamette Basin.

Life History Guilds

These wildlife species have been grouped into "life history guilds" based on their response to landscape patterns and association with special habitats (Mellen, et al, 1993 working paper - see Analysis File). Life history guilds fall into 3 groupings: aquatic/riparian, special habitat and terrestrial (see Analysis File for complete descriptions and species lists). Terrestrial guilds were developed based on individual species':

- home range size,
- patch configuration use, and
- general habitat use (seral stage at the stand level).

Table A-4 displays the 17 terrestrial guilds and the life history attributes used to define them.

Table A-4. Life history guilds for terrestrial wildlife are defined based on habitat use attributes. Acreage of habitat available in Fish Creek Watershed is displayed for each guild.

Terrestrial Guild	Group	Home Range Size	Patch Type	Structural Stage	Fish Creek Watershed Acres	Percent
TLC	TERR	LARGE	CONTRAST	NA	20,156	0.64
TLGG	TERR	LARGE	GENERAL	General	31,681	1.00
TLME	TERR	LARGE	MOSAIC	Early	7,564	0.24
TLML	TERR	LARGE	MOSAIC	Late	13,277	0.42
TMC	TERR	MED	CONTRAST	NA	10,885	0.34
TMGG	TERR	MED	GENERAL	General	31,681	1.00
TMME	TERR	MED	MOSAIC	Early	9,486	0.30
TMML	TERR	MED	MOSAIC	Late	8,078	0.25
TMPE	TERR	MED	PATCH	Early	0	0.00
TSC	TERR	SMALL	CONTRAST	NA	8,278	0.26
TSGEM	TERR	SMALL	GENERAL	EMG	16,865	0.53
TSGG	TERR	SMALL	GENERAL	General	31,681	1.00
TSGML	TERR	SMALL	GENERAL	MLG	21,155	0.67
TSME	TERR	SMALL	MOSAIC	Early	2,558	0.08
TSMM	TERR	SMALL	MOSAIC	Mid	0	0.00
TSPE	TERR	SMALL	PATCH	Early	9,449	0.30
TSPL	TERR	SMALL	PATCH	Late	13,754	0.43

LEGEND

Terrestrial Guild (Summary of Group, Home Range, Patch Type and Structural Stage)

Group

TERR: Terrestrial habitat users (may use riparian or special habitats as well but do not require them). Other groups include aquatic and riparian

Home Range Size

SMALL: Home ranges < 60 acres
MED: Home ranges 60-1000 acres
LARGE: Home ranges > 1000 acres

Patch Type

PATCH: Species requiring one homogenous 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 requiring juxtaposition of two dissimilar structural stages.
GENERAL: Species that can use all types of terrestrial habitat in any landscape pattern.

Structural Stage

Early: Early seral structural stage.
Mid: Mid seral structural stage.
Late: Late seral structural stage.
EMG: Early or mid structural stage required.
MLG: Mid or late structural stage required.
General: Uses all structural stages.
NA: Not applicable.

Existing habitat acreage for each life history guild was estimated based on a spatial relationships model (Mellen, et al, 1993 working paper - see Analysis File). A comparison of acreages and percentages of habitat for each life history guild at 3 scales (Fish Creek Watershed, Clackamas Subbasin and Mt. Hood National Forest) is available in the Analysis File. Table A-4 displays acreages of terrestrial guild habitat for Fish Creek. Forestwide maps of habitat for terrestrial guilds are in the Analysis File.

Note: Estimates of habitat acreage available for these guilds historically (or in the future) have not been completed.

Special Habitat Associates

Special habitat conditions identified in Fish Creek Watershed include wetlands (Map A-2), waterfalls, talus slopes, rock outcrops (see map in Analysis File), cliffs and bridges, as well as, snags, down logs and duff/litter (Table A-5). A list of species that use special habitats for breeding, feeding or resting and a list of obligate users of special habitats is available in the Analysis File.

Table A-5. Special habitat conditions identified in Fish Creek Watershed are displayed.

Special Habitat Type	Acres
Aspen Groves	0
Bridges	Y
Buildings	0
Caves	Y
Cliffs	Y
Down Logs*	Y
Dry Meadows	0
Duff/Litter	Y
Lava Flows	0
Rock	898
Snags*	Y
Talus	93
Waterfalls	Y
Wetlands**	1,040

LEGEND:

Y denotes habitat is present but acreage is not known at this time.
0 denotes habitat is not known to occur in the watershed.

**See snag and log section for assessment of snag and log densities.*
***Wetlands include forested seeps and/or springs, shrub wetlands, and wet meadows.*

Cliffs (for peregrine falcon nesting) and caves (for Townsend's big-eared bat hibernating) found in the watershed are of particular importance for conservation of these species. Headwall seeps and springs (included in the wetlands acreage, Map A-2), found in the high elevation, glaciated land forms at the upper reaches of Fish Creek and Wash Creek are especially notable. These communities are believed to be quite limited in this part of the Cascade Range and provide highly valued habitat for a variety of vertebrate and invertebrate species.

Coarse Woody Debris Habitat Associates

Ninety wildlife species associated with snag habitat are recognized as inhabitants of the watershed (see table in the Analysis File). Sixteen and thirty-seven of these species are primary and secondary cavity nesters, respectively. Most of the primary cavity nesters are generalists and can make use of available snags in any seral condition; however, three species (black-backed woodpecker, pileated woodpecker and three-toed woodpecker) require snag habitat in a late seral forest condition. Most of the secondary cavity nesters are also generalists; however, 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. In summary, three groupings of species are of particular interest due to their relatively specialized snag habitat use patterns:

- primary cavity nesters requiring snags in late seral habitat,
- secondary cavity nesters requiring snags in early seral habitat, and
- secondary cavity nesters using snags in late seral habitat.

Nine species associated with snag habitat are also associated with lake or riverine riparian areas (see Analysis File table). Existing habitat for these species has been depleted compared to historic levels due to timber harvest and control of fire within riparian zones.

Snag densities currently present were analyzed based on Forest-wide inventories conducted in 1986 and 1992. Although, these inventories were not designed specifically to collect snag data, sufficient data exists in some cases to provide reasonable approximations of snag habitat available to associated wildlife. Tables stratifying these data by size class, decay class, plant series and seral stage are available in the Analysis File. These data were analyzed at the Forest-wide, Clackamas Subbasin and Fish Creek Watershed scales; numbers of inventory plots declined as the scale size declined making accurate estimations of snag densities increasingly more difficult - particularly at the watershed scale (see Analysis File). Figure A-5 displays snag densities estimated for unmanaged stands in the silver fir plant series at the Fish Creek Watershed, Clackamas Subbasin and Forest-wide scales (similar figures for the western hemlock and mountain hemlock plant series are in the Analysis File). Figure A-6 displays similar data for managed stands in the subbasin (data includes all plant series).

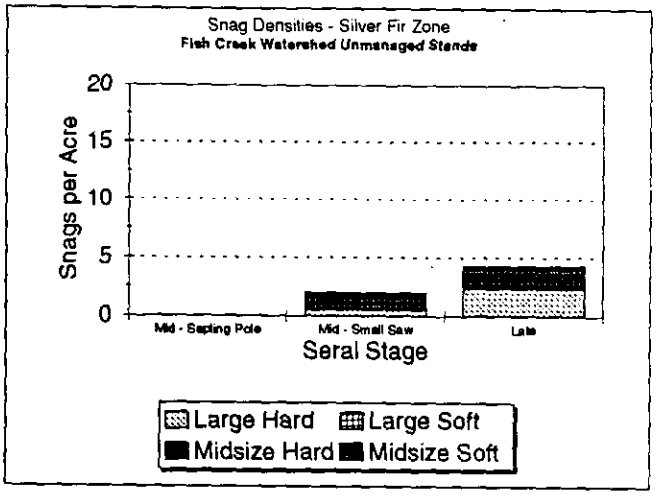
Snags in late seral forest habitat have declined markedly within the watershed in the last century - largely due to clearcut harvesting of late seral forest. However, many existing late seral stands also have depleted snag habitat due to salvage and prelogging timber management activities (see map in Analysis File).

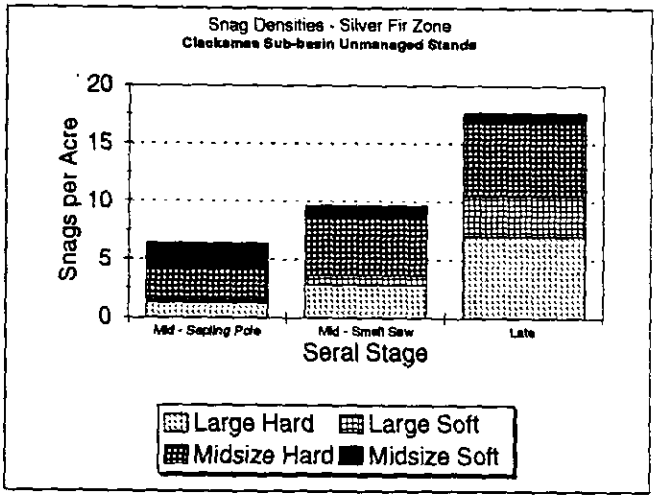
Although, historic snag density data are not available, typically early seral habitat created by stand-replacement fires was characterized by high densities of snags persisting from the previous forest. Most of the early seral stands in Fish Creek (created largely from clearcut harvesting) are nearly void of snag habitat (Figure A-6).

A century ago as much as 86% of the watershed was in late seral habitat with a fully natural compliment of snags. Today 46% of the watershed is in late seral habitat - some of which has a depleted snag supply due to salvage and prelogging. Habitat for pileated woodpecker, black-backed woodpecker and three-toed woodpecker (as well as the four species of secondary cavity users listed above) has substantially declined. Analysis sufficient to support conclusions regarding species viability is not available; however, a conclusion that these species are not serving a fully functional role in the Fish Creek Watershed ecosystem is reasonable.

Note: Douglas fir bark beetle is a common prey item of pileated woodpecker.

Figure A-5. Estimates of snag densities in unmanaged stands within the silver fir plant series are displayed at the Fish Creek Watershed, Clackamas Subbasin and Forest-wide scales.





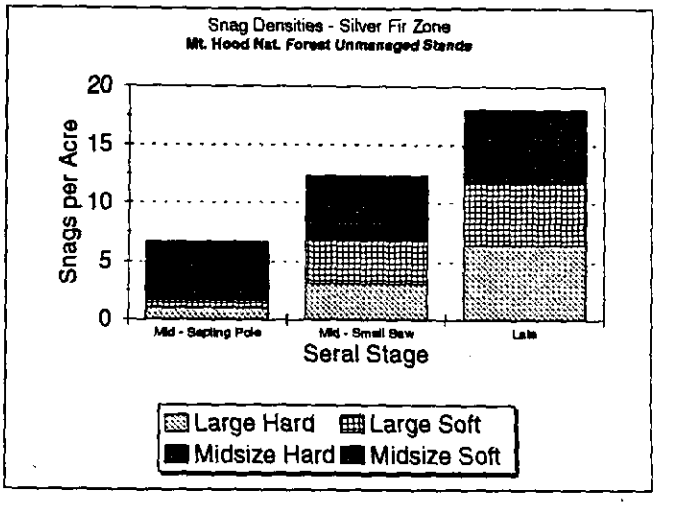
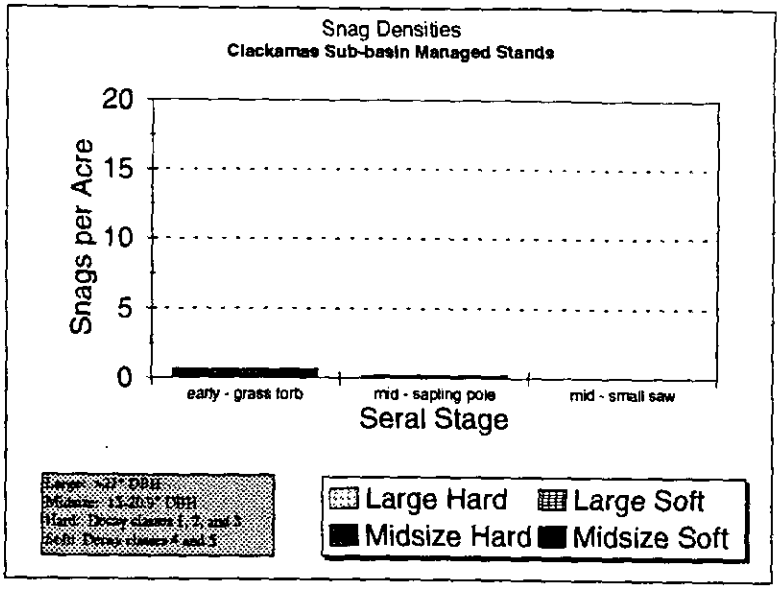


Figure A-6. Estimates of snag density in managed stands of the Clackamas Subbasin are displayed.



A century ago less than 14% of the watershed was in early seral habitat due to moderate sized fires. These stands likely had a relatively high density of snags. Today 37% of the watershed is in early seral habitat with a very low snag density. Habitat quantity and quality for western and mountain bluebird is substantially reduced.

> **Note:** Bluebirds feed heavily on the Lepidoptera family (moths) during the spring nesting period - including western spruce budworm.

Estimates of log densities were made based on a Forest-wide 1986 inventory. Data stratified by decay class, plant series and seral stage are available in the Analysis File. A list of Fish Creek Watershed wildlife species associated with log habitat is also in the Analysis File.

Species Sensitive to Human Presence

Numerous wildlife inhabitants of the watershed are recognized as sensitive to human activities. Sensitivity is defined in relation to human presence, i.e. recreational areas and roads - not habitat alteration. Sensitivity is interpreted as likelihood of displacement. A list of these species and the degree of sensitivity is in the Analysis File. One of these species (peregrine falcon) is listed as Endangered (under the Endangered Species Act); three others (California wolverine, harlequin duck, and Townsend's big-eared bat) are recognized as sensitive by the Regional Forester (FSM 2670).

Introduced Species

Five wildlife species have been introduced to the Fish Creek watershed in the last century and persist to some degree today. European starling, a competitor with secondary cavity nesting birds for nest sites, is the only recognized threat to ecosystem processes. A complete list of introduced species is in the Analysis File.

Northern Spotted Owl

In analyzing the past and current condition of spotted owl habitat and population viability, it is essential to address both temporal and spatial scales at the local level. Descriptions of past spotted owl population levels at the subbasin and watershed scales are not available and projections of future populations is difficult; available population data is limited to current conditions and is further limited by incomplete survey data throughout the subbasin and watershed. However, based on the President's Plan strategy for providing for spotted owl viability throughout its current range, the essential population data component is an understanding of current and projected populations of spotted owl within the designated LSRs. Fish Creek lies between the Salmon-Huckleberry Wilderness/Roaring River LSR complex and the Bull of the Woods/Collawash LSR complex (see Map A-5). Both LSR complexes are projected to have at least 20 spotted owl pairs present and need to maintain this population level to assure species and population viability (FEMAT). The Salmon-Huckleberry Wilderness/Roaring River LSR complex has 33 spotted owl activity centers; the Bull of the Woods/Collawash LSR complex has 26 spotted owl activity centers. These data meet current spotted owl inventory protocol (May 94 Regional Forester FSM 2670 letter).

In the late 19th century the majority of the Fish Creek watershed was in late seral habitat and presumably the spotted owl population was at its highest possible level - limited only by behavioral characteristics, e.g. territoriality. Population estimates during that time period are not available. Today, the 46% of the watershed in late seral habitat is in many places highly fragmented due to clearcut timber harvest activities. Although, the entire watershed is not completely surveyed for spotted owl presence, ten owl activity centers are recognized. Five of the spotted owl activity centers are presently blow "take" thresholds set by the USDI-Fish and Wildlife Service, i.e. these owl pairs are recognized as not having enough existing high quality habitat within there home range to sustain a viable, successfully reproducing pair. A table describing acreages by pair is in the Analysis File. Data sufficient to describe the success rate of these pairs in producing young that are actually successfully recruited into the adult population is not available.

USDI-Fish and Wildlife Service has designated critical habitat for the spotted owl under the Endangered Species Act. A large block of critical habitat is located east and northeast of the Fish Creek Watershed. Most of the higher elevations of Fish Creek Ridge are within the critical habitat unit. The pertinence of this designation is not clearly understood at this time.

Fish Creek Watershed's role in providing dispersal habitat for spotted owl was analyzed. Spotted owl dispersal success is recognized as a measure of "interconnectedness" in achieving the ROD objective (p.5) to "provide for a functional and interconnected old growth ecosystem". The watershed lies between two large LSRs (i.e. >10,000 acres) that are approximately 8.5 miles apart (see Map A-5). 46% of the watershed is currently recognized as late seral habitat. 52% of the watershed has stands comprised of trees at least 11 inches in diameter and with a canopy closure of at least 40% (see Analysis File). Additional description of dispersal habitat quality, addressing tree diameter and canopy closure, stratified by quarter township is available at the Estacada Ranger District.

Threatened, Endangered and Sensitive Wildlife Species

For a detailed analysis of the role of Fish Creek Watershed in providing for recovery and conservation of T, E and S species, see Chapter 3 and the Analysis File. The current conditions regarding threats and opportunities for selected T, E and S species are provided here.

Peregrine falcon are re-establishing as a nesting species in the Cascade Range. The Whales Head ridge area provides the best opportunities for nesting falcons in this portion of the subbasin. Human recreational access via existing roads and helicopter training flights are recognized as threats to the viability of nesting sites in this area.

Bald eagle habitat potential in the watershed is minimal - consisting of foraging and perching sites. The beaver ponds in the lower reaches of mainstem Fish Creek, Skookum Lake and Surprise Lake provide these potential opportunities.

The Forest Plan, as amended by the President's Plan, expectation of the watershed is to provide for northern spotted owl dispersal among surrounding LSRs. Ten spotted owl activity centers persist in the watershed. See spotted owl discussion (above).

One of two known hibernacula on the Forest for Townsend's big-eared bat is located in Fish Creek Watershed. Other hibernacula and maternity roosts are likely in the watershed as well, but locations are not known. Threats to the populations include impacts to the known site by human recreationsists and unprojected impacts to unknown sites. An additional potential threat is broad application of pesticides to control members of the Lepidoptera family - an apparent important prey item for these bats.

California wolverine are expected to have very large home ranges; the significance of Fish Creek Watershed for wolverine inhabiting the subbasin are not known. Conservation assessments and strategies are not available. The high human recreational uses along the lower mainstem of Fish Creek likely preclude wolverine use in both winter and non-winter seasons.

Harlequin duck have been observed in all watersheds of the subbasin, including Fish Creek. Conservation assessments and strategies are not available. Threats to reproducing harlequins in the watershed include loss of security habitat due to human presence along mainstem Fish Creek and habitat degradation due to removal of in-stream structure and stream-adjacent riparian vegetation.

Western pond turtle is believed extirpated from the Clackamas Subbasin. Fish Creek Watershed is considered to be at the fringe of the species' range - at best. A potential opportunity exists to establish a population of pond turtles at the lower Fish Creek mainstem beaver ponds. Conservation assessments and strategies are not available. Further analysis is needed regarding the viability of this opportunity.

Pileated Woodpecker and American Marten

The Mt. Hood Forest Plan designated B5 Pileated Woodpecker/Pine Marten Habitat Areas (FP p. Four-240) with the goal of providing for population viability for these species; five B5s were allocated within Fish Creek Watershed (see Analysis File). The President's Plan amended the Forest Plan to tentatively remove B5 land allocations (ROD) and to replace the B5 strategy for viability with a strategy built around LSRs and Riparian Reserves. Forests are to complete localized assessments to determine if adequate habitat is provided for these species to assure continued population viability; the assessment is currently in progress.

The B5s were originally allocated based on two primary criteria: available habitat and distribution of habitat to assure connectivity across the range of the species. The second criterion, distribution for connectivity, is of particular concern in Fish Creek Watershed. Three of the five B5s' location in the landscape are adequately maintained in the President's Plan via LSRs and Riparian Reserves. Two of the B5s represent locations or linkages across the landscape that are recognized as particularly important in bridging among reserves and are not maintained by the President's Plan. These locations are represented by the Lower Wash/Coffee Creek B5 and the Wear Creek B5 (see Analysis File). Further analysis is needed to validate this concern. No subbasin or basin wide analysis is available.

