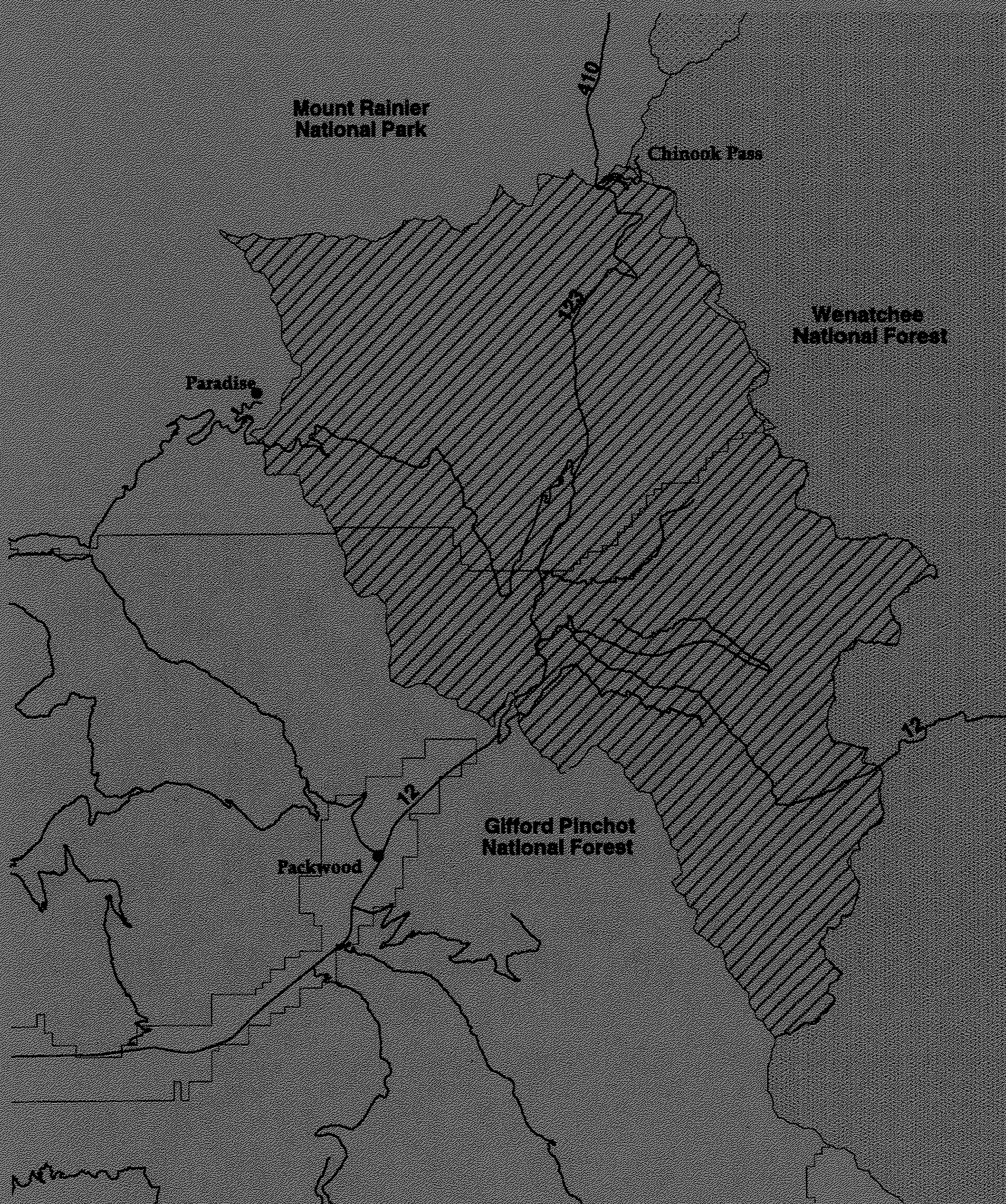
Clear Fork Watershed Analysis



Gifford Pinchot National Forest
Cowlitz Valley Ranger District
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Chapter 1 - Overview

Introduction

Watershed analysis is an analytical tool designed to describe the biophysical processes and interactions that operate on a landscape at the watershed scale. The purpose of the analysis is to provide a scientific understanding of ecological processes that can be used to guide future management activities within the watershed. Management direction pertinent to conducting watershed analysis is found within the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (USDA, USDI 1994).

Analysis Process

The process used to conduct the Clear Fork Watershed Analysis is a synthesis of previous efforts that have been utilized on the Packwood and Randle Ranger Districts. The key tasks involve, 1) identifying issues and questions that are relevant to key management objectives, 2) characterizing the historic and current condition of the watershed's physical, biological, and human elements, 3) determining trends based upon historic and current conditions, and 4) interpreting the results in the form of recommendations that are responsive to the key watershed processes identified.

Based upon the time frame given to complete the analysis, no field data collection was attempted during the process. All data used in the analysis was extracted from existing sources. Data in the following chapters are presented for National Forest and National Park lands, unless otherwise noted. Although it is important to characterize the entire analysis area regardless of land ownership, in many cases only data for the National Forest portion was available. Data sources, data gaps, and any associated assumptions are clearly expressed at the beginning of each respective resource section in Chapter 3.

The information presented in all chapters of this document may need updating to reflect changing conditions and newly discovered information. An analysis file to track document edits will be on file in the planning department at the Cowlitz Valley Ranger District. A process for editing the document needs to be developed.

Watershed Overview

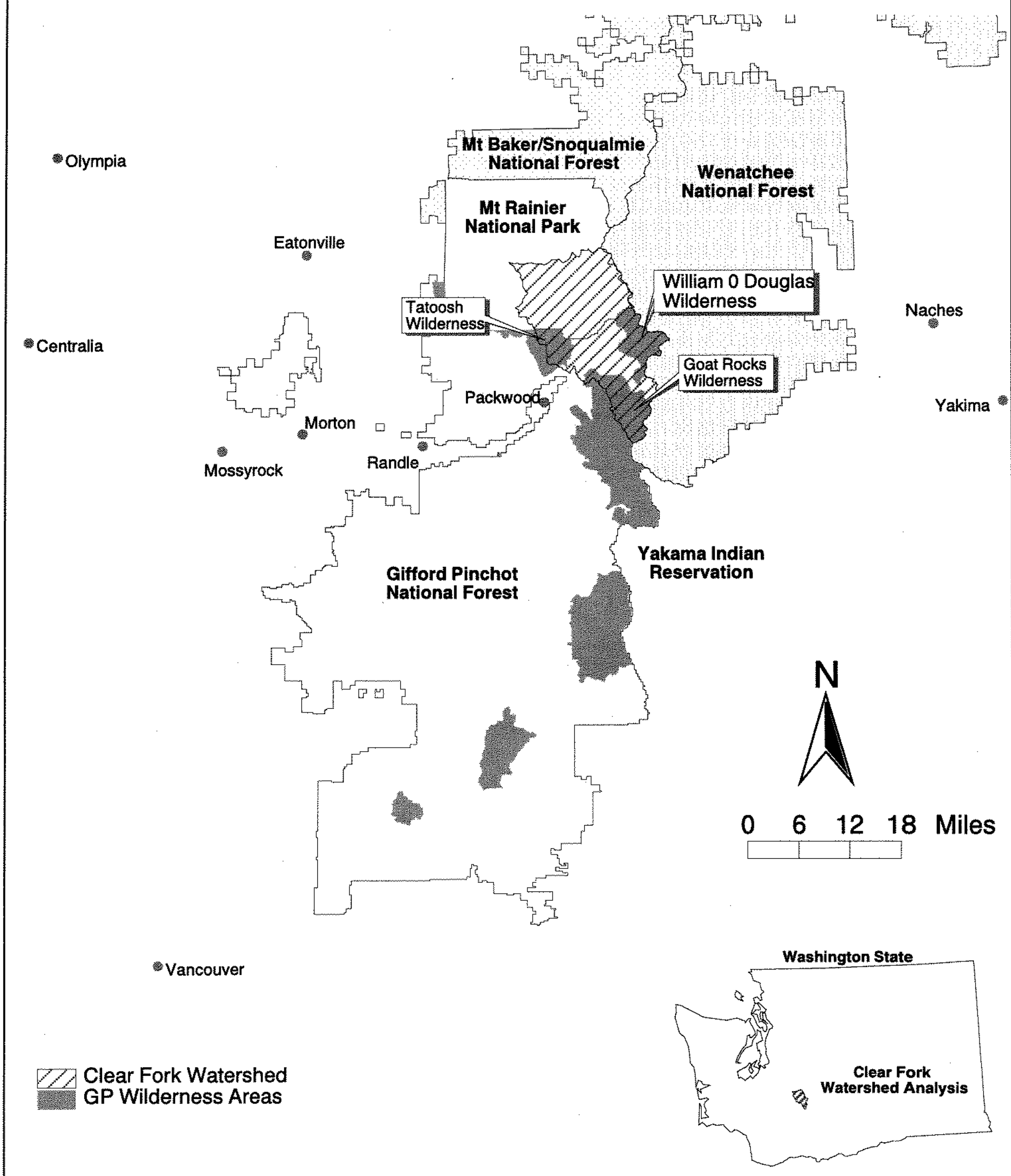
The Clear Fork watershed encompasses 137,905 acres situated in and around the Clear Fork Cowlitz River valley near the town of Packwood, Washington (Map 1, Regional Vicinity). The northern portion of the watershed is bounded by the southeastern slopes of Mt. Rainier while the southern boundary is defined by the county line between Lewis and Yakima counties in the Goat Rocks Wilderness (Map 2, Local Vicinity and Ownership).