Landscape

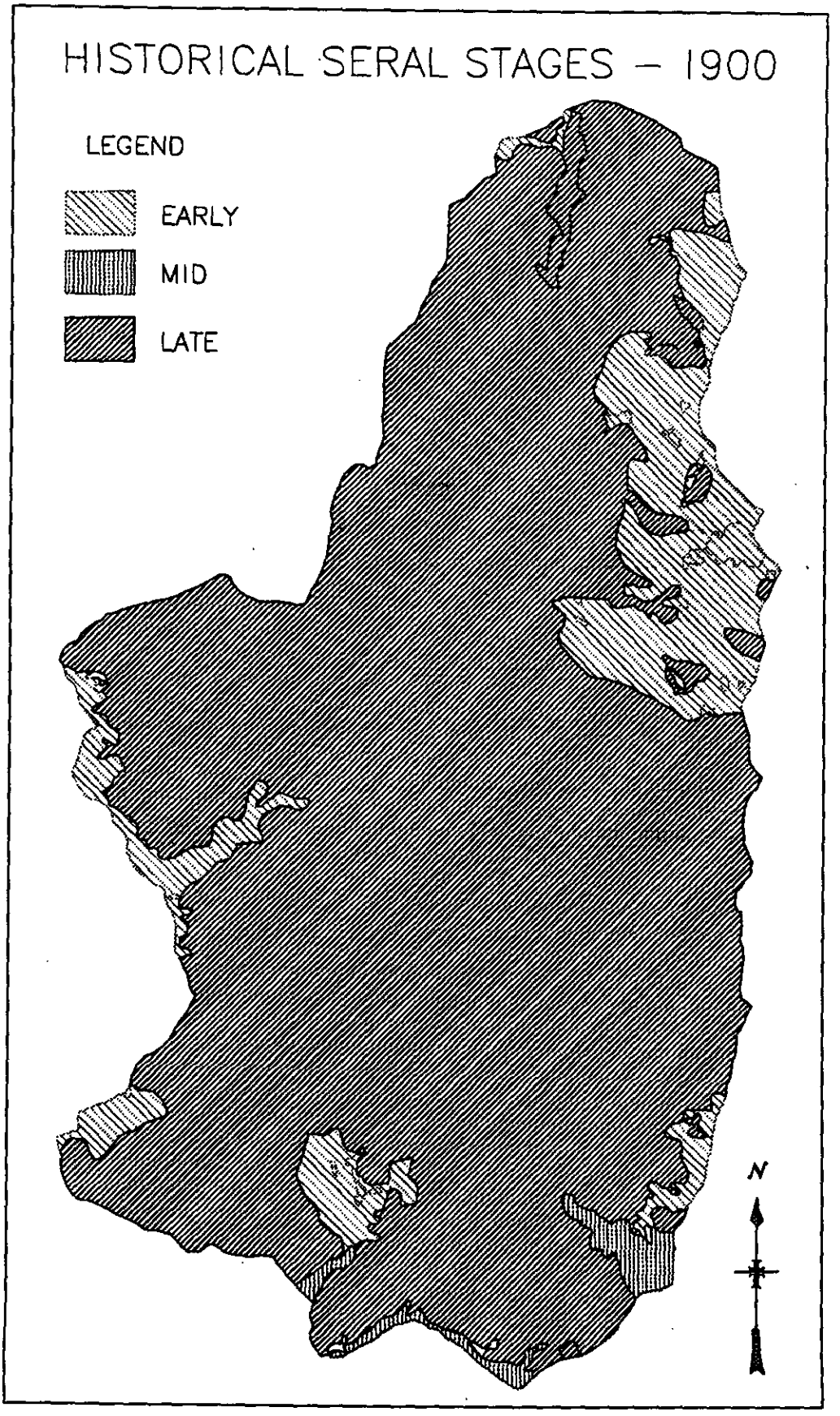
Disturbance

Reconstructed Landscape - 1900

Fire is the dominant landscape pattern-forming disturbance in this portion of the Cascades. The last major fire events in Fish Creek occurred during the period between 1850 and 1900. Map A-8 is a reconstruction of the Fish Creek landscape at the turn of the century, prior to the advent of fire suppression. The landscape pattern was reconstructed using 1946 aerial photographs and current age class information (see Analysis File for information on methodology and assumptions). Map A-8 shows the estimated amount of early, mid, and late seral stands within the watershed. In 1900, 13 percent of the watershed was in an early seral condition, 1 percent in mid, and 86 percent in late seral.

The early seral stands mapped originated from stand replacement fires occurring between 1850 and 1900. A working definition for the Mt. Hood National Forest is that it took up to 50 years for natural stands to reach canopy closure (mid seral condition) after a stand replacement fire. The amount of time varies by forest series and by area. In Fish Creek some of the stands would probably have reached the mid seral stage in less than 50 years.

Map A-8. Historic Seral Stages



The mid seral areas shown are mapped from age class information of stands originating between 1800 and 1849. There is very little of this age class in the watershed. It is found in the headwalls at the southern end of the watershed. The headwalls are very wet, with lots of seeps and springs, and it is possible that these stands are the result of some small, creeping fires. It could also be that they were mapped as younger stands on the age class map, because they are poorer, high elevation sites and looked "younger". This information needs more verification. Either way, there was very little stand replacement fire activity in Fish Creek between 1800 and 1849. Most of the watershed has a stand year of origin between 1650 and 1750 (see Existing Vegetation section).

Except for the fire shown on Camelsback ridge, all of the fires mapped extend over the ridges outside of Fish Creek. The larger fire in the watershed (Lower Fish Creek) extended east from the watershed toward the Clackamas River. The fire near Pick and Shovel Creek, along the western edge of the watershed, was part of a much larger fire extending to the west.

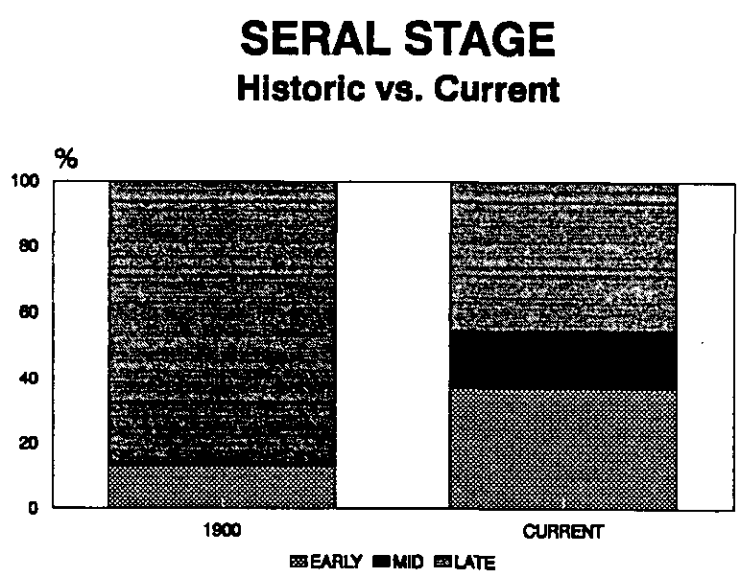
The 1946 photos also show patterns where residual trees remained. There were large "fingers and blobs" of areas in the Lower Fish Creek that either remained unburned, or only underburned. Significant remnants were primarily in riparian areas, especially one of the tributaries of Second Creek, and also around some of the rock outcrops. The Camelsback fire also had significant residual trees remaining in the drainages.

These fire areas were also verified using panoramic photos from the 1930's and historic fire maps (see Analysis File for more information, and information concerning snag patterns).

Comparison to Existing Condition

Figure A-7 shows that there is currently more early and mid seral than in the 1900 landscape. It is important to remember that it is not only the overall amount of seral stages within the landscape that has changed, but also the spatial distribution (see Landscape Patterns section).

Figure A-7. Amount of early, mid, and late seral in historic (1900) versus current landscape. Values shown are percentage of the Fish Creek watershed in each seral stage.



Fire Regimes

The Mt. Hood NF has been divided into eleven fire ecology groups based on vegetation, fire frequency and behavior (Evers et al., 1994). The Fish Creek watershed contains three of these fire ecology / fire regime groups (see Map File, "Fire Groups").

Fire group 8 is the dominant fire regime within the Fish Creek watershed, covering most of the drainage. It is titled the "warm, moist western hemlock and Pacific silver fir" group. It has an average fire frequency of 50-300+ years, and both the presettlement and current fire behavior is stand replacement crown fire. Within Fish Creek this fire regime type contains a large number of different plant associations (see Analysis File for plant association information for all three fire groups).

Fire group 6 is found in the higher elevations within the Fish Creek drainage, along the southern and eastern ridges. This is the "cool, moist lower subalpine" fire group. It has an average fire frequency of 170-430 years and the current and presettlement fire behavior is crown fires, with torching, spotting, and lethal underburning. These areas tend to be somewhat drier than in fire group 8, and are areas of prolonged snow pack.

Fire group 9 is the third fire regime found within Fish Creek. It is termed the "dry western hemlock and westside Douglas-fir" group. It has a more frequent fire frequency of 25-150 years, and the fire behavior is primarily underburning, with some crown fire. Within Fish Creek this regime is found in areas with rock outcrops and talus slopes. These areas are assumed to have reburned frequently with below canopy ground fires. These stands have a different fire regime due to their steepness, wide spacing of trees, thin soils, and the high percentage of exposed rock.

Further stratification of the Fish Creek watershed based on fire occurrence and behavior would probably separate the drainages from the mid and upper slopes. The main drainages probably had more underburning and creeping, meandering fires. The fire history reconstruction shows that the most recent stand replacement fires occurred on the mid to upper slopes. The headwalls of Fish and Wash Creeks in the southern portion of the watershed should also be separated from the rest. This is a very moist, steep area, with numerous seeps and springs, and a relatively open overstory with a mosaic of noble fir and Sitka alder patches. The predominant plant association in the area is Pacific silver fir/devil's club. Fires were probably much smaller here, burning in more of a mosaic pattern in the wet habitat.

Insects and Disease

During the Forest-wide PULSE analysis, Fish Creek was determined not to have much of a "problem" with insects and disease, relative to other watersheds on the forest. There are currently eight relatively small insect activity centers within Fish Creek (see Map File, "Insects, Disease, and Windthrow"). These areas are located on mid to upper slopes, primarily in the southern and western portion of the drainage. Mapped activity centers are primarily bark beetles found in noble fir stands, although Balsam woolly aphid has also been found in stands of Pacific silver fir. Fish Creek does not have any forest disease concerns. Hemlock dwarf mistletoe is present in the drainage, but mortality is minimal (see Analysis File for further information concerning insects and disease assessment).

Windthrow

Damaging winds in the Fish Creek drainage usually come from one of two directions, either from the east or the southwest. Areas of known windthrow since 1977 have been mapped (see Map File, "Insects, Disease and, Windthrow). Most of the windthrow has been concentrated at lower elevations, although there have been small scattered patches at higher elevations. Most of the areas are immediately adjacent to clearcut units. The dominant windthrow problem is in the lower portion of Fish Creek, on the east side of the drainage. Some windthrow has also been noted in riparian buffer strips in Upper Fish Creek.

There is little information concerning historic levels of windthrow in the Fish Creek drainage. Interviews with retired Forest Service employees indicate that there generally tended to be more windthrow in the lower portion of the drainage than the upper part. Aerial photographs show that there was very little windthrow in Fish Creek following the Columbus Day storm of 1962. This was verified by retired employees. There was apparently some very minor damage in Upper Fish and Wash Creek, which was salvaged immediately. There was no damage from this storm at the lower elevations (see Analysis File for more information).

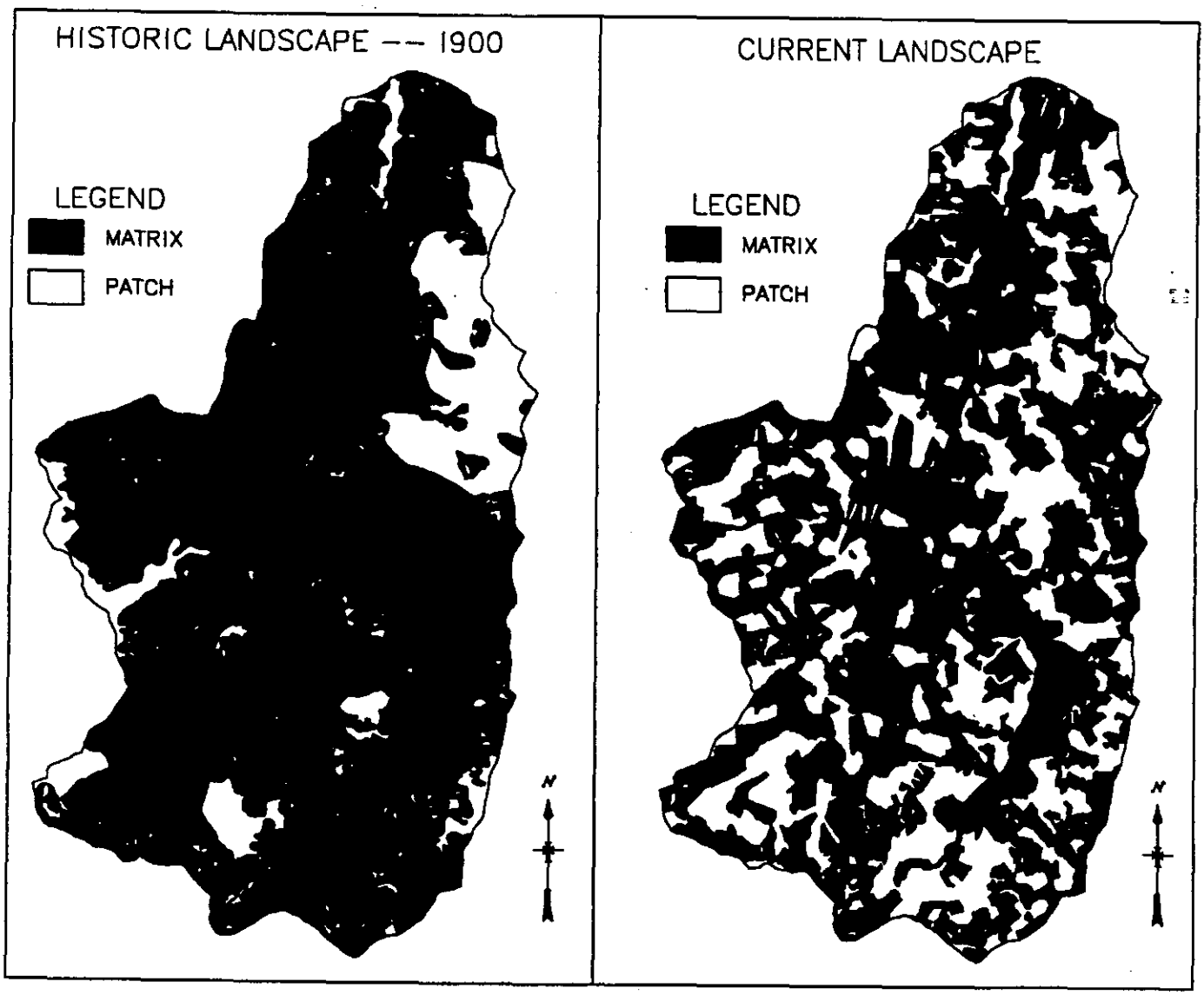
Landscape Patterns

Landscape pattern is a critical determinant of landscape-scale ecological processes. Forested landscapes in the Pacific Northwest are typically dominated by a matrix of mid to late successional forest, interspersed with natural and created non-forest openings. The spatial characteristics of the forest matrix are crucial because of the control the matrix exerts over landscape dynamics (Forman and Godron, 1986). Amount of edge habitat, degree of fragmentation of late successional forest, amount of interior habitat, and degree of patchiness are several ecologically important features of landscape pattern.

Fragmentation is one aspect of landscape pattern that has recently received a great deal of attention. As fragmentation of a landscape increases, the amount of interior forest habitat decreases and the amount of edge habitat increases. Increasing edge benefits some species and is detrimental to others (Marcot and Meretsky, 1983; Rosenberg and Raphael, 1986; Temple and Cary, 1988; Yahner, 1988). Amount of edge habitat within a landscape, therefore, has important implications for biological diversity. Degree of fragmentation not only effects species presence, but also microclimatic factors such as air temperature, relative humidity, and wind speed (Spies et al., 1990). As fragmentation increases, the amount of interior forest habitat decreases, impacting organisms which require large patches of interior quality habitat to survive (Franklin and Forman, 1987).

Current and historic (1900) landscape patterns were evaluated using spatial statistics (FRAGSTATS, McGarigal and Marks). Map A-9 and Map A-10, respectively, show the historic and current landscapes. The analysis was performed on a simplified landscape, focusing primarily on the character of the matrix. The shaded area represents the matrix, which for this analysis is defined as closed canopy forest. The white areas are the open patches. Patches were defined as any open area in the landscape, whether an early seral patch created by harvest or fire, or a natural opening such as a rock outcrop or meadow. Roads were not mapped as patches. Natural non-forest patches were assumed to have remained stable over the last 94 years.

Maps A-9 & A-10. Historic Landscape Pattern and Current Landscape Pattern



Landscape Level

Table A-6. Landscape Level Statistics for the Fish Creek Watershed, Current and Reconstructed Historic (1900) Landscapes.

Landscape	Total Area (acres)	# of Stands	Mean Stand Size (acres)	Stand Size St. Dev.	Stand Density (#/100 acres)	Edge Density (ft/acre)
1900	29,780	103	289	2,459	.34	23.6
Current	29,780	132	225	1,568	.45	57.7

Landscape level statistics (Table A-6) reveal that there are more total stands (both matrix and open patches) in the current landscape than in 1900, and that they are smaller. Stand size standard deviation indicates that the stands are more uniformly sized (variability has decreased), although there is still a high degree of variation. Stand density, a measure of landscape heterogeneity, has increased, but only slightly. There has been an increase in the amount of edge.

Patch Level

Table A-7 presents patch level statistics for the matrix, and Table A-8 presents patch level statistics for the open patches in the current and historic (1900) landscapes.

Patch level statistics reveal that matrix polygon sizes have decreased. Currently there are a greater number of matrix polygons and much less core area than in 1900. This reflects a higher degree of fragmentation of the matrix. There has been a slight increase in the number of open patches. Size of the openings has increased. The total area in open patches has greatly increased. The total core area in open patches has also increased, as patches have coalesced in the landscape. (See Analysis File for patch size frequency diagrams).

Table A-7. Patch-level Statistics for the MATRIX of the Current and Reconstructed Historic (1900) Landscapes.

Landscape	Total Area (acres)	Mean Matrix Patch Size (acres)	Number of Matrix Patches	Total Matrix Core Area * (acres)	Number of Matrix Cores
Historic (1900)	25,157	3,594	7	21,737	9
Current	18,216	1,138	16	9,948	78

Table A-8. Patch-level Statistics for the OPEN PATCHES in the Current and Reconstructed Historic (1900) Landscapes.

Landscape	Total Area (acres)	Mean Open Patch Size (acres)	Number of Open Patches	Total Open Core Area * (acres)	Number of Open Cores
Historic (1900)	4,626	48	96	2,424	20
Current	11,559	100	116	4,663	120

** Core area is defined as the area within a polygon that is inside a 100m (330 ft.) buffer.*

Conclusions

The results in the Fish Creek landscape spatial analysis are nearly identical to those found in the REAP analysis for representative watersheds throughout Region 6 (Diaz et al., 1993), indicating a common trend in landscape pattern changes throughout Oregon and Washington. Since forest management began in the Fish Creek drainage during the 1940's, the trend in the landscape pattern has been:

- Increase in the amount of edge (more edge habitat, less interior habitat, more risk of windthrow). Edge contrast is high, with abrupt transitions between early and late successional vegetation.
- Fragmentation of the mature forest matrix, loss of connectivity and isolation of mature forest blocks.
- Increasing patchiness. Patches are smaller and more uniformly sized than what would be expected under a natural disturbance regime.
- Open patches are more evenly distributed throughout the landscape and are beginning to coalesce.

This analysis was the simplest representation of the landscape. It would be interesting to complete further analyses, stratifying the matrix based on stand structural conditions and the patches based on origin (i.e. natural disturbance, harvest, natural openings).

Aquatic System (including Hillslope and Hydrologic Processes)

Hillslope Processes

Geology

The Fish Creek Watershed is located within the Western Casade Province, the older of the two physiographic provinces of the Cascade Range. The Western Cascade Province consists chiefly of dark colored lava flows, light colored pyroclastic flows, and related intrusions and deposits. These rocks have undergone widespread low-grade metamorphism and local hydrothermal alteration, and have been deeply dissected by stream and glacial erosion. In contrast, the younger High Cascade Province generally consists of dark, unaltered basaltic and andesitic lava flows.

In the northern one-third of the watershed, between elevations of about 1000 and 2000 feet, two members of the Columbia River Basalt Formation, Wanapum Basalt (Twp) and Grand Ronde Basalt (Tgr), have been exposed by down-cutting of Fish Creek. The jointing and weathering characteristics of the basalt have resulted in the formation of a series of steep cliffs and sloping benches, corresponding to resistant rock and less resistant interbeds, respectively. The southern extension of the Columbia River Basalt gives way to the generally older pyroclastic rocks of the Beds of Bull Creek Formation (Tbc) which are characterized by weak pyroclastic deposits with interbeds of more resistant andesitic flows.

The Rhododendron Formation (Tr) is positioned above the Columbia River Basalt and Beds of Bull Creek formations, generally between elevations of 2000 and 4000 feet. Like the Beds of Bull Creek, it consists of of weak pyroclastic deposits interbedded with thinner flows of resistant lava.

Of lesser extent are older basalt flows (QTb) that cap the ridge positions on the east and west flanks of the watershed, and intrusive rocks (Ti) that include an extensive pyroxene andesitic intrusion (Tipa) that forms Camelsback.

Landforms

The terrain in Fish Creek has been delineated by broad scale landform units that represent factors of geologic type, slope gradient and position, surface drainage and terrain texture as they interact to create inherent mass wasting potential. Landform units were defined to distinguish meaningful differences in landslide occurrences in the the watershed. Table A-9 displays the characteristics for landform units in Fish Creek.

Table A-9. Characteristics and processes associated with landform units defined in Fish Creek.

Landform Unit	Geologic Type	Physical Characteristics	Slope Forming Process	Sediment Delivery Mechanisms
Weak Rock - Steep Side Slopes (WRSS)	Rhododendron and Beds of Bull Creek Formations	Slopes 30 to 70 underlain by weak pyroclastic rock, highly dissected lands	Debris slides, debris flow soil creep and soil erosion	Translational processes associated with debris slides and flows
Resistant Rock - Steep Side Slopes (RRSS)	Columbia River basalt, Andesite on Nohorn	Slopes from 40 to vertical cliffs, channels steep and straight	Debris slides, debris flows soil creep and soil erosion	Translation processes associated with debris slides and flows
Bench - Forming to Large Landslides (BFLL)	Ancient landslide deposits	Large ancient earthflows and debris slides, slopes from 0 to 40 percent	Slumps, earthflows, debris slides, soil creep and soil erosion	Direct delivery to stream systems, soil creep and erosion
Glaciated Valley Side Slopes (GVSS)	Rhododendron, Beds of Bull Creek and older basalt	Glacially smoothed slopes, slightly to moderately dissected slopes, slopes from 30 to 80 percent	Debris slides, debris flows, soil creep and soil erosion	Direct delivery of debris to stream
Glaciated Valley Floors (GVF)	Compacted glacial till	Smooth valley floor and side slopes, reduced dissection by streams, slopes 0 to 40 percent	Debris slides, slumps, soil creep and soil erosion	Debris flows and slides deliver directly to stream channels, soil creep and erosion
Alluvial Flood Plain (AFP)	boulder to silt sized material	Level flood deposits along Fish Creek	Bank and surface erosion	Surface erosion and stream bank erosion
Ridgetops (RT)	Older basalt, Rhododendron formation	Slightly to nondissected upland surfaces, <20 percent slopes	Soil creep and surface colluvial processes	Surface transport with high energy storms, stream bank erosion

Sediment Delivery

Landslides and Surface Erosion

Because mass wasting is a dominant process affecting the aquatic ecosystems of Fish Creek, a specific inventory was conducted to further determine important factors involved in the process. Mass wasting was investigated using the procedure described in the analysis file for Fish Creek. The procedure relied heavily on a time sequence analysis of aerial photographs of selected areas thought to be representative of the landforms occurring in the watershed. For information on the measured frequency of mass wasting occurrence for landform types in Fish Creek refer to the Fish Creek Analysis File.