For this analysis, the Clear Fork watershed was stratified by sixth-field watersheds, land ownership and forest zones. Sixth-field watersheds were named according to the primary aquatic feature they encompass and/or general location. Table 1-1 lists the eighteen sixth-fields and associated aquatic features within the Clear Fork watershed. See Map 3, Sixth-field Watershed Boundaries, for a display of their locations.

Table 1-1 : General Location of Sixth-field Watersheds

Sixth-field	Name	Other Aquatic Features
01A	Lower Muddy Fork Cowlitz River	Taos Creek
01B	Lower Ohanapecosh River	
01D	Lower Summit Creek	
01E	Upper Summit Creek	
01F	Lower Carlton Creek	
01G	Upper Carlton Creek	
01H	Cyrenus Creek	
01I	Lower Cortright Creek	
01J	Upper Cortright Creek	
01K	Lower Clear Fork Cowlitz River	
01L	Upper Clear Fork Cowlitz River	
01M	Purcell Creek	
01N	Dam Creek	
01P	Lava Creek	
01Q	Little Lava Creek	Lily Lake
01R	La Wis Wis	Convergence of Clear Fork Cowlitz River and Ohanapecosh River
01S	Upper Ohanapecosh River	Seymour Creek, Boulder Creek, Needle Creek, Shriner Creek, Laughingwater Creek, Panther Creek
01T	Upper Muddy Fork Cowlitz River	Stevens Creek, Williwakas Creek

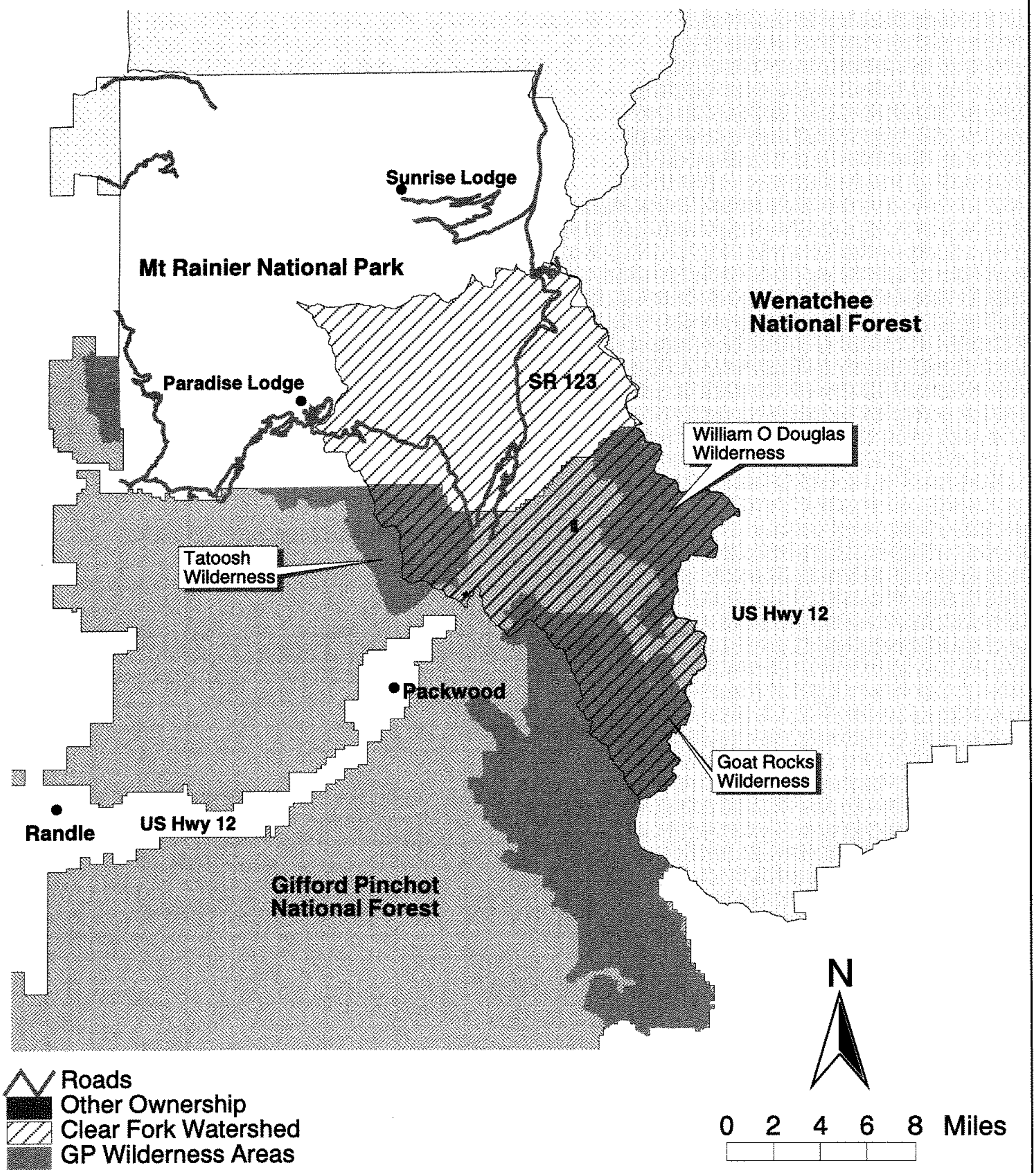
Map 1
Clear Fork Watershed Analysis
Regional Vicinity



Map 2

Clear Fork Watershed Analysis

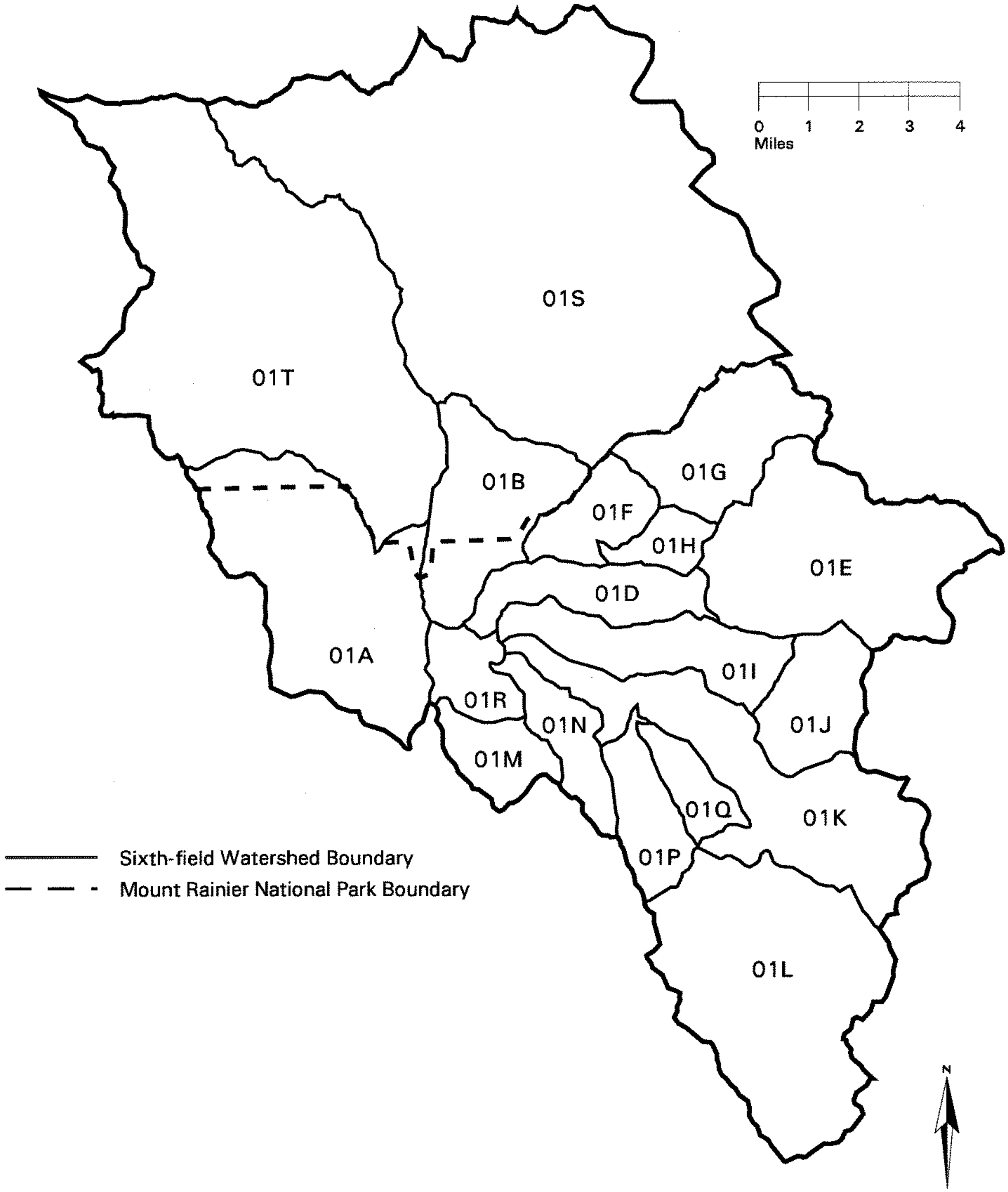
Local Vicinity and Ownership



Map 3

CLEAR FORK WATERSHED ANALYSIS

Sixth-field Watershed Boundaries



The watershed consists of 70,792 acres of National Forest land (Gifford Pinchot National Forest), 67,004 acres of National Park land (Mt. Rainier National Forest), and 109 acres of private land (Table 1-2).