Collected information indicates that the highest frequencies of mass wasting occurrence are associated with steep slopes in resistant and weak rock geologic types.

Table A-10 provides a qualitative rating for sediment delivery for both debris flow and other landslide types (non-debris flow mass wasting events). A relative comparison of projected debris flow length between landform types was the basis for the qualitative determination of relative sediment delivery.

The highest rates of sediment delivery from debris flows were associated with landform types that were steeply sloping and consisted of either weak or resistant rock types. A medium sediment delivery rating was given to the bench forming large landslides and the glaciated valley side slopes.

Table A-10. Relative sediment delivery for debris flows and other landslide types by landform unit in Fish Creek.

Landform Type	Watershed Acreage	Relative Sediment Delivery Rating	
		Debris Flows	Other Landslides
WRSS	15,531	High	High
WRSS	4,350	High	Medium
BFLL	2,364	Medium	Low
GVSS	2,856	Medium	Low
GVF	3,895	Low	Low
AFP	241	Low	Low
RT	545	Low	Low
Total	29,782		

For other types of slides in Fish Creek (i.e., all non-debris flow mass wasting events) the landform type characterized by weak rocks on steep slopes was assigned a high rating for sediment delivery. A medium rating was determined to the landform type characterized by resistant rock on steep slopes.

The landform type of weak resistant rock, which occupies 52 percent of the watershed has a high potential for sediment delivery due to mass wasting.

Table A-11 displays the number of mass wasting events by management activity and the type of mass wasting event that has occurred. The table separates managed sites (roaded and harvested areas) from unmanaged sites (mature forest and non-forest, e.g. exposed bedrock) and draws a distinction between landslides that have occurred in clear cuts less than twenty years old and those more than twenty years old.

Table A-11. Inventoried active and recent landslides by land use (sampled area).

Landuse Type	Slump	Earth-flow	Debris Flow	Debris Slide	Rock Fall	Total
Roads	2	0	5	24	1	32
CC <20 yr	2	0	13	16	0	31
CC >20 yr	0	0	0	0	0	0
Mature Forest	0	0	8	4	0	12
Non-Forest	0	0	9	1	0	10
Total	4	0	35	45	1	85

Analysis revealed little difference between road and harvest units in frequency of initiation of mass wasting (see Table A-11). There was a difference, however, in the dominant type of mass wasting associated with the two disturbances. For example, many more debris slides are associated with road construction than debris flows. In contrast, the numbers of debris slides and debris flows associated with timber harvests that have occurred within the past 20 years are quite similar.

Although no landslides were detected in units harvested more than 20 years ago, it is not clear if this means the unit has recovered or if landslides are now simply concealed by vegetation. Since some root strength has undoubtedly returned, rates of shallow landsliding have probably decreased, but it is unlikely that harvested areas older than 20 years have returned to their original, unimpacted condition.

Interpretations of surface erosion hazard for soils in Fish Creek are presented in Table A-12. For all subwatersheds 75 percent or more of the basin has a severe or moderate erosion hazard. Natural rates of soil creep and erosion for soils in the watershed are believed to be high.

Table A-12. Surface soil erosion potential for subwatersheds in Fish Creek.

Sub-watershed	Erosion Potential (acres)						
	Slight	%	Moderate	%	Severe	%	Total
Lower Fish Creek	1,720	20	2,739	32	4,005	48	8,464
Third Creek	128	8	1,306	81	182	11	1,616
Upper Fish Creek	1,652	18	5,711	63	1,754	19	9,117
Pick Creek	68	3	1,193	59	777	18	2,038
Fall Creek	169	14	516	43	514	43	1,199
Wash Creek	1,048	19	2,399	43	2,076	38	5,523
Music Creek	142	9	1,008	63	452	28	1,602
Total	4,785		14,872		9,760		29,417

In the last 5 years timber harvest has occurred within 200 feet of stream channels. Highest acreages of harvest near streams have occurred in Lower Fish and Wash Creek subwatersheds on severe and moderate erosion hazard lands. Currently these acres may have the capability to deliver sediment to stream channels.

Subwatershed Context

In the following discussion of subwatersheds, the relative sediment delivery ratings from Table A-13 have been combined by assigning the higher of the two ratings to the landform type in question. For example, the landform type BFLL has a medium sediment delivery rating for debris flows and a low sediment delivery rating for "other" landslides. Thus, its final rating is medium.

Table A-13. Subwatershed acres per relative sediment delivery class.

Sub-watershed	Relative Sediment Delivery Rating						
	High	%	Medium	%	Low	%	Total
Lower Fish Creek	6903	82	1029	12	522	6	8454
Third Creek	1527	94	86	5	9	1	1622
Upper Fish Creek	5244	57	2369	26	1515	17	9128
Pick & Shovel Crk	1485	72	338	17	233	11	2056
Fall Creek	1135	95			64	5	1199
WashCreek	2580	45	1116	20	2005	35	5701
Music Creek	1008	62	282	17	332	21	1622
Total	19,882	67	5,220	17	4,680	16	29,782

Lower Fish Creek

A large portion of Lower Fish Creek subwatershed is characterized by steep slopes underlain by either resistant or weak volcanic rocks. These landform types have a high sediment delivery rating for the debris flow and debris slides which often occur adjacent to stream channels, and may travel downstream, eventually reaching the mainstem of Fish Creek. A moderate risk of sediment delivery has been assessed for the areas of ancient landslide material in the subwatershed. Debris flows and debris slides originating at the toe of these ancient landslides can efficiently transport their sediment load to the mainstem of Fish Creek.

Third Creek

A vast majority of land in this subwatershed is in the high relative sediment delivery category. Mass wasting is the predominant slope-forming process that occurs on the steep slopes that are typical of the weak pyroclastic rock types dominant in the subwatershed. Recent debris slides that have occurred adjacent to stream channels and older debris flows are evident in this subwatershed. Old debris flows have deposited material along the lower gradients of Third Creek.

Upper Fish Creek

The higher elevations of this subwatershed have been glaciated. Steep valley side slopes and headwalls define the cirques once occupied by glaciers. A moderate rating for sediment delivery has been assigned to the steep glaciated slopes. Rocks from the Rhododendron and Beds of Bull Creek Formations are present in the glaciated reaches of Fish Creek. Locally, high ground water levels associated with the interbeds of these two formations are a factor in the frequency and distribution of debris flows and debris slides that occur within this landform type. The unglaciated portion of this subwatershed has landform features similar to Lower Fish Creek in that there is a sequence of resistant rock overlain by weaker pyroclastic rocks from the Rhododendron Formation. Another similarity is the presence of many large ancient landslides that have formed benches just above the resistant rock. These landslides have a moderate relative sediment delivery rating. Several smaller mass wasting events have also occurred in the last 50 years with more localized effects.

Pick and Shovel Creek

The dominant landform type in the Pick and Shovel Creek watershed is steep slopes underlain by either weak or resistant rock. A small portion of the upper watershed has been glaciated. Air photo interpretation revealed several debris flows have recently occurred on steeper slopes and delivered sediment into both Pick Creek and Shovel Creek in the years following timber removal. Approximately 1.5 miles of Pick Creek has been scoured by one or more debris flow events. Many small to moderate size landslides have occurred adjacent to stream channels. Portions of the toes of some of these features have been reactivated. Stream bank erosion is probably higher along these ancient landslide deposits than elsewhere. Furthermore, other more recent and locally impacting mass movements were also identified in this watershed.

Fall Creek

Rocks from the Beds of Bull Creek and the Rhododendron Formation comprise over 90 percent of the Fall Creek subwatershed. Steep slopes drive the sediment delivery processes in this landform type. Debris flow and debris slides are the major types of mass wasting occurring in this landform. Small areas of ancient landslides are adjacent to Fall Creek.

Wash Creek

Glaciation has sculpted the upper portions of Wash Creek. The steeper glacially smoothed slopes have a moderate sediment delivery rating for mass wasting, while the glaciated valley floor has a low sediment delivery rating. Review of aerial photographs dating from 1946 through 1989 revealed three channel scouring debris flows in glaciated reaches of Wash Creek. Very few smaller more localized landslides were noted. The remainder of the watershed is underlain by the Beds of Bull Creek formation. Steeper slopes are common and there are higher energy levels available to deliver sediment to stream channels.

Music Creek

Glaciation has altered the upper elevations of the Music Creek subwatershed. During air photo interpretation, one landslide was noted in the glaciated portion of the subwatershed was. A recent debris slide was identified in the landform type described by weak rock and steep slopes. This subwatershed was only partially reviewed during the analysis of aerial photographs.

Roads

Roads create disturbances on the landscape that are not replicated by natural factors operating in forest ecosystems. The impacts roads have depends on road construction techniques, topographic characteristics, the underlying geologic material and the subsurface flow of water downslope under the influence of gravity. In general roads cause steep slopes to be less stable, contribute sediment to stream systems from road surface and cutslope surfaces and interrupt the surface and subsurface flow of water to stream channels, affecting baseflow and peakflow characteristics of a watershed.

Aerial photo inventory data displayed in Table A-11 landslides (nondebris flow mass wasting) are associated predominantly with roads constructed in Fish Creek. Road related landslides occur most frequently with landform units of resistant rock, steep slopes and weak rock, steep slopes. There is a higher incidence of debris sliding on the landform unit with weak rock compared to the resistant rock unit. There also is a difference in the relative risk of delivery for landslides between the two landform types with the weak rock and resistant rock having delivery ratings of high and moderate respectively.

Road construction has initiated debris flows in Fish Creek within the two previously mentioned landform units as well as landform units that represent large benchforming landslides and steeper glaciated valley slopes.

Miles of road by landform unit for the different subwatersheds in Fish Creek are exhibited in Table A-14. Using the miles of road located within landform types which have a high relative sediment delivery rating for debris flows or debris slides, (WRSS of RRSS) as an indicator of possible sediment delivery from road related mass wasting, Lower and Upper Fish Creek subwatersheds have the greatest degree of concern for road related mass movements delivering sediment to streams. Pick Creek and Wash Creek subwatersheds have fewer road miles, however, because these two subwatersheds are smaller in area, impacts from mass wasting can have serious effects.

Table A-14. Road miles by landform type in subwatersheds of Fish Creek.

Subwatershed	Landform Unit								
	ALFL	BFLL	RRSS	WRSS	GLVS	GLVF	Ridge	Total	Road Density
Lower Fish Creek	5	8	9	24	0	0	4	50	3.8
Third Creek	0	1	0	4	0	0	0	5	2.0
Upper Fish Creek	0	11	2	16	7	11	0	47	3.3
Pick Creek	0	0	0	6	1	2	0	9	2.8
Fall Creek	0	0	0	4	0	0	1	5	2.7
Wash Creek	0	0	1	9	7	7	0	24	2.7
Music Creek	0	0	0	3	2	1	0	6	2.4
Total	5	20	12	66	17	21	5	146	3.1

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

A matrix was used to describe the relative capabililty of a road segment to deliver sediment to stream channels. Cutslope erosion risk and road surface characteristics at stream crossings and roads located adjacent to streams. A description of the process and assumptions in developing the matrix are presented in the analysis file for Fish Creek.

Typically there is a higher efficiency of sediment delivery at stream crossings via ditchline flow compared to delivery from culvert outflow occurring on vegetated slopes. Native surface roads have a greater susceptibility to erode than aggregate rock surfaced roads. Miles of roads by relative sediment delivery capability class is presented below in Table A-15.

Table A-15. Miles of road by sediment delivery capability in subwatersheds of Fish Creek.

Subwatershed	Sediment Delivery Capability					
	High	Moderate	Low	Very Low	Total	Total Roads Subwatershed
Lower Fish Creek	8.4	5.9	1.0	1.6	16.9	48
Third Creek	.9	1.0	.1	0	2.0	5
Upper Fish Creek	11.3	1.9	3.9	.3	17.4	47
Pick Creek	1.8	1.5	.4	.1	3.8	9
Fall Creek	.3	.2	.2	0	.7	4
Wash Creek	6.8	2.1	1.2	.1	10.2	24
Music Creek	1.0	.5	.1	0	1.6	6
Total	30.5	13.1	6.91	2.1	52.6	143

Approximately 53 miles of road in Fish Creek have the capability to deliver some level of sediment to streams (Table A-15). Total road miles in the watershed is 143.

There are approximately 359 crossings of streams by roads in Fish Creek watershed. Due to the high erosion susceptibility of soils derived from pyroclastic material over half of the stream crossings in the drainage are believed to have a high capability to provide material to be transported down ditchlines to stream channels.

Sediment delivered from road surfaces is thought to be greater from native surfaced roads compared to roads having a rock aggregate surface. Approximately 5 percent of the total stream crossings in the watershed have a native running surface. On a an area basis Wash Creek subwatershed has the greatest miles of native surface road and the highest number of native surface road stream crossings.

Miles of roads located within riparian reserves (200 feet from stream) with a potential to deliver sediment to streams from culvert out flow is approximately 48 miles. Highest mileages occur in the Upper Fish Creek, Lower Fish Creek and Wash Creek subwatersheds.

Hydrologic Processes

Stream Flow

Peak flow and base flow assessed for this analysis. Quantity of streamflow affects aquatic habitat and other beneficial uses in several ways. Annual water yields and the timing and magnitude of mean monthly stream flows affect fish habitat characteristics and water availability for beneficial uses such as water-based recreation and downstream consumptive and non-consumptive uses. The magnitude, duration, and frequency of peakflows affect channel morphology, fish habitat, spawning success, and fish survival. Low flows influence fish migration, availability of fish habitat, affects of water temperature on fish survival and growth, and the health and diversity of aquatic macroinvertebrates. Timber harvest activities and roads can affect all aspects of streamflow in a variety of ways. In the absence of long-term monitoring of streamflow for Fish Creek, most of these processes, interactions, and effects will be inferred from analysis of available data and interpretation of relevant research findings.

A stream gauging station operated by the United States Geological Survey (USGS) was established in 1989 and is located about 0.7 mile upstream from the confluence with the Clackamas River. For the period of record, the average annual water yield for the Fish Creek watershed is estimated to be in excess of 133,900 acre-feet per year. Over 50 percent of the annual flow comes in the months of November though February. Monthly mean flows range from a low of around 13 cubic feet per second (cfs), occurring in late summer, to a high in excess of 350 cfs during typical winter months. Maximum monthly flows generally occur during the months of December, January, and February, with a second peak (associated with spring snowmelt) occurring in April. However, high flows can begin as early as November. Extreme flows for the period of record range from a low of 6 cfs (Sept. 1-2, 1992) to a high of 3,830 cfs (Dec. 6, 1991).

Peakflow

The first flood of record in the Willamette Valley, inundated the settlement of Champoeg in the fall and winter of 1813/1814 (Brands, 1947). This was followed by a flood of greater magnitude in 1843. Major regional floods occurred again in 1844, 1850, and 1853. The greatest flood on record, possibly with a 500-year return interval occurred in December, 1861. The second largest flood in recorded history occurred in January and February 1890, preceded by a somewhat lesser flood in January 1881. In January, 1923, a flood with an estimated recurrence interval of 50 years was recorded in the Willamette Valley. Other floods affecting the Northern Cascades are reported to have occurred in November 1909 and February, 1927.

While little or no information is known about the effects of these earlier regional floods in the Fish Creek watershed, it is apparent that significant flood events have occurred on a fairly regular basis. The February 1927 flood is likely to have triggered debris slides and channel scouring within the Fish Creek watershed, as evidenced by revegetated scars observed on 1946 series aerial photographs. This event caused considerable damage to the Three Lynx railroad grade, along the Clackamas River opposite the mouth of Fish Creek (historical photos).

The most dramatic and well-documented flood event in the recent past occurred on December 22, 1964. Approaching the estimated 100-year frequency, this event caused extensive damage in the Fish Creek watershed. This was followed by a somewhat lesser magnitude flood in January 1965. Separating the watershed effects of these two events is practically impossible, and they are collectively referred to as the 1964 event.

Occurrences of high streamflows prior to establishment of the Fish Creek gage have been determined by analysis of data from other USGS gauging stations in the vicinity. Peakflows approaching the magnitude of a 25-year recurrence interval (6,150 cfs) occurred on January 20, 1972. Peakflows exceeding the 10-year event (5,514 cfs) occurred on December 2, 1977 and February 23, 1986. Peakflow episodes exceeding the 5-year return interval (4,923 cfs) occurred on December 13, 1978 and December 1, 1975. The streamflow record combined with personal observations of Forest Service personnel indicate that flows in Fish Creek are somewhat "flashy", showing relatively rapid rise and fall in discharge in response to winter storm precipitation.

Transient Snow Zone - Fish Creek flood events are similar to other documented floods in the Cascades. These historical peak flow events occurred during the rainy season, following a rapid and substantial depletion of the snowpack during a prolonged rain-on-snow period in the "transient snow zone". Normally these types of storm events are accompanied by unseasonably warm temperatures, as documented in the December 1964 event.

Approximately 77 percent of the watershed lies within the "transient snow zone" (Christner and Harr, 1982), where snow levels may fluctuate as winter storms transit the area. The Fish Creek transient snow zone is estimated to occur between 2,400 feet and 4,800 feet elevation. In this zone, shallow snowpacks accumulate and then melt rapidly during prolonged rainfall, accompanied by warmer temperatures and wind, dramatically increasing the rate of runoff. These rain-on-snow events occur relatively frequently within this zone.

Created Openings - Research has shown that more snow accumulates in openings than under canopies and that during rain-on-snow events the runoff from these snow accumulations is more rapid. Timber harvest activities, particularly clearcuts, and other created openings (roads, windthrow areas, fires, etc.) are areas of increased snow accumulation. The rapid runoff from these areas increases the magnitude of peakflows during a rain-on-snow event. The resulting higher flows may scour, downcut, or widen the stream channel. Over 41 percent of the watershed has undergone timber harvest, primarily clearcut harvest, with the majority of harvest occurring within the transient snow zone.

Roads - In addition to their role in snow accumulation, current research suggests that specific parts of road networks may contribute disproportionately to the effects of roads on peakflows (Wemple, 1994). Road surfaces and cutslopes are essentially impermeable to rainfall and snowmelt. They intercept shallow subsurface flows and concentrate surface runoff. Road ditches function as "extensions" of intermittent streams, increasing overall drainage density and transporting water more rapidly than natural processes. Increased road densities increase the amount of water delivered to surface streams, affecting the timing and magnitude of peakflows. Overall road densities within the Fish Creek watershed are among the highest in the Clackamas River Subbasin (Table A-16).

Table A-16. Road Densities for Principal Watersheds Within the Clackamas River Subbasin.

Watershed	Road Density (miles/sq. mi.)
Fish Creek	3.1
Oak Grove Fork Clackamas River	2.9
Upper Clackamas River	2.9
Hot Springs Fork Clackamas River	2.8
Lower Clackamas River	2.7
Collawash River (mainstem)	2.6

Within the Fish Creek Watershed, Lower Fish Creek, Upper Fish Creek, and Pick Creek have the highest road densities as displayed in Table A-17.

Table A-17. Road Densities for Subwatersheds Within the Fish Creek Watershed

Subwatershed	Road Density (miles/sq. mi.)
Lower Fish Creek	3.8
Third Creek	2.0
Upper Fish Creek	3.3
Pick Creek	2.8
Fall Creek	2.7
Wash Creek	2.7
Music Creek	2.4
Total for Fish Creek	3.1

Roads may also encroach on stream channels, riparian areas, and floodplains, confining and straightening channels, "capturing" streams during flood events, and generally accelerating stream velocities and increasing the magnitude and frequency of peakflows. This was observed along the mainstem of Fish Creek following the 1964 Flood, where the main access road (54) encroaches on the floodplain (between mile 3 and 4).

Aggregate Recovery Percentage (ARP) - The 1990 Mount Hood Forest Land and Resource Management Plan employed an analysis tool to assess hydrologic recovery, referred to as the "aggregate recovery percentage" (ARP) methodology. ARP values of about 65 percent were calculated for Fish Creek, indicating a high likelihood of increased peakflows associated with rain-on-snow events. The Forest Plan established a "threshold" level of 82 percent hydrologic recovery, below which hydrologic processes were presumed to be adversely affected. The Forest Plan predicted that hydrologic recovery would be achieved in approximately three decades assuming management as envisioned in the preferred alternative.

Water Available for Runoff (WAR) - The primary mechanism by which forest practices affect peak streamflows is alteration of snow accumulation and melt in response to forest canopy density. WAR is calculated by determining how much additional water over that generated by the precipitation event is from the melting snowpack during the rain-on-snow event. The U.S. Army Corps of Engineers snowmelt equation is used to determine snowmelt during rain-on-snow events. WAR is calculated for 2, 5, 10, 25, 50, and 100 year return interval precipitation events and two storm intensities (average and unusual) and two vegetative cover conditions (existing and hydrologically recovered). 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 value plus one stand 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 over 11 inches in the Grand fir, Mountain Hemlock, Silver Fir and Western Hemlock plant communities. Storm runoff was related to increases in WAR by establishing a relationship between precipitation amounts and discharges. Precipitation amounts and discharges having the same recurrence interval (e.g. the 2 year precipitation amount and the 2 year flow) are related to establish a relationship between precipitation and discharge. *A concern with this method is that this assumes that the flow events calculated from the USGS regional equation are from only rain events and this is not necessarily the case. We know that there was a 100 year flow event in 1964 and other large rain-on-snow events, and these events were used to develop the USGS regional equations.*

Modified peak flows were then estimated by substituting the calculated WAR into the regression equation for the precipitation amount that was used to develop the relationship between precipitation and runoff (Table A-18). The numbers that were generated for the peak flow values appeared to be excessively high when compared to the values generated from the USGS regional equation for estimating peakflows. This was attributed to the fact that the relationship between flow and precipitation was based on flow events being generated exclusively from rainfall when, in actuality, rain-on-snow events were used to generate the USGS regional equation. To adjust the estimated peak flows to reflect what was felt to be occurring in the watershed the percentage increase in peak flows between the existing condition and the hydrologically mature condition was used to modify the values calculated with the USGS regional equation (Table A-19).

Estimated peakflows for the 2, 5, 10, 25, 50, and 100-year return intervals have all increased from 2 to 14 percent for Fish Creek and its principal tributaries during the period of management within the watershed (Table A-19). Since the error associated with streamflow measurements is generally around 5 to 10 percent, only peak flow figures for the 2-year and 5-year events are statistically significant in this analysis. However, the other values still indicate an overall trend of increased peakflows.

Table A-18. Water Available for Runoff (WAR) and Predicted Peakflows.

Fish Creek		Water Available Runoff (inches)		Flow (CFS)	Flow (CFS) from WAR		
Recurrence Interval	Storm Intensity	Fully Forested	Existing Condition	USGS Eq. FS/BR	Hydrologically Recovered	Existing Condition	Percent Increase
2	Average	3.6	3.7	2094	4061	4301	6
				3846	**5419**	**5585**	**3**
2	Unusual	4.7	5.1	2094	5630	6437	14
				3846	**6503**	**7059**	**9**
5	Average	4.3	4.4	3193	5738	5977	4
				4923	**6579**	**6745**	**3**
5	Unusual	5.4	5.5	3193	7041	7848	11
				4923	**7476**	8033	**7**
10	Average	4.6	4.7	3932	6456	6696	4
				5514	**7077**	**7243**	**2**
10	Unusual	5.9	6.2	3932	8049	8654	8
				6514	**8172**	**8589**	**5**
25	Average	5.1	5.2	4950	7653	7893	3
				6151	**7906**	**8072**	**2**
25	Unusual	6.4	6.8	4960	9057	9864	9
				6151	**8867**	**9424**	**6**
50	Average	5.4	5.5	5759	8372	8612	3
				6639	**8403**	**8569**	**2**
50	Unusual	8.9	7.2	5759	10065	10670	6
				9639	**9563**	**9980**	**4**
100	Average	5.7	5.8	6593	9091	9330	3
				6937	**8901**	**9066**	**2**
100	Unusual	7.2	7.6	6593	10670	11477	8
				6937	**9980**	**10537**	**6**

Flow (USGS) -From prediction equations published in Harris, D.D., Hubbard, L.L. and L.E. Hubbard, Magnitude and Frequency of Floods in Western Oregon US Geological Survey Open file Report 79-553.

Flow (F/BR) - Fish Creek predicted peak flows estimated from Mainstem Bull Run peak flows using relationship developed with Water Year 1990-1993 Fish Creek and mainstem Bull Run mean daily flows.

Note: The mainstem Bull Run was selected for comparison since the watershed area above the gauging station approximates the Fish Creek Watershed in several regards: similar size, similar elevation, and unregulated. Bull Run is also the closest currently operating station on an unregulated stream.

Table A-19. Estimated Changes in Peak Streamflows for Fish Creek Adjusted for % Increases on WAR Estimates.

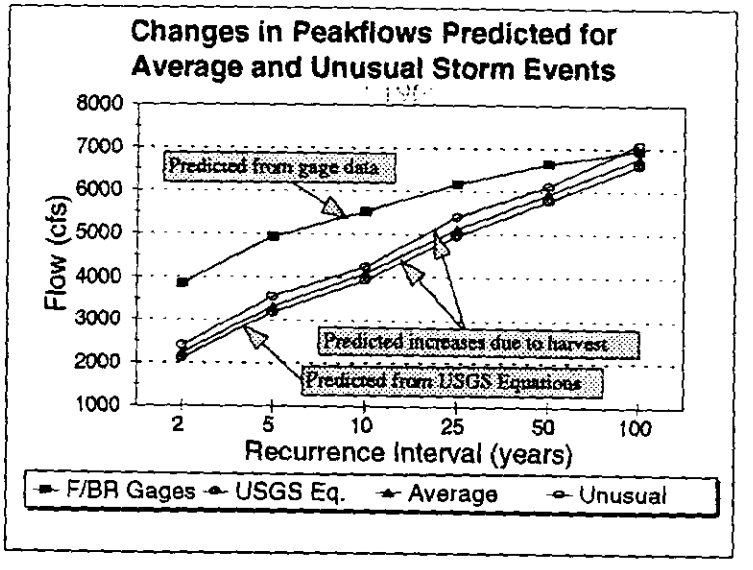
Fish Creek		Flow (CFS)*			
Recurrence Interval	Storm Intensity	F/BR Gage Predicted	USGS Eq. Adjusted	USGS Adjusted	Percent Increase
2	Average	**3846**	2094	2217	6
2	Unusual	**3846**	2094	2394	14
5	Average	**4923**	3193	3326	4
5	Unusual	**4923**	3193	3559	11
10	Average	**5514**	3932	4078	4
10	Unusual	**5514**	3932	4227	8
25	Average	**6151**	4950	5105	3
25	Unusual	**6151**	4950	5391	9
50	Average	**6639**	5759	5924	3
50	Unusual	**6639**	5759	6105	6
100	Average	**6937**	6593	6767	3
100	Unusual	**6937**	6593	7091	8

Flow (USGS) - From prediction equations published in Harris, D.D., Hubbard, L.L. and L.E. Hubbard, Magnitude and Frequency of Floods in Western Oregon US Geological Survey Open File Report 79-553.

Flow (F/BR) - Fish Creek predicted peakflows estimated from Mainstem Bull Run peakflows using relationship developed with Water Year 1990-1993 Fish Creek and Mainstem Bull Run mean daily flows.

In a separate analysis to determine changes in peakflows, Fish Creek flow data was correlated with flow data from a gauging station for a reach of the Bull Run River having a similar watershed area and a longer period of record. The predicted peakflows for Fish Creek are substantially greater for all return periods as compared to peakflows calculated from the USGS regional equations (USGS, 1979). This may be partially attributable to a very high standard error generally associated with the regional equations and to differences in the characteristics of the two compared watersheds. However, since the regional equations are derived from data from a number of stations whose period of record predates intensive management, the comparison appears useful in describing potential changes in peakflows attributable to management within the Fish Creek watershed. Figure A-8 illustrates the apparent differences in peakflows.

Figure A-8. Predicted Peak Streamflows for Fish Creek



Channel Network Expansion - An analysis of roads and stream crossings to assess the potential expansion of the channel network indicates that channel lengths and stream drainage densities appear to have increased by as much as 11 to 28 percent overall within the Fish Creek watershed (Table A-20, Figure A-9), depending on the spacing of road drainage relief culverts. Since the exact culvert spacing could not be determined for each subwatershed, a "best case" scenario (200 feet spacing) reveals that the channel network extensions range from a low of 3.2 percent for Fall Creek, to a high of 12.2 percent for both Upper and Lower Fish Creek subwatersheds, with an overall value of 11 percent for the entire watershed.

Table A-20. Stream Drainage Network Expansion Related to Roads

Stream Crossings and "Stream Network Expansion" by Subwatershed						
Sub watershed	Area (acres)	"Natural" Streams (miles)	Stream Crossings (#)	"Expanded" Streams (miles)	Total Length (miles)	Percent Change (%)
L. Fish Creek	8,454	71.65	115	21.78	93.43	30.4
Third Creek	1,623	12.13	16	3.03	15.16	25.0
U. Fish Creek	9,128	73.54	118	22.35	95.89	30.4
Pick Creek	2,055	18.13	26	4.92	23.05	27.2
Fall Creek	1,198	9.58	4	0.76	10.34	7.9
Wash Creek	5,702	44.06	67	12.69	56.75	28.8
Music Creek	1,622	13.17	13	2.46	15.63	18.7
Total for Fish Creek	29,782	242.26	359	67.99	310.25	28.1

Stream expansion assumes a distance of 500 feet from closest ditch relief culvert on either side of stream crossing, adding an additional 1,000 feet to the effective channel length.

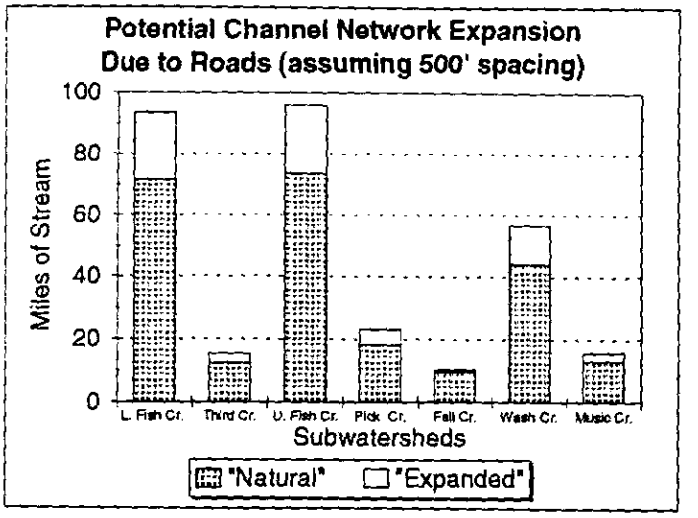
Stream Crossings and "Stream Network Expansion" by Subwatershed						
Sub watershed	Area (acres)	"Natural" Streams (miles)	Stream Crossings (#)	"Expanded" Streams (miles)	Total Length (miles)	Percent Change (%)
L. Fish Creek	8,454	71.65	115	10.89	82.54	15.2
Third Creek	1,623	12.13	16	1.52	13.65	12.5
U. Fish Creek	9,128	73.54	118	11.17	84.71	15.2
Pick Creek	2,055	18.13	26	2.46	20.59	13.6
Fall Creek	1,198	9.58	4	0.38	9.96	4.0
Wash Creek	5,702	44.06	67	6.34	50.40	14.4
Music Creek	1,622	13.17	13	1.23	14.40	9.3
Total for Fish Creek	29,782	242.26	359	34.00	276.26	14.0

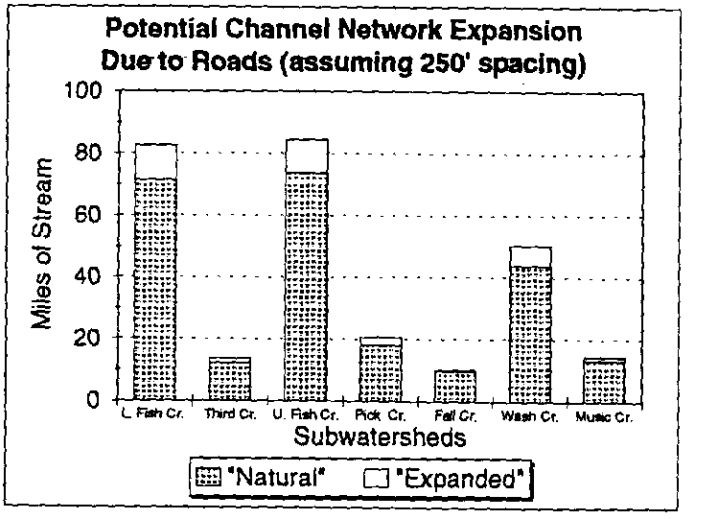
Stream expansion assumes a distance of 250 feet from closest ditch relief culvert on either side of stream crossing, adding an additional 500 feet to the effective channel length.

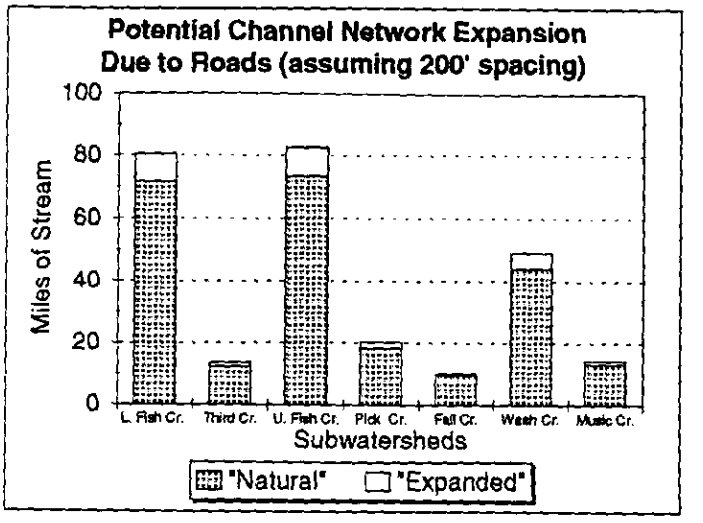
Stream Crossings and "Stream Network Expansion" by Subwatershed						
Sub watershed	Area (acres)	"Natural" Streams (miles)	Stream Crossings (#)	"Expanded" Streams (miles)	Total Length (miles)	Percent Change (%)
L. Fish Creek	8,454	71.65	115	8.71	80.36	12.2
Third Creek	1,623	12.13	16	1.21	13.34	10.0
U. Fish Creek	9,128	73.54	118	8.94	82.48	12.2
Pick Creek	2,055	18.13	26	1.97	20.10	10.9
Fall Creek	1,198	9.58	4	0.30	9.88	3.2
Wash Creek	5,702	44.06	67	5.08	49.14	11.5
Music Creek	1,622	13.17	13	0.98	14.15	7.5
Total for Fish Creek	29,782	242.26	359	27.20	269.46	11.2

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

Figure A-9. Potential Channel Network Expansion Due to Roads







This suggests that apparent increases in peakflows (discussed previously) are partially attributable to increased road density and expansion of the drainage network, processes which are not adequately addressed in the available peakflow models. Actual peak flow increases may be greater and more statistically significant, even for higher return interval floods.

It is generally accepted that elements of stream channel morphology (stream channel dimensions and characteristics) are adjusted to accommodate the bankfull (2-year) storm event in lower gradient streams (Wolman and Miller, 1960). The 5-year flow event has been suggested as the "channel-forming" flow most affecting steeper mountain streams (Lisle, 1981), such as Fish Creek and its tributaries. It is reasonable to conclude that channel-forming peakflows (2-year, 5-year, 10-year events) have been increased over natural levels in Fish Creek, the implications of which are discussed in sections which follow. It is also reasonable to infer that less frequent, longer return interval floods (25-year, 50-year, 100-year, etc.) are less affected by management and are more reflective of the specific climatic event causing or contributing to the stream discharge.

Baseflow

Baseflow is an important component in the Fish Creek watershed. Baseflow provides habitat for fish and other aquatic organisms during summer low flow periods, sustains streams utilized by terrestrial wildlife, buffers increases in water temperature due to solar radiation, and contributes to other downstream beneficial uses of water outside of the Fish Creek watershed. No long-term records of baseflow are available, though some anecdotal observations made in June of 1959 describe summer low flows as "good". Low flows ranging between 6 cfs and 13 cfs have been recorded at the USGS gage near the mouth of Fish Creek. Though the period of record is limited, it spans two years of drought and gives a good indication of baseflow character. Diurnal (day-night) fluctuations are evident, reflecting the role of transpiration of riparian vegetation.

Existing gauging records for Fish Creek and Fir Creek (unmanaged watershed, tributary to Bull Run) were examined to determine the timing and magnitude of annual minimum flows (Baseflow Module, Fish Creek analysis files). The watersheds are similar in character in terms of geology, slope, and aspect, though Fir Creek watershed is much smaller (3,500 acres). Minimum recorded flows at Fish Creek approximated 10 cfs or 0.192 cfs per square mile (csm) of watershed area, while Fir Creek, an unmanaged watershed, approximated 3 cfs or 0.576 csm. This data could indicate that land management activities within Fish Creek may have decreased baseflows.

Most research on the subject indicates that low flows are increased, rather than decreased, as a result of timber harvesting, largely attributable to reductions in transpiration. In a limited study, reductions in fog drip after timber harvesting were related to an apparent reduction in streamflow (Harr, 1982). Recent research (Hicks, et al 1991) suggests that reductions in streamflow following timber harvest may be related to the regrowth of deciduous riparian species which transpire larger quantities of water than the natural conifer vegetation. Nearly 36 percent of riparian reserves within the Fish Creek watershed are in an early seral stage, largely dominated by deciduous species. This may partially account for the apparent decreased baseflow.

Apparent reduced baseflow in Fish Creek could also be related to channel scour, down-cutting, and abandonment of former floodplains as discussed elsewhere in this analysis. Scouring tributary reaches to bedrock and abandonment of floodplains may effectively reduce the "reservoir" of water otherwise available for contributing to late summer flows.

Channel Morphology

Stream channel morphology and condition reflect the input of water, sediment, and wood to the stream channel, relative to the ability of the channel to either transport or store these inputs (Sullivan, et al, 1987). The channel's ability to store or transport these inputs is dependent on the location and timing of the inputs as influenced by the channel and watershed characteristics of slope gradients, geology, landforms, structural controls, and historical disturbance, etc.

Stream channel gradients are steep for Fish Creek and its numerous tributaries, generally exceeding 5 percent, except for the lower 3.7 miles where gradients average 2 percent. Fish Creek mainstem has a boulder and cobble substrate contributing to a predominantly riffle environment. Wash Creek and upper Fish Creek have steeper, more incised, narrow channels with a predominantly cobble and gravel substrate.

Historically, the dominant sediment sources are landslide processes including debris slides and debris flows, associated with steep slopes, geologic contacts, and high gradient stream channels; and smaller earth slumps and landslides occurring within and along the margins of the large ancient landslide features (see Hillslope Processes section for discussion by subwatershed).

Present channel morphology for Fish Creek and the lower reaches of its principal tributaries varies from historical conditions. A survey of the Fish Creek in 1959 (Oregon Fish Commission) indicated that pools comprised about 47 percent of the channel habitat available to anadromous salmonids. A resurvey of the watershed in 1965, following the flood of December 1964, indicated that pool area was reduced to about 27 percent of total habitat. Surveys and studies conducted by researchers from the Pacific Northwest Forest and Range Experiment Station from 1982-86, prior to extensive stream restoration efforts, indicated that pool habitat averaged 13 percent (range 8-18) of total during those years. This change in channel morphology is attributed to an extensive program of removing logjams and other large wood components from the channel during the two decades following the 1964 flood. As a result of extensive restoration efforts over the past decade, largely aimed at the re-introduction of large woody debris as a structural component of the channel, current habitat composition resembles 1965 conditions, prior to stream cleaning and major alteration, but has not returned to conditions observed and described in 1959.

A comparison of the 1959 and 1965 surveys revealed that relatively little change occurred in the bottom composition of the lower 4.5 miles of Fish Creek (Lower Fish Creek), with slight increases indicated in the boulder category with corresponding decreases in the small gravel and cobble categories. The same comparison revealed major changes in substrate composition in the upper reaches of Fish Creek (Upper Fish Creek subwatershed) and Wash Creek (in reaches accessible to anadromous fish), with the greatest changes occurring in the boulder and bedrock categories. In both subwatersheds the proportion of bedrock was greatly reduced and the proportion of cobble substrate greatly increased. The large quantity cobbles, boulders, and other coarse sediments are attributable to debris slide and debris flow contributions and channel erosion in high gradient tributary streams, which aggraded the former bedrock reaches. Due to generally steep gradients, fine sediments are apparently flushed through the system, and comprise a relatively small percentage of channel substrate throughout the watershed.

Anecdotal observations by district fisheries and watershed personnel suggest that channel bedrock exposure has increased in the lower reaches of Fish Creek, due to channel downcutting and the loss of coarse sediments related to the removal of large wood prior to the 1980s. The apparent result has been partial abandonment of floodplains and natural side channels in the lower mainstem of Fish Creek.

Early anecdotal observations suggest that pool features were not only more abundant prior to 1964, but pools were likely deeper, having been subsequently filled during and following the 1964 flood.

Water Quality

Water Clarity and Sediment

An examination of water quality encompasses several elements including temperature, clarity, chemistry, and microbiology. Water temperature and riparian canopy shade interrelationships are discussed elsewhere in this chapter of the analysis.

Water clarity is a good visual indicator of the presence of suspended fine sediments or excessive nutrient loading (eutrophication). Suspended fine sediments increase turbidity, reducing water clarity. Excessive nutrient loading and or high stream temperatures, promote the growth of algae, thus reducing the clarity of water. Water clarity affects recreational uses such as fishing and sightseeing. High turbidity levels, reflecting the presence of fine sediments in suspension, may detrimentally affect fish or other aquatic organisms, especially if high levels are chronic and persistent.

Water clarity of Fish Creek is generally extremely high. Streamflow is clear most of the year, except during early winter storms which tend to "flush" accumulated channel debris, and during major winter storms which may contribute sediment from bank erosion, slides, or surface erosion from disturbed areas. Instances of cloudy water are generally of very short duration, in direct response to heavy precipitation and/or rapid snowmelt. Relatively high stream gradients and stream velocities tend to transport fine sediments rapidly out of the watershed, allowing rapid clearing of water.

Recent monitoring of streambed substrate in the lower gradient transport and response reaches was carried out during the summer of 1993, utilizing the V* (V Star) methodology (Lisle and Hilton, 1992) and the Riffle Stability Index methodology (Knopp, 1993). The V Star and Riffle Stability Index methods characterize the amount of fine sediment and the size composition of stream substrate. V Star represents the proportion of the scoured pool volume occupied by fine sediments. As the quantity of sediment being transported increases, the percentage of the total pool volume occupied by fine sediments would be expected to increase.

The Riffle Stability Index (RSI) reflects the percentage of channel substrate sediments in a riffle that move at high flow. As the sediment load increases, the average particle size in a riffle decreases while the largest mobile particle remains fairly constant. Thus the proportion of a riffle's surface particles smaller than the largest mobile particle size increases. Both methods revealed that fine sediments are not abundant in the streambed substrate of Fish Creek and stream channel aggradation is not extensive. To the contrary, stream surveys and monitoring suggest that degradation, or the downcutting of channels, may be occurring (Estacada District monitoring records, 1993).

Water Chemistry

All available information and data on water chemistry within the Fish Creek watershed comes form project-specific monitoring of aerial forest fertilization activities occurring in 1990 and 1991. Monitoring procedures included sampling before and after the aerial application of fertilizer. Sampling parameters included total Kjeldahl nitrogen, nitrate-nitrite nitrogen, ammonia nitrogen, pH, conductivity, and alkalinity (Estacada District Monitoring Records, 1990-91). The available data indicates that total nitrogen, nitrate-nitrite nitrogen, and ammonia nitrogen are present in relatively low quantities, prior to and following aerial fertilization and within "untreated" subwatersheds. Measurements of pH remain relatively constant within the various subwatersheds, ranging from ph 7.2 to pH 7.6. All measured parameters are well-within the tolerance limits which research has established for aquatic organisms. Some slight increases in levels of nitrogen could be expected during the "fall flush" following fall and early winter precipitation in both disturbed and undisturbed watersheds due to the decomposition of organic matter (litter fall, algae, fish carcasses, etc.). However, the available data does not indicate such a flush of nutrients for Fish Creek or its tributaries. Only one "spike" was observed following fertilizer application, and that could be attributable to an inadvertent application directly to a riparian area.