Table 1-2: Summary of Land Ownership Within Sixth-field Watersheds

Sixth-field	Total Acres	Private Acres	% Private	USFS Acres	% USFS	NPS Acres	% NPS
01A	10,908	28	0.3	9,572	87.7	1,308	12
01B	5,351	0	0	1,537	29	3,814	71
01D	3,060	78	3	2,982	97	0	0
01E	10,021	0	0	10,021	100	0	0
01F	2,230	0	0	2,230	100	0	0
01G	4,636	0	0	4,636	100	0	0
01H	1,163	3	0.3	1,160	99.7	0	0
01I	4,037	0	0	4,037	100	0	0
01J	3,102	0	0	3,102	100	0	0
01K	9,168	0	0	9,168	100	0	0
01L	12,544	0	0	12,544	100	0	0
01M	1,965	0	0	1,965	100	0	0
01N	2,159	0	0	2,159	100	0	0
01P	2,387	0	0	2,387	100	0	0
01Q	1,479	0	0	1,479	100	0	0
01R	1,785	0	0	1,785	100	0	0
01S	37,771	0	0	0	0	37,771	100
01T	24,139	0	0	28	0.1	24,111	99.9
Total	**137,905**	**109**	**0.1**	**70,792**	**51.3**	**67,004**	**48.6**

Currently, 0.1% of the watershed is in non-federal ownership, with 48% of that land in an early-successional stage, 26% in mid-successional forest stage, 12% in late-successional forest stage, and 14% in non-forest (rock, water, meadow, shrubland, etc.). National Park Service lands make up 48.6% of the watershed, with approximately one-half of these lands being late-successional forest and one-half being non-forest land. National Forest land constitutes 51.3% of the watershed and is fairly evenly distributed between mid-successional forest, late-successional forest and non-forest land, with only 9% of the land in an early-successional stage.

Federal land holdings within the Clear Fork watershed include sections of the Gifford Pinchot National Forest and Mt. Rainier National Park (Map 2, Local Vicinity and Ownership). Private land holdings occur within the National Forest portion of the watershed.

Major roads in the watershed include US Highway 12, State Highway 123 (Forest Road 49), Stevens Canyon Road (in Mt. Rainier National Park) and Forest Roads 44, 45, and 46 (Appendix A, Access and Travel Management (ATM) Plan for Roads within the Clear Fork Watershed). These roads provide access to numerous developed and dispersed recreational sites and other destinations within the watershed. Complete descriptions of the historic and current conditions for the major terrestrial, aquatic, and social elements found within the watershed are presented in Chapter 3 of this document.

Management Direction

Lands within the National Forest portion of the Clear Fork watershed are managed according to direction provided by *Gifford Pinchot National Forest, Land and Resource Management Plan, Amendment 11* herein referred to as Amendment 11. This document combines direction from the *Gifford Pinchot National Forest Land and Resource Management Plan* (USDA 1990) and the Record of Decision (ROD) for *Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Spotted Owl (USDA, USDI 1994),* herein referred to as the *Northwest Forest Plan.*

Management direction is applied to specific lands using the overlying direction from the 1994 *Northwest Forest Plan* and the underlying Management Area Category (MAC) direction of the 1990 GP Forest Plan. Amendment 11 documents the combination of these two levels of management direction.

Northwest Forest Plan

The following *Northwest Forest Plan* land management designations are within the Clear Fork watershed (Map 4, Land Management Allocations):

Administratively Withdrawn Areas - includes wildlife, recreation, and other areas not managed to provide timber outputs.

Congressionally Reserved Areas - includes lands within congressional designations that normally preclude timber harvest (e.g. Wilderness).

Late-Successional Reserves - lands where the objective is to protect and enhance conditions of late-successional and old-growth forest ecosystems.

Matrix - lands where scheduled timber harvest is emphasized.

Table 1-3 lists the acreage and percent of each sixth-field that is occupied by each land management allocation. These land allocations refer only to the National Forest portion of the sixth-fields, therefore, land management allocation percentages for sixth-fields that contain private land or portions of Mount Rainier National Park will not add up to 100%. For information pertaining to acreage and percent of each sixth-field that is occupied by private land and Mount Rainier National Park, refer to Table 1-2.

Table 1-3: Acreage and Percent of Each Land Management Allocation within Each Sixth-field (National Forest Land)

Sixth-field	Administratively Withdrawn Areas		Congressionally Reserved Areas		Late-Successional Reserves		Matrix	
	Acres	%	Acres	%	Acres	%	Acres	%
01A	0	0%	8,420	77%	955	9%	197	2%
01B	0	0%	28	1%	1,509	28%	0	0%
01D	0	0%	120	4%	2,862	93%	0	0%
01E	0	0%	9,695	97%	326	3%	0	0%
01F	0	0%	0	0%	2,230	100%	0	0%
01G	0	0%	3,219	69%	1,417	31%	0	0%
01H	0	0%	0	0%	1,160	100%	0	0%
01I	0	0%	203	5%	3,834	95%	0	0%
01J	0	0%	1,966	63%	1,136	37%	0	0%
01K	1,772	19%	1,901	21%	4,194	46%	1,301	14%
01L	0	0%	12,544	100%	0	0%	0	0%
01M	0	0%	832	42%	1,133	58%	0	0%
01N	0	0%	1,027	48%	1,132	52%	0	0%
01P	0	0%	2,051	86%	336	14%	0	0%
01Q	0	0%	1,137	77%	342	23%	0	0%
01R	0	0%	0	0%	1,785	100%	0	0%
01S	0	0%	0	0%	0	0%	0	0%
01T	0	0%	28	< 1%	0	0%	0	0%
Total	**1,772**	**1%**	**43,171**	**31%**	**24,351**	**18%**	**1,498**	**1%**

Management Area Categories (MACs)

Table 1-4 lists the Management Area Categories (MACs) present in the Clear Fork watershed (Map 4, Land Management Allocations) and gives the reference information where specific management direction can be found.

Table 1-4: Management Area Categories		
MAC Designation	**Description**	**Amendment 11 Pages**
ES	Deer and Elk Winter Range	Pages 6-21 to 6-24
LS	Late Successional Reserves	Pages 5-31 to 5-32
ML, MM, MX	Mountain Goat Summer Range	Pages 5-33 to 5-35 and 6-28 to 6-32
NA, NL	Scenic River	Pages 5-52 to 5-56; 6-36 to 6-40; and 4-28 to 4-32
QL, QM, QX	Mountain Goat Winter Range	Pages 5-33 to 5-35 and 6-28 to 6-32
TS	General Forest	Pages 6-25 to 6-27
VL, VM	Visual Emphasis	Pages 5-49 to 5-51 and 6-41 to 6-44
WW	Wilderness	Pages 3-7 to 3-14
2L	Developed Recreation	Pages 4-6 to 4-9 and 5-21 to 5-24
3W	Administrative Sites	Pages 4-3 to 4-5 and 5-18 to 5-20

Table 1-5 provides the number of acres in the Clear Fork watershed that are occupied by each Management Area Category.

Table 1-5: Acreage of Each Management Area Category within the Clear Fork Watershed		
MAC Designation	**Description**	**Acreage**
ES	Deer and Elk Winter Range	139
LS	Late Successional Reserves	7,990
ML, MM, MX	Mountain Goat Summer Range	3,875
NA, NL	Scenic River	3,154
QL, QM, QX	Mountain Goat Winter Range	3,039
TS	General Forest	36
VL, VM	Visual Emphasis	7,195
WW	Wilderness	110,160
2L	Developed Recreation	2,171
3W	Administrative Sites	37

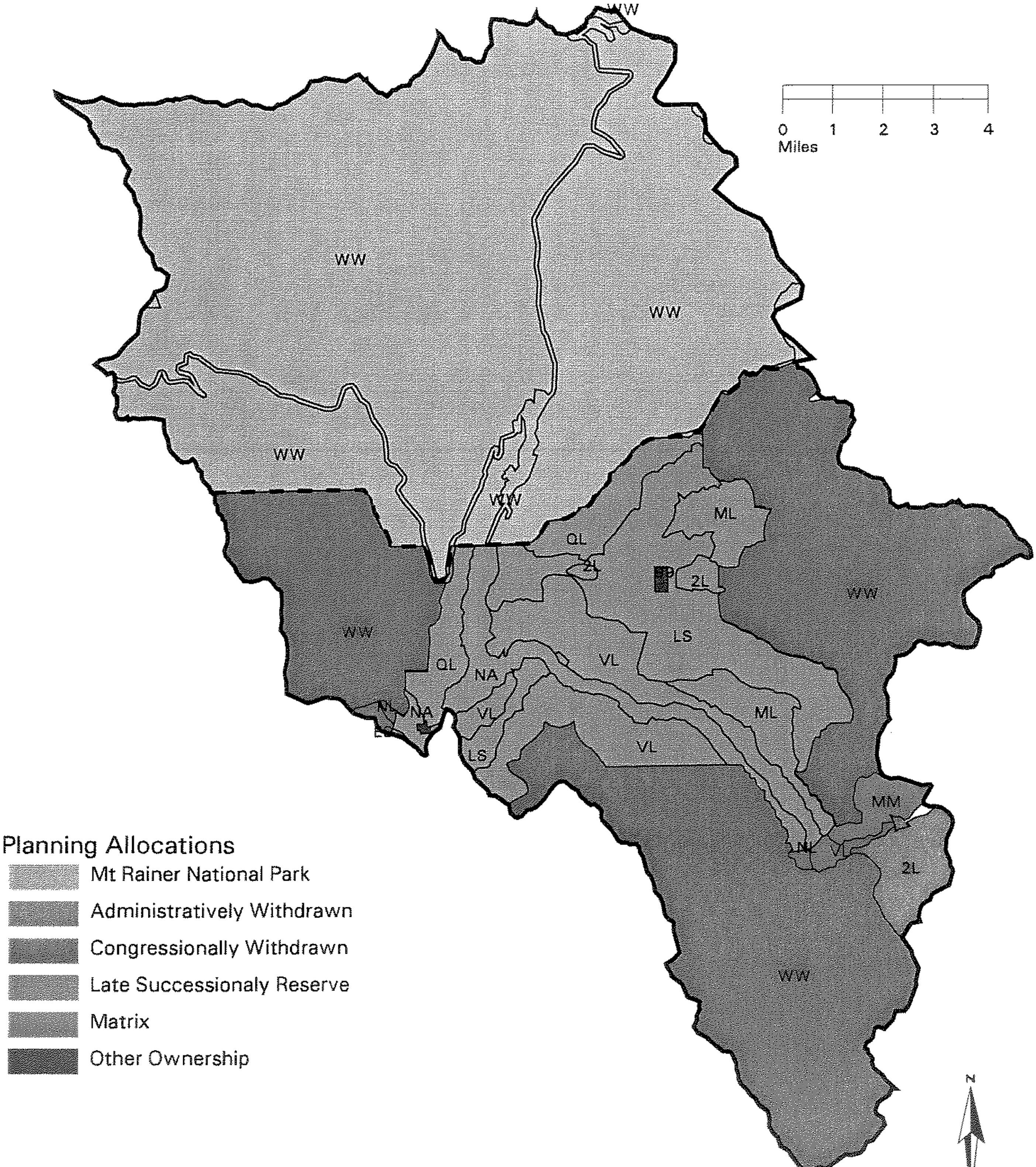
Other Northwest Forest Plan Designations

Riparian Reserves - this allocation includes areas along streams, wetlands, ponds, lakes, and unstable and potentially unstable areas. Riparian Reserves are mapped overlaying all other allocations. Riparian dependent resources receive primary emphasis and special standards and guidelines apply (see Amendment 11, pages 2-4 to 2-10). Map 5, Riparian Reserves, displays the Riparian Reserves within the Clear Fork watershed.

Map 4

CLEAR FORK WATERSHED ANALYSIS

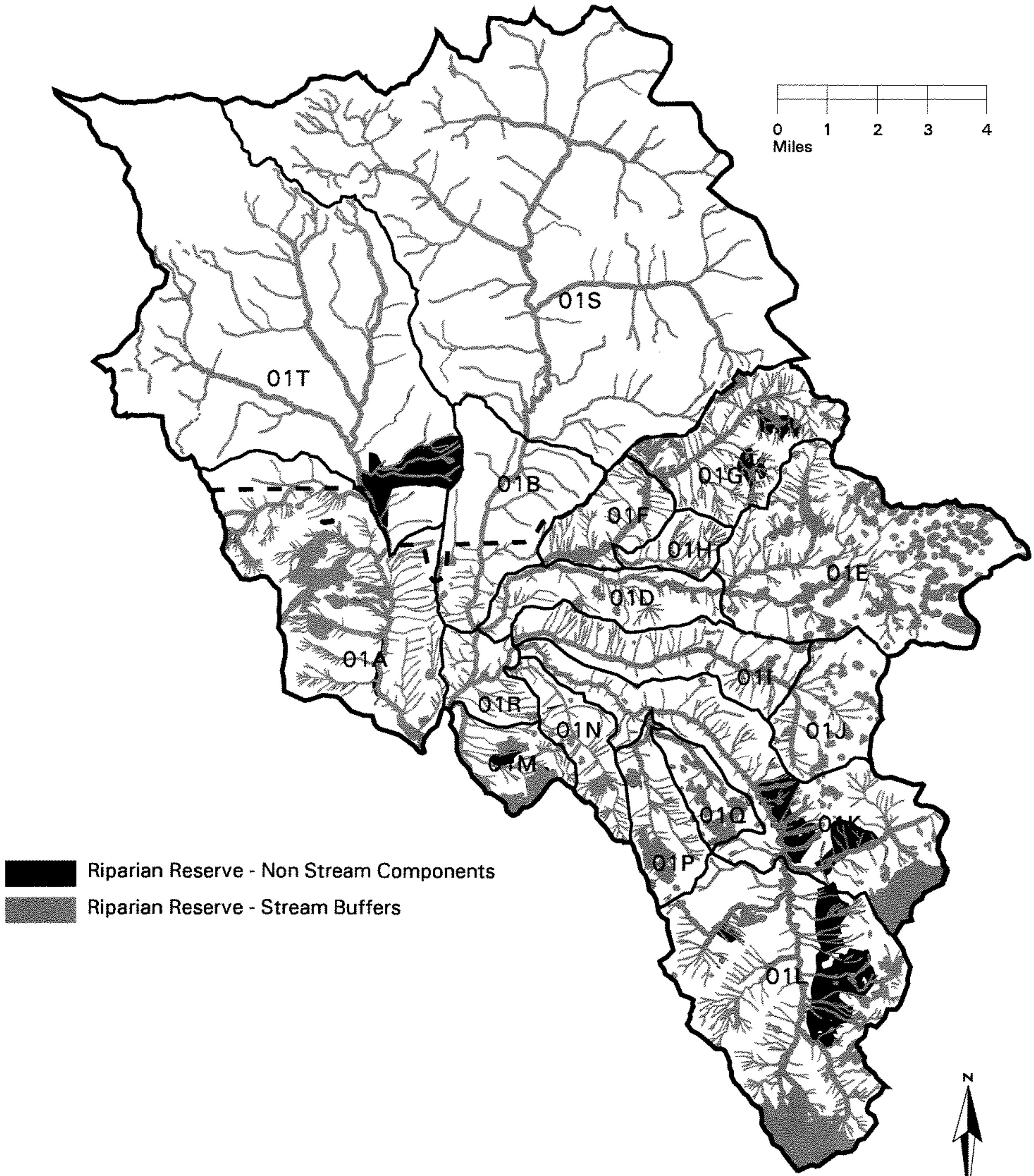
Land Management Allocations



Map 5

CLEAR FORK WATERSHED ANALYSIS

Riparian Reserves



Key Watersheds - this allocation overlays the land allocation of designated areas. Tier 1 Key Watersheds serve as refugia crucial for maintaining and recovering habitat for at-risk stocks of anadromous salmonids, bull trout and resident fish species. Tier 2 Key Watersheds may not contain at-risk fish stocks, but are an important source of high quality water. The Clear Fork watershed is a Tier 2 Key Watershed. Lands included within Inventoried Roadless Areas that fall within Key Watersheds have special direction that precludes new road construction (GPLRMP Amendment 11, pages 2-10 to 2-11).

Chapter 2 - Issues and Key Questions

Within any given area there are many issues that must be considered prior to the implementation of management activities. The following list of issues and associated questions focuses this analysis on issues that were deemed most pertinent to management within the Clear Fork watershed. The issues and key management questions were developed by the interdisciplinary team in association with the line officer on the Cowlitz Valley Ranger District. The analysis questions represent the fundamental information necessary to answer the key management questions. This document does not contain enumerated answers to all the questions listed below. Rather, answers are provided throughout chapters 3-6 in the form of narratives, tables, and ratings.

Issue 1 - Water Quality and Quantity

The water quality/quantity issue being addressed is whether changes to vegetation, soils, and aquatic features in the Clear Fork watershed are having notable or cumulative effects on water quality and quantity. Resources and processes relevant to evaluating these conditions include channel migration and widening, presence of amphibians, condition of fish habitat, amount and frequency of soil disturbance, rates of human-caused sediment input as compared to natural rates, and continuity of late-structural forest in riparian areas.