Microbiology

Concern over the potential for introduction of pathogenic micro-organisms has arisen in recent years, due in part to the increased human use associated with dispersed camping and recreation occurring in riparian areas adjacent to Fish Creek. Evidence of unsanitary disposal of human fecal matter in close proximity to streams and other water bodies has been observed with ever-increasing frequency in the watershed, particularly along the mainstem of Fish Creek, below the confluence of Wash Creek. To date, there have been no reports of disease attributable to swimming or other water contact recreation activity. No monitoring program has been initiated to confirm the presence or absence of pathogenic protozoa, bacteria, or viral agents.

Riparian Canopy Disturbance and Stream Water Temperature

Stream water temperature is a major factor influencing the composition and productivity of aquatic ecosystems. Fish, aquatic macroinvertebrates, and other aquatic organisms are affected directly and indirectly by changes in water temperature. Stream water temperature is influenced by several factors including solar radiation intensity, air temperature, stream morphology, stream discharge, and vegetative or topographic shading. Direct solar radiation is a principal factor in raising stream temperatures and largely affected by the quality and quantity of shade producing vegetation.

Natural disturbance agents such as fire, windthrow, and storm-induced channel scour, and human activities such as timber harvest, road construction, and riparian-based recreation have the potential to influence stream temperature by altering streamside vegetation and channel form.

Prior to the mid-1940s riparian areas along the mainstem of Fish Creek and elsewhere throughout the watershed were well-vegetated with mature old growth Douglas-fir, cedar, and hardwoods. The lower mainstem reach was easily distinguished on aerial photographs (1946), owing to its natural width and north-south orientation, however stream margins and floodplains appeared mostly undisturbed. The photos reveal the first entry into the watershed: a cleared area (logging camp) extending several hundred yards along the east bank of Fish Creek, immediately upstream from its mouth. The same photos reveal several clearcut harvest areas incorporating stream riparian areas in the Dog Creek drainage.

Several first and second order streams scattered thoughout the watershed exhibited "revegetated scars" consisting of younger deciduous riparian vegetation. This suggests that these areas had been scoured by debris flows, most likely associated with the 1927 flood. Overall, such evidence of natural and human-related disturbance prior to the 1940s is very limited.

Removal of streamside vegetation during timber harvesting was a common practice throughout the Fish Creek watershed from the date of timber harvest entry into the watershed (1940s) through the 1980s. Consequently, many perennial streams and most intermittent streams associated with harvest areas throughout the watershed lacked the necessary shading to maintain cool stream temperatures during summer months. Along many of these affected streams, hardwood riparian vegetation has re-established and now provides sufficient shading. However, several of these affected streams, especially at the higher elevations, still lack adequate shading from riparian vegetation.

Table A-21 details stream shade quality within managed, unmanaged, and total riparian reserve areas for the Fish Creek watershed and principal subwatersheds. Shade quality is based on an assessment of canopy closure from the 1994 Base Vegetation Database compiled for the Fish Creek watershed analysis. For this analysis, canopy closure was used as a surrogate for stream shade.

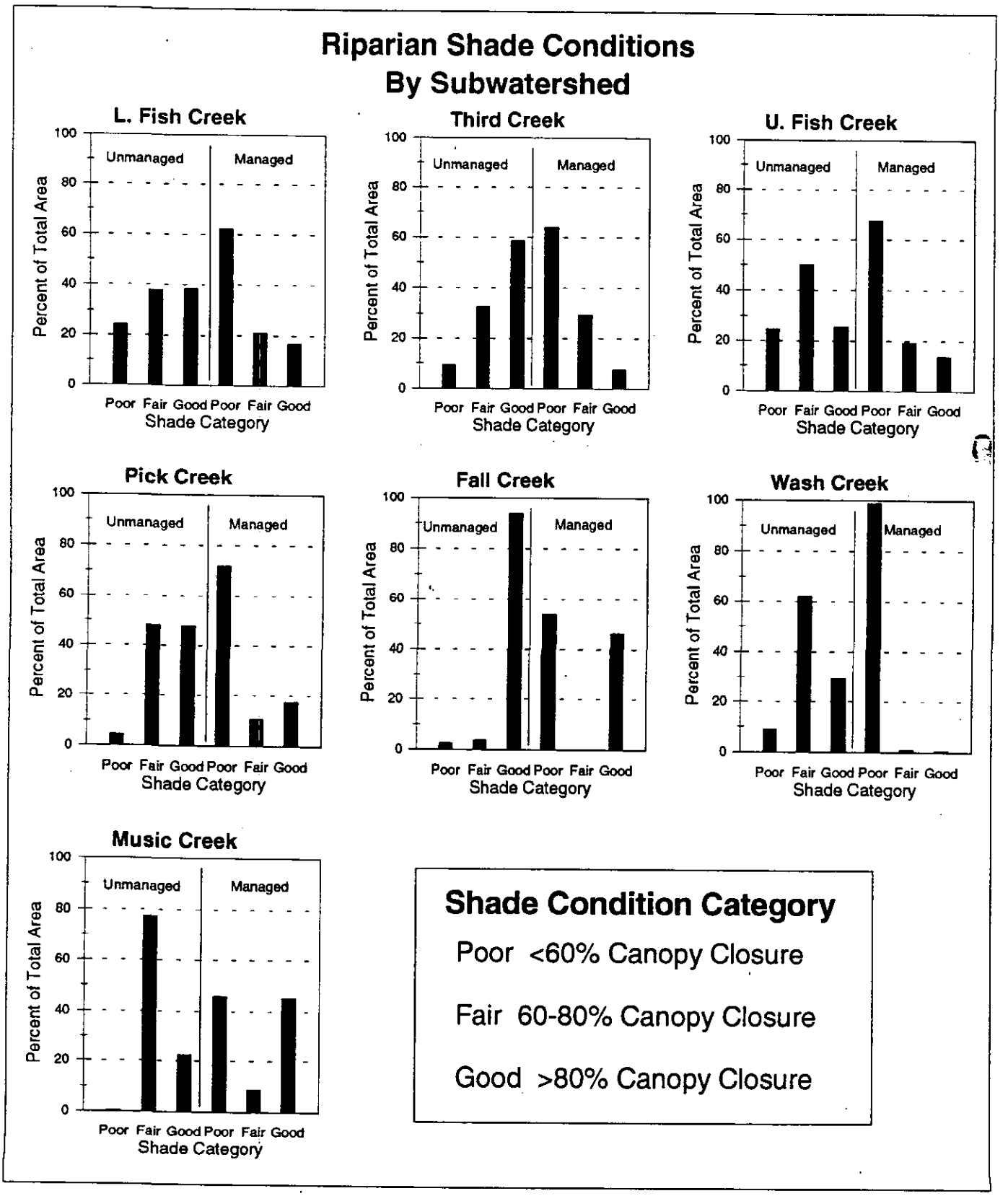
Table A-21. Stream Shade Condition

Watershed	Category	Acres Within Riparian Reserve			Percent of Riparian Reserve		
		Poor	Fair	Good	Poor	Fair	Good
L. Fish Crk	Unmanaged	373	588	595	24.0	37.8	38.2
Third Crk		23	80	144	9.3	32.4	58.3
U. Fish Crk		460	941	477	24.5	50.1	25.4
Pick Crk		15	172	171	4.2	48.0	47.8
Fall Crk		6	10	252	2.2	3.7	94.0
Wash Crk		144	1005	475	8.9	61.9	29.2
Music Crk		1	165	48	0.5	77.1	22.4
L. Fish Crk	Managed	1288	435	347	62.2	21.0	16.8
Third Crk		186	85	22	63.5	29.0	7.5
U. Fish Crk		1450	412	295	67.2	19.1	13.7
Pick Crk		346	52	84	71.8	10.8	17.4
Fall Crk		140	0	121	53.6	0.0	46.4
Wash Crk		846	7	3	98.8	0.8	0.4
Music Crk		189	37	187	45.8	9.0	45.3
L. Fish Crk	Total	1661	1023	942	45.8	28.2	26.0
Third Crk		209	165	166	38.7	30.6	30.7
U. Fish Crk		1910	1353	772	47.3	33.5	19.1
Pick Crk		361	224	255	43.0	26.7	30.4
Fall Crk		146	10	373	27.6	1.9	70.5
Wash Crk		990	1012	478	39.9	40.8	19.3
Music Crk		190	202	235	30.3	32.2	37.5

Stream shade categories are: poor (<60% canopy closure), fair (60-80%), good (>80%).

Figure A-10 illustrates the reduction in shade quality between managed and unmanaged stands in the principal Fish Creek subwatersheds. Notice the higher proportions of managed riparian reserves in the poor and fair categories, reflecting extensive timber harvesting in the various subwatersheds.

Figure A-10. Riparian Shade Condition by Subwatershed



Specific empirical data are lacking to illustrate the effect of riparian vegetation removal on stream temperatures within the Fish Creek watershed. However, this widespread removal of riparian vegetation along perennial streams has influenced the stream temperature regime within the watershed.

Non-continuous stream temperature data are available for several locations within the watershed, beginning in 1976. These data were collected at the time stream surveys were conducted and represent only single point measurements in time. From these non-continuous data, conclusions are severely limited. Several of the non-continuous stream temperature measurements taken during the low summer flow period during mid-day (1200 hours to 1600 hours) reveal temperatures in excess of 58 degrees Fahrenheit, Oregon water quality standard). However, the magnitude and duration of these departures from the state of Oregon water quality standard are unknown.

Continuous stream temperature data are available for the summer low flow periods only for the following years: 1979, 1980, 1981, 1982, 1983, 1988, 1991, 1992, and 1993. Up to five separate monitoring stations within the Fish Creek watershed were monitored from the period of 1979 to 1983 (Stream Temperature Module, Fish Creek Analysis File). Continuous stream temperature records collected for the years 1988 and 1991 through 1993 were taken at the mouth of Fish Creek only.

Figure A-11 illustrates the average seven day temperature maximums for Fish Creek, near its mouth, for years for which data is available. Similarly, Figure A-12 illustrates average seven day maximum temperatures for stations located on several tributary reaches in the Fish Creek watershed.

Figure A-11. Average Seven Day Maximum Stream Temperatures for Fish Creek, 1979-1993.

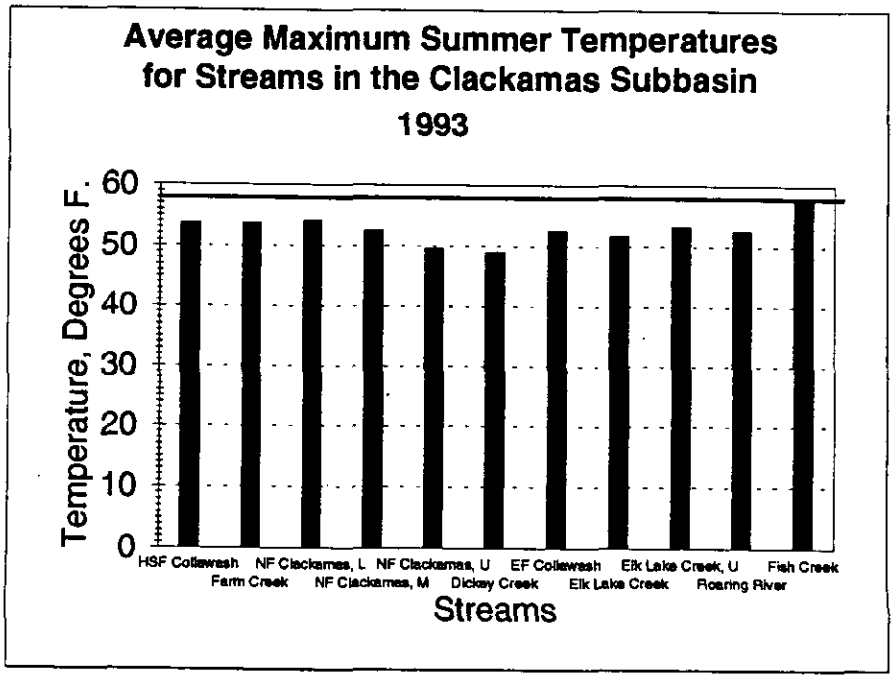
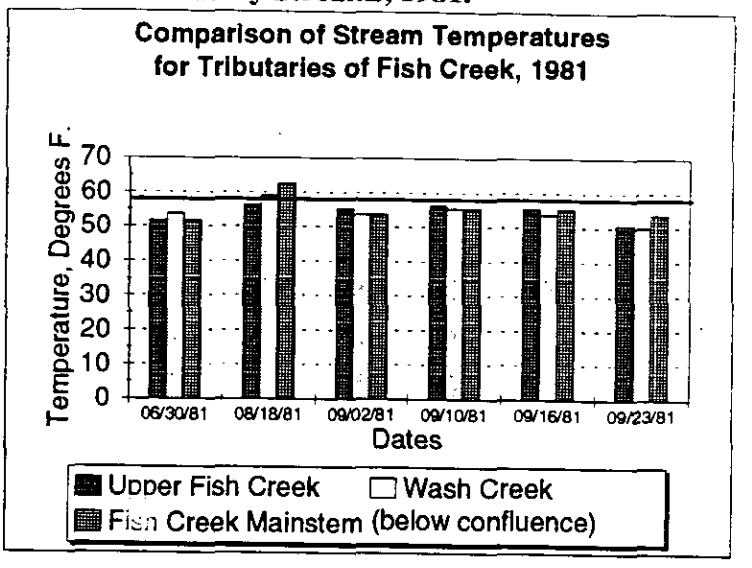


Figure A-12. Comparison of Average Seven Day Maximum Temperatures for Tributary Streams, 1981.

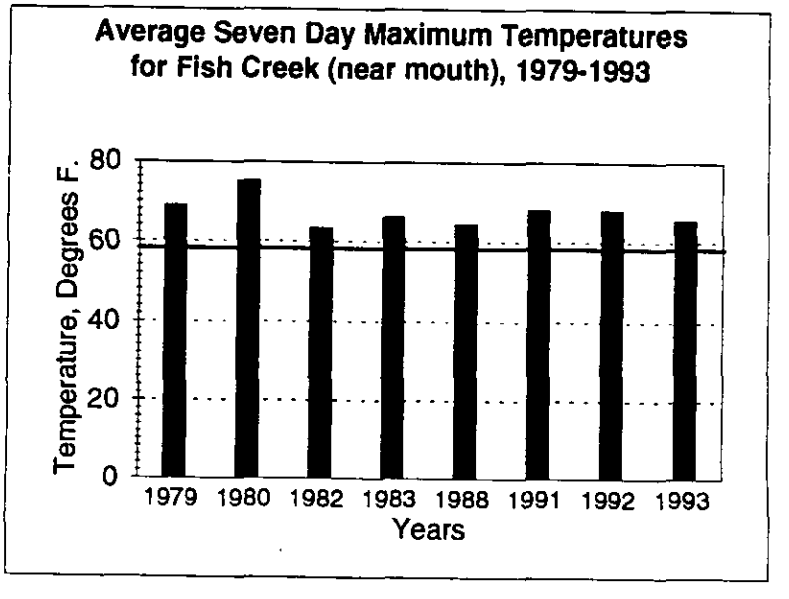


While little recent data exists for tributary streams, the 1991 data indicates that August temperatures were high for all stations. However, since flow data was not collected, Wash Creek's contribution to temperature increases in the mainstem of Fish Creek is not quantifiable.

Data collected in 1982-83 (Analysis File) suggest that stream temperatures are generally higher for Wash Creek, approaching or exceeding the State standard of 58° F.

Figure A-13 compares average maximum summer temperatures for Fish Creek and other major streams within the Clackamas River subbasin.

Figure A-13. Comparison of Average Maximum Summer Temperatures for Major Streams Within the Clackamas Subbasin, 1993



The average maximum summer temperature for Fish Creek is 57.7 degrees Fahrenheit. Figures A-13 graphically illustrates that average maximum temperatures are substantially higher for Fish Creek as compared to other watersheds within the Clackamas River subbasin. The analysis of daily temperature data reveals that Fish Creek also experiences the second greatest daily fluctuation of summer stream water temperatures, over 5.6 degrees, as compared to other watersheds whose daily temperature fluctuations range from 1.4 to 4.8 degrees. These findings are consistent with the riparian shade assessment presented earlier.

Critical high stream temperature periods occur mainly from June 1 through September 30. As Figures A-11 and A-12 illustrate, stream temperatures during this critical heating period have consistently exceeded the state water quality standard of 58 degrees Fahrenheit for the periods of available data during low summer flow conditions. In fact, maximum stream temperatures are very close to biological thresholds for salmonid fishes (70 to 74 degrees Fahrenheit). An analysis of stream temperature data collected near the mouth of Fish Creek from the period of 1991 through 1993 reveal both dramatic daily fluctuations and prolonged periods of daily departure from the state water quality standard (See reports on file).

Available benthic macroinvertebrate data for Fish Creek further indicate intensive stream heating conditions. While overall numbers of individuals was relatively high, indicating high production, species diversity (richness) was limited. For all taxa of benthic macroinvertebrates collected, none were classified as intolerant. Intolerant species are those found in cool, clean sediment-free waters.

The predominant north-south stream orientation of the mainstem of Fish Creek may also be partially responsible for elevated stream temperatures. Even though the condition of the riparian canopy is relatively good along the mainstem, the stream orientation coupled with low flows and the relative scarcity of deep pools may be contributing to the high temperatures observed in late summer. A review of available stream temperature data collected near the mouth of Fish Creek suggests a very slow recovery of substantially high maximum stream temperatures. However, maximum stream temperatures still exceed the state water quality standard of 58 degrees Fahrenheit on a daily basis during critical heating periods.

Current management activities within the watershed are not believed to pose an impact to stream temperatures given stringent standards to provide for adequate streamside shading. Thus, the stream temperature regime is truly in a recovery state from past management activities occurring from the 1940s through the 1980s.

Large Wood Supply Affecting the Aquatic Ecosystem

Large wood is delivered to stream channels naturally by landslides, by entry from adjacent riparian areas, and by transport from upstream areas. Large wood significantly influences channel morphology and is a major component affecting fish habitat. Pool spacing and the size and residual depth of pools are partially attributable to the influence of large wood in the channel. Similarly large wood contributes to the accumulation of sediment and formation of bars. Large wood can affect bank conditions by physically armoring the bank or by causing flows to impinge upon exposed banks. Large wood provides essential hiding cover for juvenile fish and creates velocity gradients to provide resting areas.

Surveys of Fish Creek conducted in 1959 indicate that large wood was abundant and contributed to the formation of large jams and numerous deep pools. Pools comprised about 45 percent of the habitat in the range of anadromous salmonids. A resurvey of the watershed in 1965, following the flood of December 1964, indicated that pool habitat had been reduced to about 25 percent. Much of the large wood was apparently redistributed and transported downstream by the flood. The mobilized large wood created jams in several locations, notably at bridges and culverts, resulting in extensive damage to the transportation system.

From 1965 until the early 1980s, much of the large wood was removed from the stream system through salvage logging efforts in a mistaken effort to reduce the risk to roads and crossings and to increase wood utilization. Moreover, many scientists believed at the time that large jams created barriers to fish passage for spawning. Surveys conducted from 1982 to 1985 concluded that the practice of removing large wood during the previous 10 to 15 years further reduced pool habitat to only 11 percent of total area.

With recognition of the value of large wood, subsequent rehabilitation efforts over the past 10 years have focused on the re-introduction of large wood. Recent surveys indicate that pool habitat has returned to levels approximating those observed immediately following the 1964 flood. However, conditions have yet to return to levels existing prior to the flood.

Riparian Reserves

Riparian Reserves are one of four components of the Aquatic Conservation Strategy (ROD, B-12). Riparian Reserves are portions of watersheds where riparian-dependent resources receive primary emphasis and where special standards and guidelines apply. In general, Riparian Reserves parallel the stream network, but also include other areas necessary for maintaining hydrologic, geomorphic, and ecologic functions.

Discussion of Riparian Reserves will focus on their goals. As outlined in the ROD (B-13), Riparian Reserves are used to:

- maintain and restore structure and function of intermittent streams,
- confer benefits to riparian-dependent species other than fish,
- enhance habitat conservation for organisms dependent on the transition zone between upslope and riparian areas,
- improve travel and dispersal for terrestrial animals and plants,
- provide connectivity in the watershed,
- and serve as a connectivity corridor among the Late-Successional Reserves.

Current condition analysis of Riparian Reserves was conducted on two areas; Riparian Reserves around standing and flowing water bodies such as lakes, streams and wetlands; and unstable and potentially unstable areas.

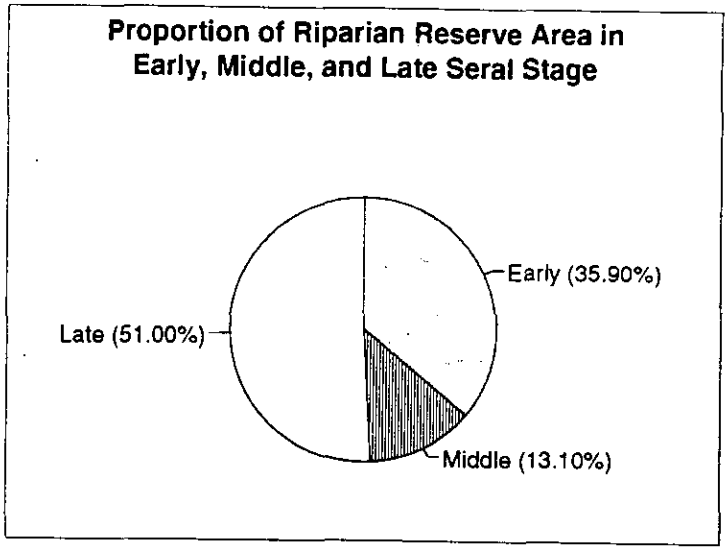
As discussed in Chapter 4, the Range of Natural Condition (the expected range of variability within vegetation seral stages) for riparian areas in the Clackamas River Basin are displayed in Table A-22.

Table A-22. Range of Natural Conditions and Current Conditions of Riparian Reserves.