Water Quality and Quantity - Key Management Questions

Do existing conditions (including natural or human-caused cumulative effects) meet NMFS and ACS objectives in the watershed?

Which roads/trails, sideslopes, stream crossings, and riparian areas have restoration needs?

Where is restoration of streams and aquatic refugia needed to improve aquatic habitat?

Water Quality and Quantity - Analysis Questions

What is the extent of past road construction and use of stream crossings, campsites, diking, channelization, and floodplain isolation in Riparian Reserves?

Are road/trail crossings affecting the distribution and populations of aquatic species?

Have road densities within the watershed affected peak flows or sediment delivery?

What were historical peak flows?

What is the history of flooding and measured changes in peak flows, and what is the influence of land use on water available for runoff?

Have management activities caused or contributed to increased peak flows at the sixth-field watershed level?

What type of stream channels exist in the watershed?

Does upslope delivery to stream channels exceed the ability of the stream channel to route the sediment through the system?

How have stream channels or lakes changed from historic/reference (ca. 1880) conditions?

Have management activities caused or contributed to mass wasting or surface erosion? Where are there opportunities to correct these occurrences?

How does natural sediment delivered to streams compare to increased sedimentation caused by management activities?

What are the dominant stream channel types that exist within the watershed and habitat-forming processes that occur in the channel network?

Are there any known water quality problems such as temperature or turbidity?

Has the function and condition of floodplains in the watershed been altered by management activities? If so, how?

Issue 2 - Economic Outputs (Timber, Recreation, Mining, Fish and Wildlife, etc)

The issue of economic outputs from the Clear Fork watershed is analyzed in the context of the sensitivity of resources that support economic demands. Water quality conditions, existence of TES species, amount and distribution of forest vegetation structural stages, and the ability of the ecosystem to function normally will be evaluated with respect to their effects on economic outputs (potential timber harvest, recreational activities, mining activities, fishing, hunting, wildlife viewing etc.)

Economic Outputs - Key Management Questions

In Riparian Reserves, where and under what circumstances is regeneration harvest appropriate?

Outside of Riparian Reserves, where and under what circumstances is regeneration harvest appropriate?

In Riparian Reserves, where and under what circumstances is stocking manipulation, precommercial and commercial thinning appropriate?

Outside of Riparian Reserves, where and under what circumstances is stocking manipulation, precommercial and commercial thinning appropriate?

Are there sensitive habitats within the watershed which may be adversely affected by vegetation management or other activities? Where are they?

What standards should be developed for human uses in Riparian Reserves?

In Riparian Reserves, where or under what circumstances can roads or trails be constructed without preventing the attainment of ACS objectives?

What human-use sites, dispersed or developed, are preventing attainment of the ACS objectives? How can these be addressed in the short- and long-term?

What is the current Road Plan (Access and Travel Management Plan) for the area and how does it apply to project proposals?

Are there any opportunities to improve habitat conditions for fish and wildlife?

Economic Outputs - Analysis Questions

What is the current distribution and amount of forest vegetation structural stages?

How has the distribution and amount of forest structural stages changed over time?

What changes have occurred to forest structural stages and their spatial and temporal distribution as a result of past management activities?

What is the distribution and amount of non-forest vegetation and non-vegetated areas?
What is the distribution and size of the forest vegetation zones?

What is the contribution of recreation activities to the local and regional economy?

What economic outputs would be derived from the proposed expansion of the White Pass Ski Area?

How much and what kinds of human use is occurring in the watershed and what are the trends?

What special forest products occur within the watershed? What is the current use of these products? How will management activities affect special forest products or use of them?

Issue 3 - TES and S&M Plant and Animal Species

The issue to be addressed by this analysis is to determine whether changes to vegetation, soils, and aquatic features in the Clear Fork watershed are having cumulative impacts on habitat for TES and S&M species. Resources and processes relevant to evaluating these conditions include population levels, habitat distribution and use, vegetative diversity and continuity, and riparian conditions.

TES and S&M Plant and Animal Species - Key Management Question

Are habitats for TES and S&M species adequately protected under GP Forest Plan and *Northwest Forest Plan* standards and guidelines?

TES and S&M Plant and Animal Species - Analysis Questions

What are the known and suspected TES and S&M species within the watershed?

Where are suitable habitats present for TES and S&M species in the watershed?

How does the current condition of these habitats affect species viability?

How much nesting, roosting, foraging, and dispersal habitat exists for northern spotted owls, and what is its condition?

Where is the summer/winter range for the prey species of wolves, grizzly bears, and other forest carnivores?

How well are late-structural habitats linked within the watershed?

What are the road densities within the watershed and how do they affect big game, TES and S&M species?

What is the current level of coarse woody debris and snags in the uplands?

How much spawning and rearing habitat exists for TES fish species?

Are there current or anticipated human activities that may affect TES and S&M plant and animal species?

Issue 4 - Ecosystem Function

One of the primary issues affecting forest land managers is the necessity of maintaining a properly functioning, self-sustaining ecosystem. This includes ensuring that all native plant and animal species are retained, distribution of the species is adequate, and suitable habitat is abundant enough to maintain populations across the landscape. The issue to be addressed by this analysis is to determine the role of this watershed as it fits into the larger landscape and whether impacts to vegetation, soils, and aquatic features in the Clear Fork watershed are having notable or cumulative effects on overall ecosystem functions. Resources and processes relevant to evaluating these conditions include changes in aquatic condition, loss of populations, presence of riparian and overland migration corridors, amount and frequency of soil disturbance, continuity of late-structural forest in riparian areas, and rates of human-caused sediment input.

Ecosystem Function - Key Management Questions

What are the unique ecological functions of National Forest and National Park lands in the context of the southwest Washington Province?

Which riparian corridors may be adversely affected by human use such as road construction, trail construction and recreational activities?

What are the necessary riparian reserve widths needed to maintain or restore ecosystem function?

Ecosystem Function - Analysis Questions

How does the existing landscape pattern compare to the historic/reference (ca. 1880) landscape pattern with regard to forest vegetation patch size, shape, spatial arrangement and connectivity?

Have any plant or animal species been lost from this watershed? If so, what was the cause?

Have any non-native or exotic plant or animal species become established within the watershed? If so, what is the cause?

What proportion of each sixth-field watershed falls within the various riparian reserve types (wetlands, streams, and unstable areas)?

What are the natural limiting factors and processes related to attainment and maintenance of healthy riparian areas throughout time?

Where are areas of key aquatic habitat in need of protection?

Has channel widening occurred and if so, what are the contributing factors?

What past natural conditions would suggest a need for standards and guidelines beyond current direction?

Where is there evidence of dam-break floods and debris flows within the watershed?

Are changes in the sediment regime apparent in this watershed, and if so what effect does this have on ecosystem function?

What are the landscape conditions on adjacent National Park and private lands?

How are existing conditions on National Park and private lands affecting resources within the National Forest portion of the watershed? How could future management of these adjacent lands affect resources within the National Forest portion of the watershed?

Within the riparian corridors, what is the degree of canopy closure, large woody debris recruitment, shading, and stream bank stability? How do these factors relate to attainment and maintenance of healthy riparian areas through time?

What is the current distribution of structural stages within riparian corridors, and how does this compare to historic or reference conditions?

Currently, how well are riparian corridors functioning with regard to connectivity of late-successional refugia and Late Successional Reserves?

Are there any vegetative health concerns within the watershed?

Are there current or anticipated human activities that may affect ecosystem function?

Chapter 3 - Historic and Current Conditions

Introduction

The purpose of this chapter is to describe what we currently know about the historic and current conditions of the various physical, biological, and social components of the watershed. In previous watershed analyses, the difference between historic and current conditions has been used synonymously with the concept of a "range of natural variability". In most cases, we do not have sufficient data to accurately describe a "historic" condition for the entire watershed. Thus, it would be erroneous to conclude that these differences constitute the "range of natural variability". Landres, et al. (1997) states that "natural variability is a complex temporal and spatial property of all ecosystems that is best described with several metrics, not just range."

What we do have, and present in this document, are scattered historic data for small areas, small pieces of the puzzle or discreet snapshots in time, that are better described as "reference" conditions. The historic or reference data are compared to the current condition to determine trends within the watershed. Our understanding of these trends allows us to prescribe appropriate management activities within the watershed that are designed to lead us toward desired future conditions.

Reference (historic) and current conditions are presented for the major terrestrial, aquatic, and social elements of the Clear Fork watershed in the following narratives. Each topic begins with a statement of the data sources used, data gaps, and any major assumptions that are important to the interpretation of the data.

Past Human Uses

Prehistoric Land Use Patterns

Early Prehistoric Period: ca. 7,000 to 3,500 years ago

Archaeological evidence from sites in the Clear Fork watershed suggests that initial human use of the area began around 7,000 years ago. Early residents of the area likely employed foraging subsistence strategies that required frequent shifts in residence and a broad-based economy. During the initial period of human occupation, hunting and gathering would have involved daily forays from camp to obtain food on an ``encounter basis". Little use was made of storage technology. As resources close to camps were exhausted, camp locations were moved. Some subsistence activities were probably planned around locally abundant resources. Archaeological data from the Clear Fork area have provided little information regarding social or political organization, beliefs, cultural affiliation, or the structure of the settlement system.

Faunal remains from Early Period occupations indicate that deer and salmonids were probably the most important sources of food to early peoples. Some researchers (Ellis *et al.* 1991) have suggested that prior to 4,500 years ago the Cowlitz River flowed at a lower level. Anadromous fish runs may have been impeded by falls lower on the river. As annual precipitation increased, river levels rose, allowing salmon and steelhead to reach the Clear Fork watershed. The presence of salmonid remains in several Early Period occupations dating from 7,000 to 5,000 years ago may negate this theory. Elk, mountain sheep, snowshoe hare, mountain beaver, and grouse were also hunted or caught during this time period. Archaeobotanical remains from two sites suggest that elderberries and hazelnuts were gathered locally, and huckleberries were also collected by Early Period people. Samples from Layser Cave suggest higher frequencies of xeric flora, such as oak, existed during this period, a trend also apparent in the results of local pollen studies (Barnosky 1981).

Early Period people engaged in trade with groups from outside the area. Exotic materials found within the area include clamshell and *Olivella* beads, indicating a trade network with coastal groups. Obsidian toolstone from Oregon sources suggests a southern network of exchange that may have involved contact with lower Cowlitz River, Columbia River, or Yakima River Basin groups. The distribution of local toolstone materials in archaeological sites suggests that bands living in the lower Cispus and middle Cowlitz River area traveled as far as the crest of the Cascade Range, within the analysis area, during annual subsistence forays.

Several archaeological sites within the analysis area provide evidence of occupation during this time period. The earliest is a toolstone quarry (45LE286) at the headwaters of the Clear Fork Cowlitz River, which produced a radiocarbon date of 6,250 years BP (before present). An occupation from the end of this period, dated to 3,560 years BP, was identified at a site (45LE220) near the mouth of the Ohanapecosh River.

Abandonment: ca. 3,500 to 1,500 years ago

Initial human use of the Clear Fork Cowlitz River basin appears to have ended abruptly with the onset of Mount St. Helens' Smith Creek Eruptive Phase 3,900 to 3,500 years ago. Lewarch and Benson (1991) have suggested that the intensity of vulcanism, including the largest tephra eruptions in the history of the volcano, may have been the initial cause of human abandonment. Environmental degradation resulting from Smith Creek phase eruptions may have included tree defoliation, burial of herb and shrub layer flora by a meter thick deposit of pumice, and intensive sediment loading in streams and rivers (McClure 1992). Effects to the subsistence resources of the native human population were undoubtedly devastating. The sequence of radiocarbon dates for the Clear Fork Cowlitz basin shows a hiatus in occupation that lasted for nearly 2,000 years.

Tephra studies by Mullineaux (1996) and others demonstrate that the analysis area was outside the zone of thickest tephra deposition, which lay within a zone trending northeast from the volcano. Archaeological sites east of Packwood lack the deposits of the Smith Creek (set Y) pumice so common in soil profiles near Randle. A site near Morton, west of the zone of thickest tephra, produced a radiocarbon date of 2,240 years BP (300 BC), suggesting that peripheral areas were recolonized by people somewhat earlier than the sites within the analysis area.

Late Prehistoric Period: ca. 1,500 to 150 years ago

By about AD 450 people were reoccupying the same sites used by Early Period inhabitants, as well as establishing camps and settlements in new locations. Presumably, these people utilized a subsistence strategy quite different than their predecessors. A regional shift toward increased sedentism occurred between 5,000 and 2,500 years ago (Burtchard 1990). Groups that reoccupied the area about 1,500 years ago are thought to have used a strategy incorporating logistically-organized collection, processing, and storage of key resources. These developments may have given rise to the development of semi-permanent winter villages not unlike those used by native groups in the historic period.

Well-preserved faunal remains from several sites within the Clear Fork watershed indicate some of the animal species present in the general area ca. AD 750 to AD 1690. Archaeobotanical studies suggest that plant communities along the Cowlitz River valley bottom during this period were reasonably similar to the modern native vegetation, as Douglas-fir, western red cedar, red alder, salal, and Oregon grape are represented in samples of charcoal, seeds and tissue.

Throughout the northwest, prehistoric populations peaked during this time period. Burtchard (1990) suggests that the density of human populations was reaching environmental carrying capacity. Possible responses were greater emphasis on the collection of more ``marginal" resources - those requiring greater energy expenditure for return. Late Period people appear to have exploited a greater variety of environments than had the earlier culture.

Several archaeological sites within the analysis area contain evidence of occupations from the Late Prehistoric Period. The Ohanapecosh site (45LE220), located at the Clear Fork - Ohanapecosh confluence, is the most extensively studied of these sites. Excavations during the fall of 1997 focused on a portion of the site used ca. AD 1545 to AD 1565. Recovered faunal remains include salmonid bone and highly fractured mammal long bone. Blood protein residue of mountain goat and mountain sheep were identified on arrow points recovered in the excavation. Archaeobotanical remains collected from a fire hearth at this site include charred hazelnut hulls, elderberry seeds, and kinnickinick seeds.

Late Period sites have also been identified along the Clear Fork Cowlitz River, within the Carlton Creek drainage, at the mouth of the Muddy Fork, and adjacent to the Sarvent Glaciers, high on Mount Rainier.

Historic Period American Indian Use

During the 19th century, much of the Clear Fork analysis area lay within territory that was jointly used by the Taidnapam, or Upper Cowlitz Indians, from settlements in the Cowlitz River valley, and the Yakama, from settlements in the Naches River basin, east of the Cascade crest. A thorough study of tribal boundaries by anthropologist Allan Smith (1964) concluded that Cowlitz Divide and Backbone Ridge formed the western limits of territory claimed by the Yakama as their own, whereas the Taidnapam claim extended further east, to the crest of the Cascade Range. According to Smith, this area was ``equally accessible to both groups and evidently its berry and hunting resources were exploited by both, without contest and enmity."

The Taidnapam

During the 19th century most of the Clear Fork study area lay within the territory of the Taidnapam, or Upper Cowlitz, Indians. These people spoke Northern Sahaptin, a language shared with several groups living east of the Cascade Range, including the Yakama. Taidnapam settlements were scattered along the Cowlitz River and larger tributaries between Mossyrock and Packwood. Individual settlements - winter villages - were the basis of band organization.

Settlements were comprised of one or more large cedar wood gable-roof houses occupied by multiple family groups. The two settlements closest to the analysis area were *chawachas*, located ``where the present town of Packwood lies," and *temxex*, on the Cowlitz River southwest of Packwood (Hajda *et al.* 1995, Smith 1964). Average estimated populations of settlements prior to the effects of disease suggest a combined population of between 50 and 75 individuals, although at least one source describes *chawachas as* ``a thriving Indian village... with several hundred members" (Tompkins 1933).

Two sites within the analysis area functioned either as summer villages or fishing camps. Most frequently mentioned is *lekalwit*, the name both for the Clear Fork Cowlitz River and the camp at its mouth (Yoke 1934). Chinook salmon were netted and speared at this site. The fish were roasted over fires for immediate consumption, but also dried in quantity on wooden racks to prepare them for storage and future use. A Taidnapam consultant interviewed in 1927 noted that "steelhead, silverside, grayling, Dolly Vardens, a great many large Dolly Vardens" were also found here (Costima 1934). The "grayling" may actually refer to mountain whitefish (Carl, *et al.* 1959). Dolly Varden, or Dolly Varden charr, are also known as bull trout. *Awxanapaykash* ("Ohanapecash") is another fishing site mentioned by Taidnapam consultants, located near the mouth of the Ohanapecosh River.

Deer and elk were likely hunted in the vicinity of seasonally occupied camps. The Taidnapam also hunted bear and mountain goats, the latter in late summer, when family groups were camped in the mountains for berry picking. The bow and arrow was the principal hunting weapon for larger game. Deer, elk, and mountain goat meat was dried in the sun on wooden racks, sometimes over smoky fires, as a means of preservation (Yoke 1934). Smaller game obtained by the Taidnapam include mountain beaver, marmot, and grouse (Kiona 1964; Smith 1964). Grouse were probably taken during the late summer when they congregate in huckleberry patches.

A variety of plant foods were gathered by the Taidnapam from several ecological communities. Most frequently mentioned in the ethnographic and ethnohistoric literature are huckleberries. Three species, *Vaccinium deliciosum*, *V. membranaceum*, and *V. ovalifolium*, which occur most abundantly between 915 m and 1,520 m in elevation, were preferred (Smith 1964). Camps were established at berry patches in the mountains during the late summer. *Paxutaasha* and *sim-sim* were traditional berry patches in the Tatoosh Range accessed by trail from the fishing site of *lekalwit.* At least seven other named berry patches have been identified within or immediately adjacent to the analysis area. Berries collected in quantity near the camps were pressed into cakes or dried to a raisin-like form on mats laid atop wooden racks or directly on the ground. Fires were purposefully set to promote productivity of huckleberry patches (Kiona 1964, 1965, Plummer 1900).