Clackamas River	Early Seral 3 - 22%	Late Seral 36 - 78%
Current conditions are:		
• Fish Creek (all Riparian Reserves)	36%	51%
• Pacific Silver Fir Zone	50%	49%
• Western Hemlock Zone	29%	59%

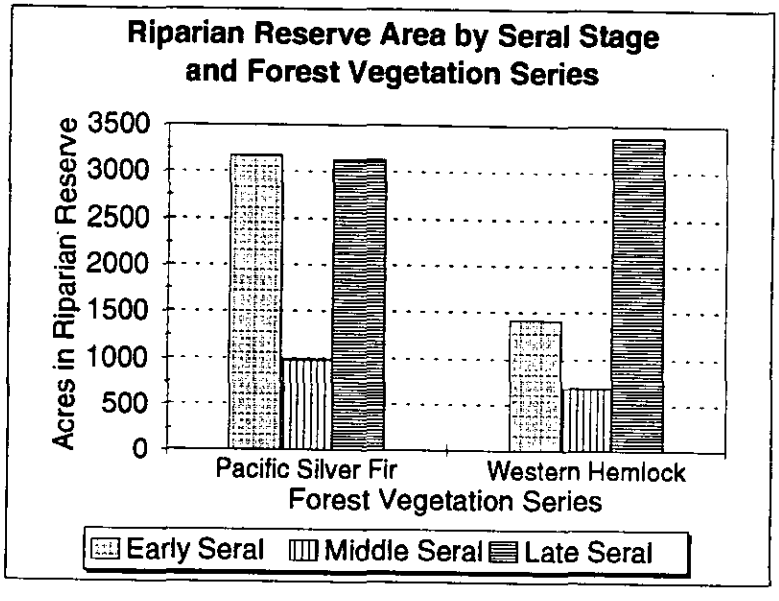
Figure A-14 displays seral stages of all Riparian Reserves in Fish Creek. Nearly 36% of Fish Creek Riparian Reserves are in an early seral stage, which is above the Range of Natural Conditions.

Figure A-14. Proportion of Riparian Reserve Area in Early, Middle, and Late Seral Stage.



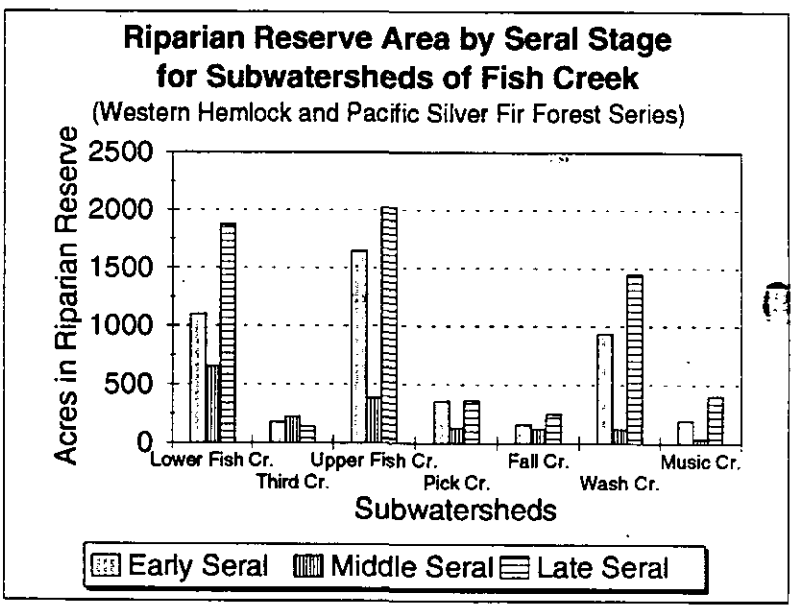
Displaying information by forest series further refines the trend. Figure A-15 displays total number of acres by seral stage and forest series. 57% of Riparian Reserves in Fish Creek are in the Pacific Silver Fir Zone, and 43% in the Western Hemlock Zone.

Figure A-15. Riparian Reserve Area by Seral Stage and Forest Vegetation Series.



Sub-watershed level information displays where management impacts (timber harvest/clearcutting) have been the greatest. Most mid-seral stage vegetation are plantations clearcut harvested in the 1950's and 1960's which are now displaying mid-seral stage characteristics. For example, the Third Creek watershed was one of the first sub-watersheds in Fish Creek to be roaded (see Road synthesis for further information) and current Riparian Reserves are nearly 73% early and mid seral stage (Figure A-16).

Figure A-16. Riparian Reserve Area by Seral Stage for Subwatersheds of Fish Creek (Western Hemlock and Pacific Silver Fir Forest Series).



Another indicator of Riparian Reserve integrity is the condition of intermittent and headwall areas. The Pacific Silver Fir Zone of Fish Creek is the higher elevation zones in the watershed (above 3,000 feet). Most intermittent and headwall areas in Fish Creek are in the Pacific Silver Fir Zone. The two following graphs (Figures A-17, A-18) display:

- seral stages by vegetation zone (Pacific Silver Fir and Western Hemlock)
- by sub-watershed.

Acres by watershed display relative impacts. For example, in Wash Creek (a stream containing anadromous and resident fish in the Western Hemlock Zone, and resident fish and most intermittent and headwall areas in the Silver Fir Zone) a relatively large percentage of the Western Hemlock Zone is in late seral stage (about 74%). However, in the Silver Fir Zone 47% is in early seral stage, and 45% is in late seral stage.

Figure A-17. Riparian Reserve Area by Seral Stage for Subwatersheds of Fish Creek (Western Hemlock Forest Series).

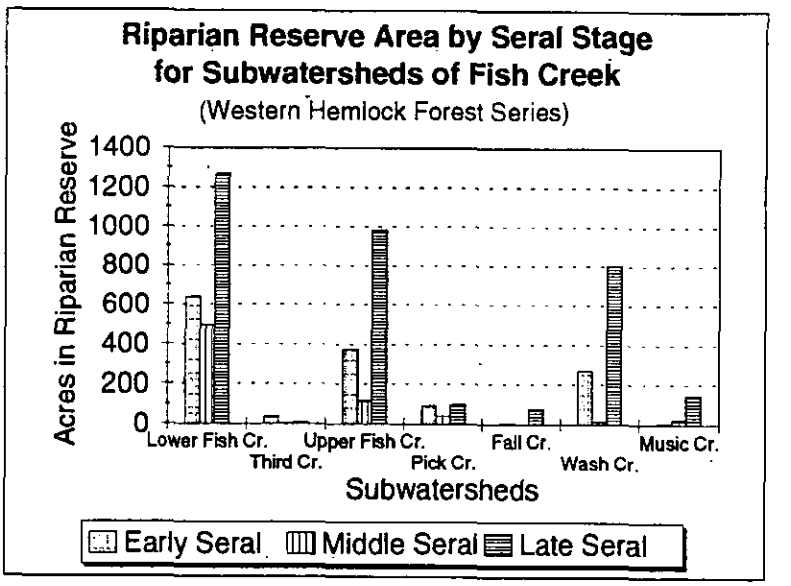
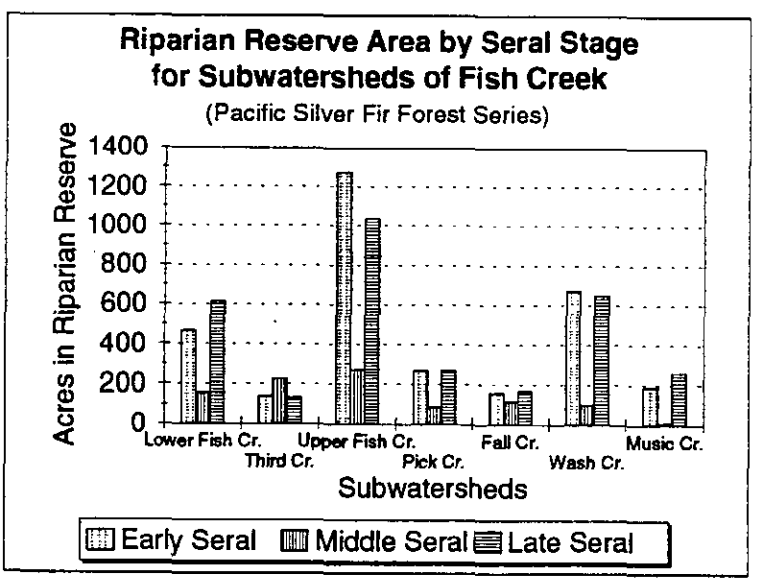
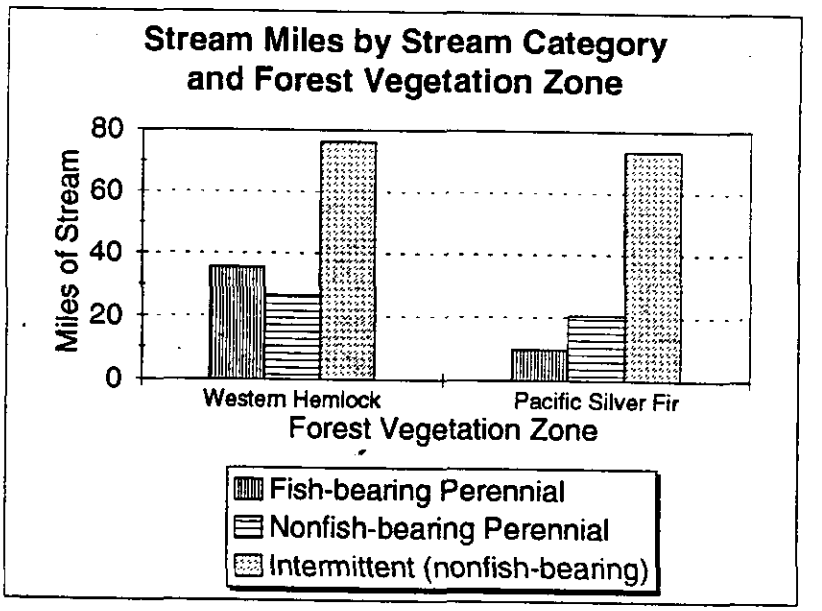


Figure A-18. Riparian Reserve Area by Seral Stage for Subwatersheds of Fish Creek (Pacific Silver Fir Forest Series).



One of the areas of greatest concern is the large percentage of early seral in intermittent streams. Over 50% of streams in Fish Creek are intermittent (Figure A-19). Future management of Riparian Reserves should consider the disproportionate impacts to these major waterbodies of the watershed.

Figure A-19. Stream Miles by Stream Category and Forest Vegetation Zone.



Aquatic Organisms

Fisheries and Aquatic Biology

Fisheries and aquatic biology are described in a historic context, followed by a summary of current condition and projected trends. Physical processes affecting fish, fish habitat and aquatic invertebrates are also examined. This report is outlined as follows:

- species present, distribution and population viability,
- habitat conditions, connectivity and habitat fragmentation,
- effects of physical processes on fish and aquatic insects, and
- lakes, springs and wetlands.

Species Present, Distribution and Trends

Fish

Prior to 1900, commercial fish harvest occurred near the mouth of the Clackamas River. Harvest estimates were as high as 12,000 spring chinook per year. Hatcheries were also built during this period, including one in the upper watershed of the Clackamas River used for the production of spring chinook. In 1904 Portland General Electric began construction of one of a series of dams on the Clackamas River. All dams were built with bypass facilities, however, in 1917 the ladder on Faraday Dam washed out and was not rebuilt until 1939. There was no upstream migration during this period. The existing fish populations are a combination of native fishes that have naturally reseeded the upper basin, and introduced/non-native fishes.

Indigenous fish stocks found within the Clackamas River basin above River Mill Dam include spring chinook salmon (Oncorhynchus tshawytscha), late run coho salmon (O. kisutch), late winter steelhead (O. mykiss), resident rainbow trout (O. mykiss), and resident and searun coastal cutthroat trout (O. clarki). Introduced stocks include Willamette spring chinook, early run coho, Big Creek and Eagle Creek stocks of winter steelhead, and summer steelhead (Skamania stock). Brook trout (Salvelinus fontinalis), brown trout (Salmo trutta) and kokanee salmon (O. nerka) have been introduced into high lakes in the upper Clackamas River basin.

Fish present in Fish Creek are spring chinook salmon, late run coho salmon, late winter and summer steelhead, rainbow trout, resident and searun coast cutthroat trout and brook trout. Other fish present in the Fish Creek watershed are sculpin (Cottus sp.), longnose dace (Rhinichthys cataractae), and mountain whitefish (Prosopium williamsoni)(Map 4-11).

In the early 1980's the Pacific Northwest Research Station (PNW) in Corvallis, Oregon began studying the effects of habitat restoration on physical characteristics and aspects of salmonid life history in Fish Creek. Results of these studies are found in a series of publications (see Analysis File). These reports document life history characteristics such as over-winter survival, total fish production, habitat use by juveniles and distribution in the watershed. There is a summary of their finding by species later in this document.

Other studies that have occurred in the Clackamas subbasin include radio tracking of late winter run coho (Cramer and Merritt 1991) and analysis of juvenile stock identification between native and introduced salmonids (Beyer 1992). An interagency working group of fish biologists has developed a working agreement on priorities for future study (Clackamas River Working Group 1994 work plan). Priorities for study in the upper Clackamas River basin include smolt trapping in three watersheds to determine relative abundance of fish stocks, radio tracking of migrating adult winter steelhead and PIT (passive integrated transmitter) tagging of juveniles to determine survivorship through the PGE dam system. The Clackamas River Wild and Scenic River plan (1991) thoroughly discussed the outstandingly remarkable fish values.

There are a total of 42.5 miles of fish bearing streams in Fish Creek (get from Ron for GIS numbers). About 16 miles of the 42.5 are anadromous. The lower portion of Fish Creek (from the confluence of Fish and Wash Creeks to the confluence with the Clackamas) is 2-5% gradient, and contains the only unconstrained reaches in the watershed. Fish Creek above the confluence of Wash Creek contains 1.3 miles of anadromous habitat, and the lower 3 miles of Wash Creek are accessible to anadromous fish. These reaches increase in gradient up to 8%, and rainbow and cutthroat trout populations are found throughout the watershed in tributaries with gradients from 8% up to 15%.

Coho (Oncorhynchus kisutch)

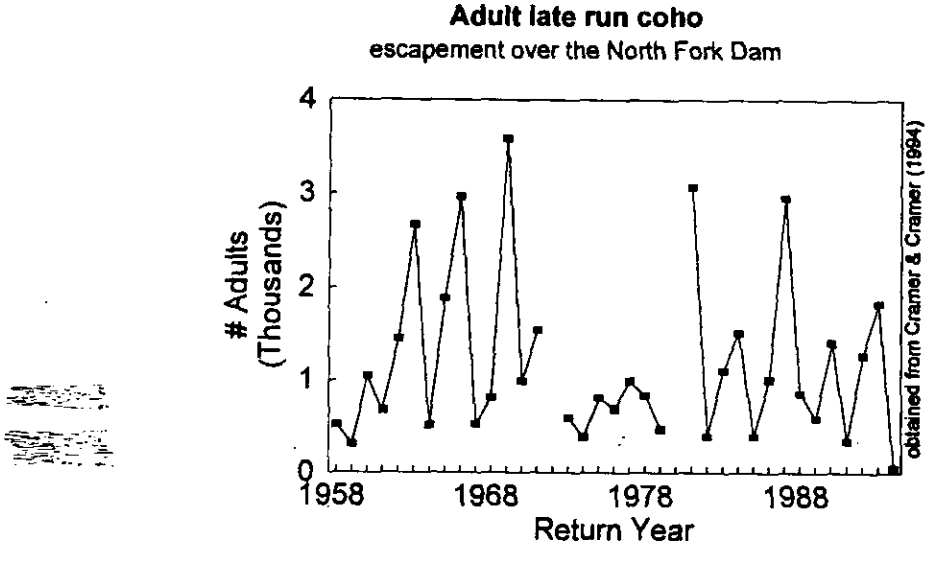
Fish Creek has a native run of late winter coho. Genetic testing is underway to determine the ecological significance of the run. It is believed to be the last self-sustaining wild run of coho salmon in the lower Columbia River (Cramer and Cramer 1994). Adults enter the river system between November and February and spawn January through March (Cramer and Merritt 1991). The fry emerge between March and May and rear in freshwater for eight to sixteen months. The fish smolt and migrate to saltwater during high flows in the spring and the fall.

In 1957, Eagle Creek Fish Hatchery began releasing early run coho in the Clackamas Basin. These fish enter the river as adults in September and October and spawn in October and November (Beyer 1992). Early run coho have come from Bonneville, Cascade, Oxbow, Sandy, and Knat Creek fish hatcheries. Although the early run is no longer released above the North Fork dam, a naturally produced run of early coho has been established. Overlap occurs in spawning and rearing between the two stocks, and the presence of the wild and natural stocks in the same habitat has been documented (Beyer 1992). Potential competition between the stocks is assumed, but needs additional study. It is unknown how this competition is contributing to the current decline of the wild coho stock.

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

National Marine Fisheries Service is currently conducting a status review for the late run coho pursuant to the Endangered Species Act. Declines in the run are documented (Cramer and Cramer 1994), and modeling for the three brood years predicts extinction for one, possibly two of the brood years (Lee 1993, unpublished report). Figure A-20 shows escapement over North Fork Dam of late run coho from 1958 to 1994.

Figure A-20. Escapement Over North Fork Dam of Late Run Coho.



It is unknown, but currently under investigation (Clackamas River Working Group 1994 work plan), what the contribution of Fish Creek late run coho is to the overall population in the Clackamas River. Based on Fish Creek's position in the watershed and known spawning activity (Cramer and Merritt 1992) it is thought to be a moderately to highly significant contributor of coho to the overall subbasin population.

There are about eleven miles of habitat accessible to anadromous fish in the Fish Creek watershed. Coho are present in the lower gradient portion of Fish Creek, and are usually found between river mile 0.0 to 3.0-6.0. Two off channel rearing ponds were constructed near river mile 3 in 1983. The total surface area of the ponds is about 2 acres.

During four years of published reporting, coho smolt production in Fish Creek has ranged from 2,371 in 1986 to 3,831 in 1987. The ponds on Fish Creek have contributed from 6% to 38% of the total production in the watershed. Knowing the high survival and production rates of the coho rearing ponds, fry from late winter coho were stocked in the ponds to establish a self-sustaining population. In the late 1980's the ponds were contaminated with Bacterial Kidney Disease, and have never returned to earlier production rates.

In the context of the Clackamas River, the contribution of Fish Creek to overall numbers to the coho population is low. In the late 1960's, to establish the early coho run, Oregon Department of Fish and Wildlife stocked coho smolts from the Sandy and Bonneville hatcheries, averaging about 200,000 per outplanting. In 1991 and 1992, outmigrating coho smolts averaged 65,000 at the North Fork dam. Overall, Fish Creek smolt numbers are comparatively low, but the contribution may be significant. Fish Creek has been managed for late run coho, and it is unknown what percentage of the late run coho population originates from the Fish Creek watershed.

In the past decade PNW research has documented the following life history characteristics for coho:

- There has been no direct correlation with habitat improvement projects and increases in numbers of juvenile coho. However, it appears there has been an upward shift of survival rates of juveniles - populations peaks are higher, and mortality rates have decreased. Weights of outmigrating smolts appear to increasing.

- Overwinter survival of juveniles appears to be related to timing and magnitude of first storm events. Coho use large wood-boulder complexes located along stream margins. If a large winter storm occurs prior to when habitat is accessible (before rains in the fall have recharged winter base flow) then mortality or movement out of the watershed would be high (Reeves et al 1990).

- Rearing ponds, when functioning, had a survival rate for coho of 70% and contributed up to 38% of the watershed population. The ponds have had problems with maintaining suitable environmental rearing conditions and have not maintained this level of production.

- Distribution of fish in the watershed varies from year to year. Coho have been found at the confluence of Fish and Wash Creeks (river mile 6.2) in some years, and only at river mile 3.0 in other, lower flow, years.

- Coho contribute to the Oregon troll fishery, and it is believed the Clackamas River stock moves south after entering the ocean at the mouth of the Columbia River (Reeves et al. 1990).

Winter and Summer Steelhead (Oncorhynchus mykiss)

The native wild winter adult steelhead enter the Clackamas River between April and June and spawn soon after reaching their natal streams (Beyer 1992). Fry emerge between late June and late July and rear in fresh water for one to three years. Juvenile steelhead smolt in in spring emigrate downstream from April through June during high spring flows.

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

In 1956 Eagle Creek National Fish Hatchery began releasing hatchery winter steelhead smolts in the upper Clackamas River. Between 1979 and 1988 the average annual release was 140,000 smolts. Parents of these smolts were a mix of Big Creek stocks and native Clackamas winter steelhead stocks. These returning adults, along with other hatchery produced adults released below the North Fork dam, appear to be shifting the return time of the winter steelhead to earlier in the winter (Beyer 1992). There is a potential for increasing breeding between native and hatchery stocks.

Beginning in 1968, another stock of steelhead was introduced into the Clackamas River. Skamania/Foster stocks of summer steelhead were released for the next 20 years to increase angling opportunities. Releases averaged 160,000 smolts a year in the Clackamas River.

Investigations are continuing on interactions between introduced winter steelhead and wild winter steelhead, and between winter and summer steelhead. Overall, there has been an increase in steelhead adult escapement into the upper Clackamas River. The general trend from 1958-1992 shows adult winter steelhead populations declining at a rate of 15 fish per year, while the total number of natural smolt emigrates has been on a gradual increase. It is feared overall wild winter steelhead numbers are continuing to decline, and numbers of introduced stocks are increasing (Clackamas River working group 1993).

In Fish Creek, steelhead use all eleven miles of anadromous habitat. Both winter and summer steelhead are known to occur in the watershed, but there is little information on competition between stocks. During four years of published reporting, steelhead smolt production in Fish Creek has ranged from 3,100 in 1988 to 7,600 in 1987. Estimating contribution of Fish Creek steelhead stocks to overall numbers in the Clackamas River is difficult, similar to coho. The only numbers to compare are outmigrating smolt counts at North Fork dam. In 1991 and 1992 wild winter steelhead smolt counts averaged 42,800.

In the past decade research has documented the following life history characteristics for steelhead:

- There has been no direct correlation with habitat improvement projects and increases in numbers of juvenile steelhead. However, it appears there has been an upward shift of survival rates of steelhead - population peaks are higher, and mortality rates have decreased.

- Production of steelhead smolts appears to be highly variable.

- Summer low flows may be the "bottleneck" (Reeves et al in Meehan 1991) for steelhead production. There is a strong correlation between available rearing habitat during the summer low flow period during previous the year and estimated numbers of steelhead trout smolts the following year (Reeves et al 1990).

- The number of the 1+ population is strongly correlated to the next year outmigration of steelhead smolts (Reeves et al 1990). Over winter survival ranges from 40% to 92%, and appears to be dependent on timing and magnitude of winter flow events. If habitat is available during winter storm events (if flows are adequate to allow steelhead to enter substrate outside the thalweg prior to major events), then survival appears to be greater.