Salal berries, wild strawberries, red elderberries, thimbleberries, salmonberries, blackberries, and the berries of Oregon grape were also eaten (Gunther 1945). The bulbs of several lilies were collected in the mountains and baked in earth ovens. Some Taidnapam travelled over the mountains to the Tieton River valley to collect bitterroot and *Lomatium* (Yoke 1934).

The principal travel route between Taidnapam and Yakama territory was the Cowlitz-Yakima Trail. From the Packwood vicinity, the trail extended northeast, connecting the camps of *lekalwit* and *awxanapaykash,* and continuing upstream via Summit Creek to Cowlitz Pass. From the pass, the trail descended into the Tieton River drainage, and led to villages on the east side of the range. An Indian trail along Backbone Ridge was reportedly used to reach berry patches and goat hunting areas on Mount Rainier (Sethe 1938). Another Indian trail reportedly extended from Cowlitz Pass south to the Goat Rocks ``crossing the ClearFork below the mouth of Millridge Creek". According to Sethe (1938), the trail was primarily used by Indian goat hunters".

The Yakama

The tribal group known as the Yakama incorporates several individual bands that occupied settlements along the middle Yakima River and its tributaries. Like the Taidnapam, the Yakama are speakers of the Sahaptin language. The band living within the Naches River basin called themselves *Nahchish-hlama* (Smith 1964). Their closest village to the analysis area was *miyáwax,* on the Tieton River approximately 14 miles east of White Pass. Residential structures in this village consisted both of semi-subterranean pithouses and tule mat lodges. A minimum population size of 50 individuals is suggested by data summarized by Schuster (1975). The village was adjacent to an important salmon fishery and root grounds. Another village, called *tautunu'k*, was located about 18 miles from White Pass, on upper Cowiche Creek, within the territory of the *Tkaywáycas-hlama* band (Schuster 1975). Other Yakama villages were located on Wenas Creek and Ahtanum Creek.

Unlike the Taidnapam, the Yakama, at least during the 19th century, had become an equestrian culture. As such, they were able to increase the efficiency of their subsistence economy by exploiting the food resources of a much greater territory. In the spring, Yakama subsistence activities involved spring salmon fishing and root digging. In mid-summer, families moved to the mountains to gather huckleberries. Camps were established in open parks and old burns along the crest of the Cascades and slopes of Mt. Rainier. Distances from villages were 2-3 days journey by horse. Huckleberries were collected and processed using similar methods to those described above for the Taidnapam, and included the use of small fires to assist in the drying of the berries. While the women picked and dried the berries, men frequently hunted deer, elk, bear and mountain goats (Smith 1964). Fires were purposefully set to promote productivity of the berry patches.

The principal travel route from Yakama territory to summer camps in the analysis area was by way of the Cowlitz-Yakima Trail over Cowlitz Pass. During the summer, some familes traveled over this route on horseback to fish at the site of *lekalwit.* This was a popular place for Yakama and Taidnapam families to meet for trading, and many went on to the Tatoosh berry fields to collect huckleberries (Eyle 1955; Kiona 1953, 1964, 1965; Sethe 1933). The fishing site of *awxanapaykash* may also have seen joint use by both the Taidnapam and Yakama.

Few other specific Yakama camps or use areas have been identified within the study area, but the seven berry patches named by a Taidnapam consultant (see above) may have been used by Yakama people. Sethe (1933) notes, however, that Yakama Indians picked berries on Carlton Ridge, turning their horses out to graze there and in a meadow at Jug Lake. Historic peeled cedar trees have been identified in several locations throughout the study area, including the Summit Creek, Carlton Creek, and Cortright Creek drainages, and scattered along the Cowlitz River from *lekalwit* to *awxanapaykash.* Elsewhere in the Cascade Mountains, these trees seem to be associated with specific huckleberry patches or access routes to known berry camps. While those identified in the analysis area provide clear evidence of historic use by Indian people, it is not possible to determine if the peeled tree sites were used by Yakama or Taidnapam.

Historic Conditions - Historic Period Land Use Patterns

The Taidnapam and Yakama people who historically utilized the analysis area probably had initial encounters with non-native Europeans and Americans between 1810 and 1830. These first encounters were with fur traders and missionaries on both sides of the Cascade Mountains, but in locations distant from the home villages of the isolated upriver bands. The first non-native entry of the analysis area occurred in 1867 with exploration of Cascade Mountain passes by a surveyor for the Northern Pacific Railroad. In 1870, two government surveyors followed Backbone Ridge to timberline on Mt. Rainier, eventually pressing on to the summit (Haines 1962). Their hired guides were Indians from a village, probably *chawachas,* in the Cowlitz valley. The first mineral prospecting occurred near Jug Lake and Summit Creek ca. 1872-1875. Additional Northern Pacific Railroad surveys of the area were conducted in 1878 and 1880, examining potential routes up Summit Creek and the Clear Fork Cowlitz River. Until the 1890s, however, non-native visitation was infrequent.

A significant shift in human land use occurred between 1880 and 1890. It was during this decade that the cultural composition of the Clear Fork Cowlitz River basin changed from an essentially Sahaptin-speaking indigenous population to one of English-speaking immigrants. Into the 1880s, the subsistence economy of the small local native population continued to focus on traditional hunting and gathering. Increasingly, they sought employment as laborers and hired hands for the settlers who had begun to establish land claims along Cowlitz valley floor in 1883 and 1884. These settlers brought with them the traditions of agricultural subsistence, property ownership, and the desire to become part of a regional market economy.

By 1890, there were 20 families living in the Cowlitz River valley bottom between Randle and Packwood (Packwood Community Study Proceedings 1954). During subsequent decades, as the numbers of settlers grew and trails were converted to wagon roads, small town centers were established to meet the commercial and social needs of the local population. The town of Packwood was established following an influx of workers hired for the construction of a hydroelectric project at Packwood Lake. In 1910, the company hired 125 men for the project, most of them living in a tent camp with their families. A number of businesses were established near the camp to provide goods and services to the workers, and included a hotel, stores, and a post office. Ten acres were platted as the new townsite, originally named Lewis to honor the hydroelectric company president.

Residents of the Packwood area began to make regular seasonal use of the Clear Fork analysis area early in the 20th century. On National Forest lands, these uses included mineral prospecting, trapping, and stock grazing. In contrast, public use of National Park lands was primarily recreational in nature.

National Forest Management

Public forest lands in the analysis area were set aside as the Pacific Forest Reserve in 1893, and subsequently administered as the Mount Rainier Forest Reserve (1897), Rainier National Forest (1907), Columbia National Forest (1922) and Gifford Pinchot National Forest (1949). The executive order creating the Forest Reserve effectively closed the Cowlitz valley to further land claims. A limited number of homestead claims were allowed within the Forest Reserve subsequent to the enactment of the Forest Homestead Act in 1906. Only one such claim was filed within the analysis area.

To establish an administrative presence on Forest Reserve lands, a local settler was hired in 1897 as the first Forest Ranger in the Cowlitz Valley. In 1907, the Sulphur Springs Ranger District was created as a smaller administrative unit, with a ranger headquartered at the Skate Creek Guard Station. The ranger station was moved to a storefront in Lewis (Packwood) in 1923, and to its present location in 1930. Early management activities included trail construction and maintenance, establishment of telephone lines, and fire patrols, as well as the administration of grazing permits and mining activity.

Within the analysis area, fire lookout stations were built on Tatoosh Mountain, Lost Lake, and Tumac Mountain. In 1933, the Army established a Civilian Conservation Corps (CCC) Camp at Packwood. CCC enrollees were engaged in a variety of ``forest improvement projects" in the District from 1933 to 1941. Major accomplishments within the analysis area included development of La Wis Wis Forest Camp and the construction of new trails, roads, and buildings. In 1952, the maintained trail system on National Forest lands in the analysis area consisted of 13 trails totaling 129 miles. By contrast, the National Forest road system in this area consisted of six roads totaling 18.4 miles, most of which had been built in the 1930s. The road system expanded significantly in the 1950s, when land management shifted toward commercial timber harvest. Construction of the White Pass Highway began in 1937 under direction of the Bureau of Public Roads, but was suspended during World War II. The road was completed and opened to the public in 1951.

Stock Grazing

By the 1890s, ranchers in the Naches and Yakima River basins were taking bands of sheep to the extensive upland meadows along the crest of the Cascade Range for summer grazing. The pasturing of livestock was excluded from Mount Rainier National Park with its creation in 1899, but went largely unregulated on National Forest lands until 1910, when extensive grazing laws and an allotment system went into effect (Uebelacker 1980). Five allotments were established in the analysis area. The largest of these was the Cowlitz Pass sheep allotment, with approximately 16,000 acres within the Clear Fork and Ohanapecosh watersheds (Sethe 1933). A small portion of the Fish Lake allotment included the area around Carlton Pass. South of White Pass, the Hogback and Lost Lake allotments occupied the headwaters of the Clear Fork.