Spring chinook (Oncorhynchus tshawytscha)

Historically (in the early 1900's), the Clackamas River was considered one of the best wild spring chinook producers (ODFW 1991). Since then numbers of wild fish have dramatically declined. Distribution of returning adults is fairly uniform in the upper Clackamas River (above North Fork dam). Adult spring chinook typically migrate through the areas between May and September. Downstream migration peaks between April and May and between October and November.

Since 1980, the number of spring chinook returning to the upper Clackamas River has increased from 530 fish annually (speculated to be primarily wild stock) to over 2,500 fish per year (primarily hatchery strays from the Clackamas River hatchery).

Distribution into Fish Creek is highly variable, and appears to be dependent on flow at the mouth. When late summer baseflows are low it appears chinook are unable to access Fish Creek during their spawning period. This has led to a highly variable production in the watershed. Estimates of juvenile chinook numbers range from 0 in 1988 to 6,290 in 1987. Due to this variability little additional information about spring chinook in Fish Creek is known.

Rainbow and Cutthroat trout (Oncorhynchus mykiss and O. clarki)

Endemic cutthroat and rainbow trout are found in Fish Creek. Coastal cutthroat trout are a State Sensitive Species (ODFW 1991). They have been found in Fish Creek, but their numbers are thought to be variable and low.

Information on distribution of rainbow and cutthroat trout in the Fish Creek watershed is poorly documented. Fish biologists are continuing to conduct presence/absence surveys to determine distribution of rainbow and cutthroat (D. Shively, pers. comm.)

Other Fish Species

Information on other fish species is a by-product of investigations of salmonids. Information is poor, and inconsistently documented. Other fish species known to exist in Fish Creek are sculpin (Cottus sp.), longnose dace (Rhinichthys cataractae), and mountain whitefish (Prosopium williamsoni).

Bull trout (Salvelinus confluentus) were known to inhabit the Upper Clackamas as recently as 1970. Anglers have reported past "Dolly Derbies", and other anecdotal information. They are currently thought to be extinct (Kamikawa and Eberl 1991). It is unknown if they historically occupied Fish Creek.

Aquatic Insects

In 1991 a biomonitoring program was begun on the Estacada Ranger District. Objectives were to provide baseline data for long-term trend analysis of aquatic biological integrity, and to augment the Mt. Hood National Forest stream database on invertebrate communities (Benthic Invertebrate Biomonitoring 1991).

Seven streams were sampled on the Estacada Ranger District (see summary report on file at Estacada Ranger District). Data results for Fish Creek are based on a comparison between the seven streams, and regional Environmental Protection Agency Protocols.

Fish Creek taxa are typical of lower to mid-elevation montane streams of the Pacific Northwest. No sensitive species were found. Taxa present were indicative of fair to good water quality, and taxa representative of excellent water quality were present in low numbers.

The taxa present are correlated with habitat conditions. Results included:

- Of all streams sampled, Fish Creek had the highest impairment rating, and was close to declining from slightly impaired to moderately impaired.

- No taxa representing warm water intolerant, cool water dependent montane mayflies were found in Fish Creek.

- Abundance in Fish Creek was highest of all sites sampled (outside the range of natural variability), indicating autotrophic (solar production) conditions.

- Taxa in montane streams is generally evenly distributed representing a diverse community. Fish Creek was the only site where a taxa (Trichoptera) exceeded 30% of the community composition.

- Functional feeding groups describe community composition. It appears Fish Creek has shifted towards a collector-gatherer community dominance from shredders and scrapers. Shredder and scrapers numbers decline when coarse organic debris (leaves and needles) are not retained in an aquatic system, or when silting of rock surfaces occurs.

Amphibians

Minimal surveys have been conducted for amphibians in Fish Creek. Species such as Pacific Giant salamanders have been found during fish surveys. Cope's salamander has been located in Pick Creek Subwatershed. There are no exotic species, such as bullfrogs, known to occupy Fish Creek.

Population Dynamics

Management of fish populations is the responsibility of the Oregon Department of Fish and Wildlife (ODFW). ODFW's sub-basin plan for the Clackamas sub-basin includes a determination of the "biological potential" (numbers of fish supportable under current habitat conditions), and sets "escapement goals" (numeric goals for numbers of anadromous fish returning to spawn). These goals are developed by species in the upper subbasin (above North Fork reservoir). These goals are consistent with goals set forth by the Northwest Power Planning Council, and are as follows:

Table A-23. Anadromous Fish Escapement Goals for the Clackamas River above North Fork Reservoir

Fish Species	Biological Potential	ODFW/NWPPC Plan Escapement Goals	90/91 Escapement Over North Fork Dam
Spring Chinook	3,700	2,900	3,514/3,059
Late-Run Coho	4,500	3,000	342/1,259
Winter Steelhead	4,300-13,000	3,000	2,107/1,352

No searun cutthroat were counted in 1990 or 1991

Escapement levels for late-run coho and winter steelhead continue to fall short of minimum escapement goals. Long term population viability is uncertain and of concern. Reasons for these declines are well documented in the Columbia Basin, and are a combination of harvest, impacts of hatchery stocks, reduced habitat quality and effects of hydroelectric facilities.

The Clackamas River Working Group of Fish Biologist made a preliminary estimate of which factors are most impacting fish stocks of concern on the Clackamas River (Information and Action Priorities for Managing and Restoring Clackamas River Salmonids 1993). Their findings were:

- Late-run coho are most impacted by commercial harvest levels.
- Steelhead are most impacted by hatchery effects, potential harvest of juveniles and overall declines in habitat quality.

Habitat Conditions, Connectivity and Fragmentation

Habitat conditions are described beginning with general historical information, and then comparing current habitat conditions to planning goals and desired conditions. Physical processes discussions are restricted only to those that appear to be affecting aquatic habitat and populations.

A variety of physical processes affect fish habitat. A few components important to species in Fish Creek are:

- Riparian vegetation and large woody material provides organic matter, shade, nutrient storage, low velocity areas, microhabitat, structure to scour pools and provide cover.

- Distribution of aquatic organisms is usually determined by habitat type. Side channels, ponds and low velocity riffles provide habitat for post-emergent fry. Pools provide habitat for many different salmon. In general, older age cutthroat trout are found in pools, and shallow riffles are occupied by young-of-year trout.

- Winter high flows often limit salmon production. Important winter habitat components are roughness elements such as boulders and large wood, and floodplains and other off-channel habitat areas. These provide low velocity and off channel habitats.

- Summer high temperatures, which can stress or kill fish.

Historical habitat information is based on stream surveys done in 1959 and 1965 (Fish Commission of Oregon 1960 and 1965). The 1965 surveys were done to determine the effects of the 1964-65 floods on fish habitat of Fish and Wash Creeks. Pools (rearing area) decreased in Fish Creek from 45 per cent in 1959 to 25 per cent in 1965. Spawning areas decreased about 30 per cent during the same time frame. It was also determined bedrock substrate decreased and percentage of boulders increased.

An aerial photo analysis comparing historic (1946) photos against current (1992) photos in Fish Creek shows a simplification of channel sinuosity, and it appears downcutting in channels has decreased interaction of the stream channel with the historic floodplain. This has resulted in a loss of fish habitat for overwintering fish during high flows. Since overwintering habitat is often a "bottleneck" for survival of juvenile salmonids, it could be limiting production (Reeves et al 1991).

Vigorous wood debris removal followed the 1964-65 floods to reduce hazards to bridges and culverts and improve access for adult salmon migration (a practice later determined to be detrimental to fish habitat). This resulted in further habitat simplification (Reeves et al 1990).

Aggressive restoration of habitat structure occurred in Fish Creek in the 1980's. By 1988 over 40% of the length of Fish Creek had been treated with some sort of habitat restoration. Some have met habitat restoration objectives (such as restoring pools to near pre-1964 conditions), and others, such as alcoves and cross channel boulder berms have not been as successful. These efforts are well documented in the PNW reports.

Current habitat conditions are measured by pools per mile and large woody debris per mile (Mt. Hood Forest Plan 1990 FW-095 and FW-094). Another regional guide, the Columbia River Policy Implementation Guide/Salmon Summit (PIG 1991), also sets goals for habitat conditions. Some of those relevant to aquatic ecosystems in Fish Creek are discussed in Table A-24.

Table A-24. Desired and Current Conditions for Aquatic Processes and Functions in Fish Creek

Parameter	Desired Condition	Current Condition			
		Fish Crk	Wash Crk	Pick Crk	Roaring R.*
In-channel Large Woody Debris	Minimum length 50'; 80 pieces/mi	**	**	166	68
Pools	28 primary pools/mi	12	8.2	**	7.7
Stream Temperature	Not to exceed 58 degrees	58	**	**	53
Aquatic Insects	3 sediment sensitive species present	Appears not to meet.			

** Roaring River is an nearby unroaded watershed with somewhat similar characteristics as Fish Creek.*

*** Large woody debris dimensions do not correspond directly with Mt. Hood Forest Plan Standards and Guidelines.*

None of the sampled reaches in Fish Creek meet standards for pool depth or frequency. Large wood rates appear to meet standards in Pick Creek. Overall, habitat conditions in Fish Creek have been improving since the restoration project began in the 1980's but do not meet standards and guidelines. Data collected by the Pacific Northwest Research Station does not correspond directly with Mt. Hood Forest Plan standards and guidelines.

Stream surveys have not indicated an excessive amount of fine sediment. As noted in the hydrology report, as Fish Creek and feeder tributaries were subjected to debris flows or had large woody debris removed, storage capacity for fine sediments was reduced. As structure has been returned to Fish Creek there has been increases in retention of finer sediments. There do not appear to be any limiting factors regarding amount of spawning gravel availability.

Overall riparian connectivity is also an important component of fish habitat. Riparian habitat connectivity is considered for floodplains, localized disturbance (such as culverts), and connectivity of late seral stands. Downcutting and channel simplification in mainstem Fish Creek has decreased overall channel connectivity with floodplains (see channel morphology section). Culverts have been inventoried for fish passage, and on Third Creek and Pick Creek impassable culverts were replaced. There are other culverts blocking passage (such as on Music Creek and Rimrock Creek) that are decreasing riparian connectivity. Connectivity of late seral stands along the mainstem of Fish Creek is high on the west side of the stream, although the integrity of the riparian area is punctured by several clearcuts with boundaries next to the stream. The east side of Fish Creek is bordered by a road, and habitat fragmentation is high.

Lakes, Springs and Wetlands

There are two lakes are in the Fish Creek watershed, Surprise and Skookum. Skookum Lake is three acres in size, and is stocked with brook trout. Surprise Lake is five acres in size, and is stocked with brook trout. Both are popular recreation sites. See Analysis File for the complete lake survey reports. Seeps, springs and wetlands are described in the "special habitat" section of the Terrestrial section.

Effects of Physical Processes on Fish and Aquatic Insects

The management related debris flows described in the hillslope processes section have accelerated delivery rates of large wood, boulders and fines to stream channels. These debris flows have traveled 1/4 mile to 1 1/2 miles, many intersecting or traveling in fish bearing streams. In upper tributaries there are major deposits of large wood where these flows stopped. Channels altered by debris flows are often scoured to bedrock, and channel roughness has been simplified and have lost storage capacity of sediment and nutrients. Debris flows are also a source of large woody debris, but with the aggressive stream cleaning following the 1964-65 floods, little is left in fish bearing streams. More localized debris flows have large debris jams still intact.

Peakflows continue to shape and modify channel geomorphology. The hydrology section discusses the probable increase in peakflows. This has a direct effect on fish in Fish Creek, since overwinter survival appears to be directly linked with onset and magnitude of winter flows (Reeves et al 1990). Trends indicate peakflows have increased, and if these increases appear early in the winter storm season it has a direct negative affect on fish survival.

Large woody debris recruitment potential to streams has sharply declined since forest management began in the 1940's. This will continue to have a long term negative affect on fish habitat until existing stands reach a size to once again contribute a stable large wood supply.

Another effect of the intensive timber removal along streams has been the increase in temperatures. Water temperature is a determining factor in the composition and productivity of aquatic ecosystems. In the Clackamas River subbasin Fish Creek has highest average daily summer temperatures. It also has the greatest diurnal temperature fluctuations. Steelhead are probably the most sensitive to increased water temperatures. Summer low flow conditions are directly correlated with steelhead production (Reevest et al 1990).

Peak summer water temperatures appear to be affecting composition of aquatic macrointervebrate communities. It appears to have shifted functional feeding groups from Shredders to Collector-gatherers. It also appears to be affecting community diversity, as a Trichoptera taxa is dominating community composition.

Stream carrying capacity of Fish Creek also appears to be affecting production of steelhead. With decreased low flows, overall production is reduced for steelhead. Access to margin microhabitat, a critical habitat need of juvenile coho, is also reduced during summer low flows. Low flows can also exacerbate stream temperature highs.

Low summer flows appear to affecting the distribution of coho within Fish Creek, and the ability of migrating spring chinook to enter Fish Creek.

Changes in channel morphology and loss of floodplain connectivity would most affect overall channel complexity, and survival of fish during storm events.

Social

Prehistoric

Knowledge of prehistoric use within the Fish Creek drainage is somewhat limited. Several archaeological sites have been located within the watershed, but none have been evaluated to provide specific data on earliest occupancy. Other sites within the Clackamas Subbasin have been evaluated as dating back 7000- 8000 years.

Several prehistoric sites found within the watershed indicate that it was used by prehistoric peoples, especially the area along lower Fish Creek. These were likely places where native peoples stopped or camped for a limited time during their seasonal rounds. Key uses identified within the Fish Creek watershed include:

- gathering areas near the mouth of Fish Creek and at its confluence with Wash Creek (cedar bark was collected for clothing, storage containers and cordage, along with medicinal herbs),
- a fishing and camping corridor along lower Fish Creek, and
- a number of possible travel routes (see Analysis File for "Prehistoric Uses" map).

Heaviest use probably occurred near the mouth of Fish Creek at its confluence with a major anadromous fish bearing river, the Clackamas. The lower elevation and perhaps milder climate, along with the availability of resources may have contributed to stays of longer duration than in other parts of the watershed. Huckleberries were also an important dietary staple and are found at higher elevations within the Fish Creek drainage, although not in great abundance.

Historic

A 1916 Oregon National Forest map indicates a trail system already in place running in an east/west direction, crossing the watershed close to the confluence of Fish and Wash Creeks (see Analysis File for "Historic Euroamerican Uses" map). This was part of a much larger trail system providing a travel route between the Willamette Valley and the upper Clackamas River and beyond. Trails were also in existence along the ridge systems bounding the drainage headwaters. Previous use of these ridge systems as travelways by native peoples is evidenced by sites located in scattered locations along their route.

Following the turn of the century and establishment of the National Forest system, fire protection and improved access to contain wildfires led to the establishment of remote "Ranger Stations" for fire and small work crews, along with fire lookouts on major peaks throughout the forest. Small work crews were needed for the development of a more extensive trail network and maintenance of telephone lines connecting the lookouts with the outside world. The lookouts which bordered the Fish Creek drainage were Fish Creek Mountain, existing from 1915 to 1963, Baty Butte 1914-1950, Thunder Mountain 1929-1967, and South Fork Mountain 1931-1960. There was also a Ranger Station at Baty Butte and one at Cold Springs on the ridge system between South Fork Mountain and Baty Butte.

Management History

Fire Suppression

Active fire suppression began in the Fish Creek drainage around the turn of the century. Earliest recorded suppression activities occurred in 1910 on a 75 acre fire near Dead Horse Butte. During the 1940's there were four recorded fires that were suppressed within the drainage. All were very small and were caused by lightning strikes. Two of these fires were along Fish Creek ridge, one on Camelsback ridge, and one in the Wash Creek drainage. The 1950's saw 8 fire starts in Fish Creek, 7 of which were person-caused. All of these fires were located in the northeast portion of the drainage, where management activities were centered. During the 1960's there were 8 fire starts within the drainage, 2 of which were person-caused and the rest of which originated from lightning strikes. The strikes primarily occurred on the ridge systems, although there were two lightning-caused fires in the lower elevations near the mouth of Fish Creek. All of these fires remained small.

Roads

Road construction in the Fish Creek drainage began in the mid 1940's. At that time roads were constructed into the lower reaches of the drainage near the confluence of Fish Creek and the Clackamas River, and then on to the broad upland benches occurring on the mid slope positions in the eastern portion of the watershed. The road entering the drainage traveled through and adjacent to Fish Creek, breaching the integrity of the established flood plain. The first two miles of this road was completed by 1945. A trail was also constructed about the same time, connecting the end of the road with the east/west trail running through the drainage.

During the mid 1950's several new mainline roads, constructed as single lane aggregate surfaced features, were placed in the drainage. By 1960 the eastern portion of Fish Creek drainage had a well developed mainline system providing access to the headwaters of Fish Creek. The first roads were being placed on the west side of the drainage, providing access to the mid slope benches in that area. At the end to the 1940 to 1960 time period approximately 33 miles of aggregate surface road had been constructed in the drainage (Table A-25).

Table A-25. Road Development Through Time

Surface Type	New (miles)	Reconstruct (miles)	New (miles)	Reconstruct (miles)	New (miles)	Reconstruct Road (miles)	Current Roads
Native	1.9	0	11.1	0	.4	0	13.4
Aggregate	31.0	0	84.4	0	8.4	0	101.5
Paved	0	0	2.4	19.7	0	2.5	24.6
Total	32.9	0	97.9	19.7	8.8	2.5	139.5

The greatest level of road construction activity in the drainage occurred during the time period between 1960 and 1980. During this period an additional 53 miles of aggregate surface road had been constructed, providing access into the headwaters of Wash, Pick, and Fall Creeks, both sides of Camelsback Ridge, and the entire western part of Fish Creek drainage. Road densities were increased in the headwaters of Fish Creek and the entire eastern portion of Fish Creek drainage. New construction in this time period occurred on the steepest, unstable portions of the 5430 road.

Road reconstruction also occurred during this time period. Many of the road segments constructed prior to 1960 were improved to a single lane or double lane standard and paved. Approximately 98 miles of new road construction occurred in Fish Creek watershed during the 20 year period ending in 1980.

By the end of the 1980's the road system in the watershed was extensive, with 130 total road miles creating a road density of 2.8 miles per square mile. Road densities in the watershed are not uniformly distributed. Highest road densities occur east of the main stem of Fish Creek.

During the 1980 through 1994 period road construction activity in the drainage was at its lowest levels.

Presently, there are 139.5 total road miles in the drainage with a road density of 3 miles per square mile. Miles of aggregate surface roads comprises 73 % of the total, while native surface roads comprise 10 % of the total road mileage.

Timber Harvest

The first timber harvest within the Fish Creek drainage began in 1944, to provide a quick source of lumber during World War II. The earliest harvest units were located near the mouth of Fish Creek and were sold to the Dwyer Lumber Company. Robert Dwyer established a small airstrip, at about the 1000 foot level southeast of the mouth of Fish Creek, to provide a landing area for his small airplane. This was to provide him quick access from his office in Portland to check on his logging operations in the area. By 1946 the Dwyer Lumber Company had established a logging camp with at least three large buildings slightly upstream from the mouth of Fish Creek.

The earliest harvest activities in the watershed were confined to the lower portions of the drainage along Fish Creek and on the steeper valley sides. Harvest levels increased in the 1950's in the Upper and Lower Fish Creek subwatersheds, with timber removal located on the hummocky terrain of ancient landslide benches and on the steeper valley side walls of Fish Creek canyon. By the beginning of 1960, harvest on 2,000 acres had yielded approximately 133.2 MMBF of timber (Table A-26).

Harvesting rates accelerated during the next 20 years, an additional 6,720 acres of harvest occurred from 1960 through 1980 in the drainage. During this twenty year period harvesting took place in all seven subwatersheds, with harvest continuing on mid-slope benches formed by ancient landslides and glaciated valley slopes in newly entered subwatersheds. Over 420.2 MMBF of volume was removed in this twenty year period.

Table A-26. Historical Timber Harvest

	1940-1960	1960-1980	1980-1994	Total
Harvest (acres)	2,036	6,720	3,530	12,286
Estimated Volume (net MBF)	133,238	420,222	204,278*	757,738

**Includes only the period from 1980 through 1989.*

Harvest levels remained high from 1980 through 1993, occurring mostly in the first decade of the period. From 1990 to the present approximately 430 acres of harvest occurred in the watershed. The remaining 3,100 acres of harvest for the most recent period occurred during the 1980's.

Timber harvest, predominantly by clearcutting, has occurred over 41% of the watershed (12,200 out of 29,782 acres).

Special Forest Products

The history of special forest products use coincides with development of access into the Fish Creek drainage. Historically, there has been firewood collection, Christmas tree harvest and harvest of cedar for shakes and bolts.

In recent years there has been increased harvest of ditchside alder and vine maple for furniture and crafts, upland alder and vine maple, beargrass in higher elevations, and sites for bee hives.

Recreational Use

The general pattern of recreation in the Fish Creek watershed is based upon landscape characteristics and management direction. Fundamental factors include proximity to Portland and surrounding communities, low elevation, topography, management direction in the Forest Plan, and roaded access. Fish Creek is located in close proximity to the Forest boundary and is within a shorter driving time than watersheds further upriver and receives a comparatively high level of human use. It is a low elevation watershed which allows a long season of use but little consistent snow based recreation. The topography is steep limiting the amount of flat land available for facility development particularly along the creek and backcountry lakes which is the preferred setting for camping. Management direction also limits fishing opportunity and facility development. The watershed is highly roaded which facilitates road based recreation activity but limits unroaded primitive and semi-primitive recreation opportunities. Recreation activities in the watershed include dispersed camping, trails along the watershed divide, fishing and camping at backcountry lakes, hunting, pleasure driving, limited mountain bike activity, dispersed OHV activity, and limited environmental education.

Dispersed Camping

The pattern of dispersed camping within the Fish Creek watershed is a reflection of the general pattern found within the larger Clackamas drainage. Flat areas near water with easy access are a preferred setting during the warm weather recreation season and a concentration of dispersed campsites are found along the Fish Creek corridor. A 1993 study revealed 22 dispersed campsites along Fish Creek's mainstem from the confluence of the Clackamas River to the confluence of Wash Creek. An additional 6 sites are located at or near the Wash Creek confluence. Each campsite contains one or more camping units as indicated by the number of fire rings so that there are approximately 42 camping units within 100' of the creek. While some changes in the distribution of sites has occurred since 1977 data collection (due to agency blocking of sites with berms and boulders or site development) the number and pattern of sites is roughly consistent in 1994. All sites except the Wash Creek sites are located between road 54 and the east bank of Fish Creek and occupy over 1,200 linear feet of stream bank. The average size of the campsites is approximately 2,500 square feet and occupy an estimated 2.4 acres of the riparian area. Another 1.6 acres of potential expansion area is noted in the 1993 study. All sites show ground compaction, understory devegetation, and overstory tree damage or death. There are an estimated average 5.5 large trees greater than one foot in diameter per camp unit. Over half of the sites have less than 50% groundcover. In addition to the dispersed campsites, Wards Camp is a former industrial camp cleared by the Forest Service and now converted by users to a dispersed campground.

Anecdotal evidence from district personnel suggest a user profile of the dispersed campsites. Because Fish Creek is legally closed to fishing, users tend to be those seeking campsites away from regular recreation areas along the Clackamas. The low elevation which permits year round access, convenient road access, and proximity to urban areas also tends to attract long term homeless campers which is identified as the major issue in the watershed. Lacking a large campsite with parking for multiple vehicles, underage drinking parties are a minor concern. Adult camping parties with public displays of intoxication, domestic disputes, and fighting are, however, common. Gang activity is present but is deliberately unobtrusive. Signs of gang graffiti can be found on the back side of bulletin boards and underneath bridges. Illegal activity in the watershed also includes dumped stolen cars, assaults, car clouting, illegal drug use and cultivation, firewood theft, and garbage dumping.

Environmental Education

A limited amount of environmental education and interpretation occurs along the mainstem of Fish Creek. School classes and biologists visit a number of sites along the creek to view fish structures and monitoring sites. Three bulletin boards placed along the creek provide messages about fish and fish habitat.

Backcountry Lakes

Dispersed camping also occurs in the watershed at the backcountry lakes, Skookum and Surprise which offer a legal fishing opportunity. The campsites at Surprise Lake have roaded access and are available to RVs. The designated campsite at Skookum Lake is a walk-in site but a fire ring also exists at the trailhead parking area. Surprise and Skookum Lakes could also be considered "special places" as defined in the Forest Plan.

During the fall hunting season, the pattern of use disperses more broadly throughout the watershed to upland sites along roads and timbersale landings. There are no reported "special place" hunting camps. Desired settings for fall hunting camps does not appear to be contingent upon a wooded or scenic setting but is dependent upon flat areas, roads, and open stands.

Recreational Driving

Although every road in the system can be expected to have some level of recreational driving, only the loop 54 and 5420 have been clearly identified by district personnel as having consistent recreational use.

Target Shooting

Target shooting in the watershed occurs primarily in rock pits and borrow pits. Two sites, the waste disposal site and the airstrip, receive consistent use. In addition, shooting trees and signs from vehicles is a common practice and problem.

Developed Recreation

There is only one developed recreation facility in the watershed, the Fish Creek Barrier Free Fishing Pier. Located at the confluence of Fish Creek and the Clackamas River, the pier is visible from HWY 224 and serves as an attraction drawing visitors to the watershed. Constructed in 1990, the pier receives a high level of use and a comparatively low level of vandalism. The pier parking lot also serves as the trailhead for the Clackamas River Trail and as a staging area for river events.

Trails

Four and one half miles of trail are either located in or accessed through the Fish Creek watershed. These include:

Trail 541	Fish Creek Mountain, 2.0 miles
Trail 542	Skookum Lake, 1.0 miles
Trail 543	Thunder Mountain, 1.0 miles
Trail 545	Baty Butte, 0.5 miles

All trails except Baty Butte are open to and suitable for mountain bikes and horses. They are not preferred by those users because they are too short and/or the terrain is too steep. Baty Butte is currently not maintained but accesses the old "Boundary Trail" which is proposed for rehabilitation and would be appropriate for long distance horse use. In addition, the Clackamas River Trailhead is located at the Fish Creek Pier and the proposed Urban Link Trail would cross a portion of the watershed at its confluence with the Clackamas River.

Mountain Bikes

Potential mountain bike trail development is limited within the watershed. Criteria for mountain bike trails include loop connections, scenic destinations, 10-20 miles in length, single track preference, a slope 15% or less, and a close proximity to Portland. Road travel by mountain bikes is acceptable if it is in short segments necessary to finish a loop route. Steeper grades are also acceptable if there is the opportunity for a steep downhill grade as well. The Fish Creek watershed has minimal current use by mountain bikes and has only marginal potential for development.

Hunting and Trapping

Hunting and trapping as recreational or livelihood persuits have been a part of the human experience in Clackamas Subbasin for centuries (at least). No clear information regarding these persuits are available to describe historic or existing use levels; however, Fish Creek Watershed has likely played only a minor role in the subbasin due largely to its dense vegetation and rough terrain.

Historic trapping likely focused on beaver, mink, otter and perhaps pine marten. Some gray wolf trapping may have also occurred. Beaver trapping has been prohibited on the Mt. Hood National Forest since the late 1970s by Oregon Department of Fish and Wildlife as an effort to re-establish population numbers and improve aquatic habitat conditions. Very little trapping occurs today in the Fish Creek area; some recreational trapping efforts may occasionally occur targeting bobcat and coyote.

The most heavily hunted species in the subbasin and watershed are black-tailed deer and Roosevelt elk. Cougar and black bear are also targeted species. Ruffed grouse and blue grouse, and possibly band-tailed pigeon, receive occasional recreational hunting pressure. Two exotic species have been introduced into the subbasin to potentially establish as huntable populations, i.e. ring-necked pheasant and wild turkey (Fish Creek Watershed provides virtually no quality habitat, existing or potential, for these species).

With some of the earliest roading access for hunters in the subbasin occurring in Fish Creek (late 1940s), along with the close proximity to the valley communities, the watershed has experienced a fairly long standing and consistent hunting pressure. Deer and elk herd numbers are believed to have increased in response to high quantities of forage being produced in the subbasin and watershed due to clearcut harvesting and broadcast burning. Elk populations have also been augmented by Oregon Department of Fish and Wildlife's cooperative program with the Forest to release elk in the drainage. Tables showing total timber harvest by decade, stratified by subwatershed, are available in the Analysis File. A relatively high open road density (i.e. 3.1 miles per square mile - the highest watershed in the subbasin) has limited the availability of some of the forage produced by these timber harvest areas due to human harassment of the animals. A map depicting existing forage, hiding cover and thermal cover areas in the watershed and the highest potential winter range is in the Analysis File. Existing elk populations are below Oregon Department of Fish and Wildlife's Herd Management Objectives for the North Santiam Unit. Fish Creek is expected to play a relatively minor role in the subbasin (and the North Santiam Unit) in providing habitat for deer and elk.

Cougar population densities are believed to be relatively high in the watershed. Black bear are present, but at densities less than in upper portions of the subbasin. These 2 species receive specialized hunting pressure - primarily from hound hunters (i.e. animal persuit with domestic dogs). Wash Creek cougar populations have received notable harvest in recent years (pers. com. Joe Pesek, ODFW wildlife biologist).

Habitat for ruffed grouse is believed to have increased in the last few decades, indirectly associated with timber harvest activities. Ruffed grouse prefer hardwood stands for foraging; red alder is of particular value. The increase in landslides within the watershed associated with clearcut harvesting and road building (see Hillslope Processes) has resulted in increased red alder dominated plant communities. Data regarding past, current or future population numbers for ruffed and blue grouse are not available. Mountain quail are present in the watershed, but no evidence of any hunting pressure is recognized (pers. com. Joe Pesek, ODFW).

Band-tailed pigeon are declining as a species throughout their range (pers. com. Joe Pesek, ODFW). The lower elevations of the western slopes of the Cascade Range are the eastern edge of the species range. Population data or use patterns for band-tailed pigeon in the watershed or subbasin are not available. Significance of the watershed to population trends or viability is not known.

Fishing

Prior to 1989 Fish Creek was open to sport angling. Closure to fishing was instituted in 1989 to decrease the effects of angling on the research project in mainstem Fish Creek and Wash Creek.

Lakes are still open to fishing. Both Surprise and Skookum lakes are stocked with rainbow trout and brook trout.

Appendix B

Appendix B - Ecosystem Components (Issues)

Three watersheds within the Clackamas River Subbasin were proposed for comprehensive watershed analysis:

- Fish Creek,
- Collawash River/Hot Springs Fork, and
- Upper Clackamas River.

Ecosystem components (also referred to as issues, but perhaps more inclusive) identified for each watershed have been grouped into three broad categories:

- physical,
- biological, and
- social.

The watershed analysis team recognizes that there is considerable overlap and interaction in natural systems, and these subdivisions may be somewhat general and arbitrary.

This list of ecosystem components is not intended to be exhaustive, site-specific, prioritized, or all-inclusive. It is intended to be a display of the "issues, values and uses" described in Step 1 of "A Federal Agency Guide for Pilot Watershed Analysis". These ecosystem components represent the pieces of the puzzle upon which identification of Key Questions for watershed analysis will be based.

Note that the format for the Fish Creek Watershed Analysis evolved into a slightly different grouping of ecosystem components:

- terrestrial,
- aquatic, and
- social.

This appendix documents the evolution of the iterative process used to identify the issues or ecosystem components which provided a basis for formulation of "key questions" to facilitate watershed analysis.

Key to Coding

On the left side of the document are 4 columns. The headers are coded by:

- **Fi** - Fish Creek Watershed
- **Up** - Upper Clackamas Watershed
- **Co** - Collawash/Hot Springs Fork Watershed
- **O** - Other:
    - **S** - Subbasin,
    - **P** - Province,
    - **A** - other agencies, and
    - **WS** - Warm Springs

"Watershed" columns (first 3), coded as yes (Y) or no (N):

Y = The ecosystem component is a part of the watershed ecosystem, or best addressed at the watershed scale.

N = The ecosystem component is not a part of the watershed ecosystem, or it is deemed to be best addressed at some other scale.

"Other" column:

Subbasin and Province indicates that aspects of these ecosystem components are appropriately addressed at these geographic scales (analysis at the S and P scales does not necessarily prohibit analysis at the Watershed scale as well).

Other agency (A) coding indicates that the jurisdiction for addressing this particular ecosystem component rests either partially or totally with an agency other the Forest Service.

Warm Springs (WS) coding indicates the Confederated Tribes of the Warm Springs have special consideration with respect to this ecosystem component.

Physical

Altered Hydrologic Regime

Fi	Up	Co	O	
Y	N	Y		changes in the magnitude, timing, and frequency of peak flows (tiered to other watershed research)
Y	N	Y		changes in the magnitude and duration of base flows

Altered Stream Geomorphology (channel condition)

Fi	Up	Co	O	
Y	Y	Y		increases in sediment delivery and changes in sediment routing, related to changes in channel form, channel scour, bank erosion, and aggradation, etc.
Y	Y	Y		channel downcutting, channel migration, floodplain and side channel abandonment
Y	Y	Y		loss of large wood and other structural components

Altered Water Quality

Fi	Up	Co	O	
Y	Y	Y		increases in sediment loading and turbidity
Y	Y	N		increases in the potential for localized pathogenic contamination related to activities in riparian areas
Y	N	Y		increases in the range of diurnal and seasonal water temperature extremes (higher highs, lower lows)(tiered to other watershed research)

Altered Riparian Ecosystem Function

Fi	Up	Co	O	
Y	Y	Y		changes in plant community composition (contributing to changes in water temperature and reductions in large wood recruitment)
Y	Y	Y		changes in nutrient input and cycling
Y	Y	Y		alteration of the function of the hyporheic zone (major concern about early seral in Fish, see PULSE products, same concern about Upper Clack although may be less than Fish)

Altered Hillslope Processes

Fi	Up	Co	O	
Y	N	Y		increases in frequencies and magnitude of mass movement (landslides, etc.)
Y	Y	Y		increases in surface soil erosion associated with roads, timber harvest activities, etc.
Y	Y	Y		reduction of infiltration and increases in surface runoff related to ground disturbance
Y	Y	Y		interception and concentration of surface and subsurface water by roads, landings, skid trails, etc.

Altered Soil Quality

Fi	Up	Co	O	
Y	Y	Y		loss of soil productivity on detrimentally disturbed areas due to compaction, soil displacement, burning, erosion, etc. (Fish Creek question on magnitude)

Biological

Recovery of Species/Populations in Peril

Fi	Up	Co	O	
Y	Y	Y		peregrine falcon nesting habitat
Y	Y	Y		bald eagle nesting, foraging and wintering habitat
N	Y	Y		spotted owl reproductive habitat in Late Successional Reserves and critical habitat
Y	Y	Y		spotted owl reproductive pairs
Y	Y	Y		spotted owl dispersal habitat
Y	Y	Y	A	harlequin duck reproductive habitat
Y	N	N		Townsend's big-eared bat population viability
N	Y	N		Greater sandhill crane reproductive habitat and seasonal foraging habitat
Y	Y	Y	A	wolverine population viability
Y	Y	Y		herptile population viability (Cope's giant salamanders, western spotted frog, western pond turtle, painted turtle)
Y	Y	Y	A	Lower Columbia Coho reproductive and rearing potential
Y	Y	Y	A	searun cutthroat reproductive and rearing potential
Y	Y	Y		sensitive plant population viability, e.g. cold water corydalis, Gorman's aster, fir club moss, adder's tongue, loose flowered bluegrass, pale blue eyed grass

Conservation of Biotic Communities

Fi	Up	Co	Q	
Y	Y	Y		conservation of aquatic communities (e.g. fish, insects, molluscs)
			A	native fish population structure (especially resident trout)
Y	Y	Y		conservation of terrestrial communities (e.g. lichens, mushrooms)
Y	Y	Y		conservation of riparian communities
Y	Y	Y		impacts of introduced species
Y	Y	Y		conservation of historic plant communities, late successional forests
Y	Y	Y		conservation of species guild associated with coarse woody debris (e.g. woodpecker group), i.e. regarding timber harvest practices, insect control, etc.
Y	Y	Y		conservation of special habitats

Extirpated Species (opportunities for re-establishment)

Fi	Up	Co	Q	
			A	bull trout
Y	Y	Y	PA	fisher
N	Y	Y		common loon as a nesting species
			PA	grizzly bear
			PA	gray wolf
			PA	California condor (downstream from NFS lands)
			PA	Columbian white-tailed deer (downstream from NFS lands)
			PA	yellow-billed cuckoo (downstream from NFS lands)

Altered Landscape Patterns

Fi	Up	Co	O	
Y	Y	Y		loss of connectivity
Y	Y	Y		seral stages outside the range of natural conditions
Y	Y	Y		changes in natural disturbance
Y	Y	Y		fragmentation of late successional forest

Social

Ecosystem Participation and Education Opportunities

Fi	Up	Co	O	
			SP	people as an integral, interacting component of the ecosystem, e.g. native Americans
			SP	environmental education

Adequacy of Human Access (roads and trails)

Fi	Up	Co	O	
Y	Y	Y		for commodity extraction
Y	Y	Y		for recreation

Visual Impacts of Disturbances

Fi	Up	Co	O	
Y	Y	Y		changes to the recreation experience associated with scenery

Availability of Natural Resources for Human Needs

Fi	Up	Co	O	
Y	Y	Y		commodities (timber, clean water, special forest products, wildlife and fish etc.)
Y	Y	Y		recreational experiences (including conflicts between/among)
Y	Y	Y		dispersed recreation
Y	Y	Y		preservation, maintenance or conservation of old growth ecosystems, riparian ecosystems and other special experience places
Y	Y	Y	WSS	spiritual experiences
Y	Y	Y	WSS	medicinal purposes
Y	Y	Y	WSS	subsistence

Human Recognized "Special Places"

Fi	Up	Co	O	
Y	Y	Y		i.e. waterfalls, scenic vistas, secluded sites, etc.

Human Expectations of Biotic Communities

Fi	Up	Co	O	
Y	Y	Y	S PA	conservation or maintenance of all species
Y	Y	Y	S PA	safety (removal of threatening species i.e. grizzly bear or gray wolf)
Y	Y	Y		maintenance of exotic non-native species for consumption (e.g. wild turkey and brook trout)
Y	Y	Y		watchable wildlife, especially high profile species (e.g. bald eagle, chinook salmon)
Y	Y	Y	AS	maintenance of some species populations at a high level to allow for hunting and trapping (i.e. a sustainable level that includes annual harvest) - deer/elk forage production, i.e. quantities of high quality forage are expected to decline due to changing forest mgt practices - deer/elk security habitat, i.e. degraded by wide spread people presence (largely due to high road densities) - deer/elk poaching - elk calf survival - ruffed grouse and mountain quail habitat, i.e. intensive forest regeneration efforts minimize successional stages important to these species
Y	Y	Y	A	sport fishing (on and off Forest; private and commercial)
N	N	N	A	commercial fishing (off Forest)

Urban Influence (i.e. urban needs/problems overflowing to the Forest)

Fi	Up	Co	O	
Y	Y	Y	PA	gang activities
Y	Y	Y	P	crime, vandalism, dumping
Y	Y	Y	P	shooting opportunities; uncontrolled recreational shooting
Y	Y	Y	P	visitor safety
Y	Y	Y	P	homeless encampments (e.g. squatting, home roving); use of the Forest by homeless people
Y	Y	Y	P	degradation of forest experience due to over crowding

Special Uses

Fi	Up	Co	O	
N	Y	Y	A	utility transmission corridors and sites
N	N	Y		administrative sites (e.g. Bagby Hotsprings)

Appendix C

Appendix C - List of Projects

Fish Creek Watershed Analysis
Potential Projects
Estacada Ranger District

- ☐ Urban Link Trail *
- ☐ dispersed recreation site management
- ☐ commercial thinning areas *
- ☐ precommercial thinning areas
- ☐ fertilization
- ☐ wildlife management (down wood and snags)
- ☐ winter range - forage
  - road densities
- ☐ riparian restoration - diverse stands and dependent species
- ☐ late successional connectivity
- ☐ neotropical birds
- ☐ wetland restoration
- ☐ PNW research

- ☐ restoration - roads
  - riparian areas
- ☐ road maintenance and upgrades (including culverts)
- ☐ aquatic or channel restoration
- ☐ lower mile of Pick Creek restoration *
- ☐ wooden stringer bridges *
- ☐ emergency land training at Whales Head *
- ☐ Special Forest Products *

* *environmental analysis completed or underway*

Appendix D

Appendix D - Fish Creek Map Layers that are available at Estacada Ranger District in the Analysis File (Scale 1:24000)

Land Allocations

- ☐ FEMAT Late Successional Reserves
- ☐ Mt. Hood Forest Plan - Land Allocations

Existing Vegetation

- ☐ Landscape Structure
- ☐ Stand Age (50 yr. Intervals)
- ☐ Rock/Talus
- ☐ Harvest Activities by Harvest Code
- ☐ Hardwood/Administrative Sites
- ☐ Seral Stage
- ☐ Wet Areas

- ☐ Stand Structure (Early Seral Stands)
- ☐ Stand Structure (Mid Seral Stands)
- ☐ Stand Structure (Late Seral Stands)
- ☐ Late Seral Stands
- ☐ Managed Stands Year of Orgin (10 yr. interval)
- ☐ Managed Stands by Harvest Activity and Fuels Treatment (1989-1994, 1984-1989, before 1984)

Plant Species

- ☐ Noxious Weeds Areas of Infestation
- ☐ Sensitive Plant Approximate Locations
- ☐ Sensitive Plant Surveyed Areas (Hand Drawn Layer)

Disturbance

- ☐ Historical Seral Stages
- ☐ Fire Groups (Hand Drawn)
- ☐ Area Affected By Insects (Hand Drawn)

Potential Vegetation

- ☐ Ecology Plot Data with Plant Association
- ☐ Plant Association Stratification (Hand Drawn)
- ☐ TSHE Plant Association
- ☐ ABAM Plant Association
- ☐ Forest Series (Hand Drawn)

Wildlife

- ☐ Late Successional Reserve Owls
- ☐ Deer and Elk Habitat with Winter range
- ☐ Townsend Big Eared Bat Habitat (Hand Drawn)
- ☐ Harlequin Duck Habitat (Hand Drawn)
- ☐ Bald Eagle and Western Pond Turtle Habitat (Hand Drawn)

Soils/Geology

- ☐ Landslide Potential Area (Hand Drawn)
- ☐ Roads with the High Potential Erosional Soils
- ☐ Landform Map (Hand Drawn)
- ☐ Landslide Map Existing
- ☐ Road Related Sediment Map
- ☐ Earthflow Map
- ☐ Landform Map
- ☐ Soil Resilience Class
- ☐ Soil Erosion Hazard

Riparian

- ☐ Seral Stages with Riparain Reserves
- ☐ Riparian Reserves
- ☐ Large Woody Debris Recruitment Potential
- ☐ Stream and Road Crossings
- ☐ FEMAT Minimum Fixed Width Riparian Reserves

Slope/Aspect

- ☐ Transient Snow Zone
- ☐ Aspect
- ☐ Slope 10% or Less
- ☐ Slope 30% or Less
- ☐ Slope 0-29, 30-49, 50-69 or 70 percent

Roads

- ☐ Road Surface Types with Road closure Devices (Hand Drawn)
- ☐ Road Maintenance Level (Hand Drawn)
- ☐ Road Surface Types
- ☐ Rock Pits
- ☐ Historic Road Construction (1940-1960, 1960-1980, 1980-1994) (Hand Drawn)
- ☐ Road Maintenance Concerns (Hand Drawn)

Vegetative Database Cell Delineations

- ☐ MOM and VEG89
- ☐ TRI
- ☐ Base Vegetation 94

Social

- ☐ Potential Commercial Thinning Opportunities
- ☐ Future Noble Fir Bough Sale Areas
- ☐ Potential Pre-commercial Thinning Opportunities
- ☐ Current and Potential OHV and Mountain Bike Use
- ☐ Current Recreation Use

Appendix E

Appendix E - Watershed Analysis Team and Persons Consulted

The Fish Creek Watershed Analysis Interdisciplinary Team included:

Larry Bryant, Hydrologist

Cindy Froyd, Ecologist

Tracii Hickman, Fisheries Biologist

Rick Kneeland, Wildlife Biologist

Mike McArthur, Soil Scientist

Ron Wanek, Analyst/GIS Specialist

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Appendix F

Appendix F - References

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