An average of 1200 sheep were brought to the Cowlitz Pass allotment for three months each summer. The sheep were trailed to the allotment from a spring range in the lower Naches River basin. Similar numbers were permitted on the other sheep allotments. Sheep grazing activity peaked between 1913 and 1920 with the high market value of sheep associated with the World War I period (Uebelacker 1980). By the 1930s, however, the use of National Forest lands for grazing declined. The decline was related to a shift in agricultural focus toward irrigated farming practices among many ranchers in the Naches and Yakima River basins. Natural factors also contributed to a decline in use. Most allotment areas were former burns. Natural reforestation eventually reduced the available forage and economic feasibility of allotment use. Sheep grazing ended within the analysis area by 1945.

The history of grazing on the Tatoosh Range, in the Muddy Fork sub-basin, was quite different. Local Cowlitz valley residents began pasturing horses on the range in 1893. Summer use for cattle grazing began soon after this time. During the 1930s, an average of 100 head of cattle used the allotment. Use continued through the 1960s.

Mining and Trapping

Mineral prospecting within the analysis area has centered primarily upon deposits of anthracite coal and carbonaceous shale exposed in outcrops within the Carlton, Summit, and Cortright Creek drainages. As early as 1875, mining claims were filed on Summit Creek. Numerous prospects, workings, and exploratory tunnels were observed in the area during geological inspections between 1902 and 1919 (Culver 1919). The highest grade anthracite was identified in a series of prospects on Summit Creek known as the Davis Coal Mines. In 1910, an assistant Forest Service ranger was stationed at the mines. Development of the Davis mines began in the 1890s, but was not commercially successful until the 1930s, when road access was completed. As late as 1936, coal from the Davis mines was being trucked to Tacoma for sale.

A natural mineral springs on Summit Creek was commercially developed by the Tumac Springs Bottling Company under Forest Service special use permit between 1939 and 1959. A building was constructed on the site to house the bottling operation. Marketing of the soda water was unsuccessful.

National Forest lands were also used for trapping, and the plateau surrounding Cowlitz Pass was considered a "trapper's paradise". Marten, mink, weasel, fox, bobcat, cougar, and occasionally lynx, fisher, wolverine, and wolf were trapped in this area (Packwood Community Study Proceedings 1954). Trappers working this area reportedly brought out over 100 marten skins each spring. One commercial trapper from Packwood worked traplines in the Summit Creek and Cowlitz Pass area between 1905 and 1935.

Recreation

Early recreational use of the analysis area was oriented toward fishing and hunting. Game fishing became popular in the 1920s after the Washington State Department of Fish and Game, county, and private parties planted eastern brook trout, rainbow trout, and other species in many of the high lakes and streams. A pack string was used to transport eyed fish eggs and hatchery fry into the backcountry (Packwood Community Study Proceedings 1954). In 1926, the State Food Fish Department constructed the Clear Fork Salmon Hatchery in what is now La Wis Wis Campground.

During the 1930s, public interest in recreational hiking grew. The Cascade Crest Trail was formally established in this period, and grazing use along its route modified to reduce potential user conflicts.

A 1946 inventory lists the following established campgrounds within the analysis area: Jug Lake, Dumbell Lake, Soda Springs, La Wis Wis, Summit Creek, Millridge Creek, Knuppenberg Lake, Backbone Lake, and Lava Creek. Trail shelters existed at Skeeter Creek, Cortright Creek, Carlton Creek, and Jug Lake.

National Park Management

Mount Rainier National Park, the fifth in the nation, was created in 1899 from Forest Reserve lands. Initially, the Park was administered by the superintendent of the Forest Reserve (Thompson 1981). In 1906, the Interior Department appointed the first ranger, but overall supervision remained with the Forest Service until 1910. By 1913, Park administration was based seasonally at the Nisqually Entrance and at Longmire. A log cabin for ranger use had been built on the Ohanapecosh River, within the National Park, during the previous year. With an expansion of Park staff in 1915, a ranger was stationed at the Ohanapecosh cabin.

To facilitate ranger patrols, trail construction was an ongoing activity in the early decades of Park administration. Between 1914 and 1916, two trails were built to connect the Ohanapecosh Ranger Station with points north and west (Thompson 1981). The Ohanapecosh Trail connected to Reflection Lakes and Narada Falls, and the East Side Trail followed the Ohanapecosh River to Owyhigh Lakes and the White River road. There was little additional trail construction in the area until the 1930s, when the Civilian Conservation Corps built many miles of fire trail in the Park. Park management included fire detection and prevention. Between 1920 and 1934, a series of fire lookout stations were built, among them was the Shriners Peak Lookout within the analysis area. A log cabin built in 1934 at Three Lakes was used by rangers on patrol duty along the Park boundary during the fire and hunting season (Thompson 1981).

In 1931, the National Park boundaries were expanded eastward to the crest of the Cascade Range, and south to incorporate Ohanapecosh Hot Springs. As early as 1912, when the area was under Forest Service jurisdiction, a tent camp was in operation at the hot springs (Thompson 1981). Access at that time was over 13 miles of trail from Lewis (Packwood). A small hotel and bathhouses were constructed in 1921, and the trail was made passable for cars in 1924 (Packwood Community Study Proceedings 1954). The resort continued to expand over the next decade, into the period of its inclusion within the National Park. In 1933, the opening of a new highway from Packwood increased visitation to Ohanapecosh Hot Springs. By 1939, there were 25 two-room cabins at the hot springs resort. By 1941, seven more cabins had been added. The concession was finally closed by the Park Service in 1960, and all buildings were removed.

During the 1930s, work continued to extend the road north from Ohanapecosh Hot Springs to meet the state highway at Cayuse Pass. This route, known as the East Side Highway, was finally opened in 1940. Construction of the Stevens Canyon Road, connecting the Nisqually road and East Side Highway began in 1932. Work was halted in 1941, and did not resume until the 1950s. The road was completed in 1957.

A Civilian Conservation Corps (CCC) summer camp was established near Ohanapecosh Hot Springs in 1933. Under Park Service supervision, enrollees constructed Ohanapecosh Campground, built trails, and bridges, and erected new telephone lines.

Early recreation use within the National Park included game fishing. Two non-native game species, eastern brook trout and Montana black-spotted trout, were introduced to streams and lakes throughout the analysis area in the 1920s. Stocking of eastern brook trout was so successful in Mount Rainier National Park, that by 1924 they were probably the most abundant trout in the Park (Schmoe 1925). The 1920s also saw an increased interest in recreational trail use. Within Mt. Rainier National Park, the Wonderland Trail, a 93-mile path encircling the mountain, received particular attention. Twenty miles of the trail traverse the analysis area. Gaining popularity in the 1930s, the Cascade Crest Trail was another important recreation trail, used by hikers and horse enthusiasts.

Development of the Timber Industry

Initially agricultural in focus, the economy of the Clear Fork Cowlitz area gradually shifted its orientation toward forest products, a trend that ultimately changed the role of the Forest Service. In 1935, a commercial sawmill began operation in Packwood, and continues today as the Packwood Lumber Company (Packwood Community Study Proceedings 1954). By 1940, many area residents were engaged in part-time or full-time work associated with forest resources, including logging, lumber millwork, and the production of cedar shakes and shingles (Clevenger 1942). Prior to World War II, most production was from private timberlands. Up to this time, timber harvest on National Forest lands had been limited to small sales of posts, poles, or cedar for shingle bolts. The national post-war economic boom resulted in a demand for timber from National Forest lands to supply Puget Sound area mills and local operators. Responding to economic and political pressure, the Forest Service left behind the era of "custodial" resource management to enter a period of intensive commodity production (Hirt 1994).

Commercial harvest of National Forest timber within the analysis area began in 1951. The Summit Creek Timber Sale was the first large clearcut sale in the area (Packwood Community Study Proceedings 1954). District timber sale records indicate that between 1951 and 1965 logging occurred on 61 individual timber sales within the Clear Fork analysis area, with a total area of 4,400 acres. The timber sales ranged in size from 1-acre road right-of-way harvest to larger multi-unit clearcut sales averaging 200 acres in size. Smaller local operators from the Packwood and Randle area generally purchased the small sales, while larger companies such as Packwood Lumber Company, Cowlitz Veneer, and U.S. Plywood purchased the higher volume clearcut sales. These sales of National Forest timber had a significant effect on the economy and growth of the Packwood community.

Recreational Uses

Data Sources/Data Gaps

- Information on recreational use of the area came from a variety of databases, maps and individual knowledge of the area. Facility information was obtained from maps and the Infrastructure and Geographical Information System (GIS) databases. Recreation visitation numbers were compiled from vehicle count summaries, the Wilderness use database

(WILDPERM), and from the observations of Forest Service personnel. Historic information on recreational use and dispersed site inventories and conditions are rare or nonexistent for most areas including Wilderness. Vehicle count information for Forest Service roads in the watershed is minimal.

- Recent information on the number and size of dispersed campsites outside of Wilderness is haphazard. The Wilderness monitoring database (WILDMON) has information on the number, location, size and condition of sites within the Tatoosh, William O. Douglas and Goat Rocks Wildernesses.

- Information on trail conditions for most trails within the watershed is available in trail surveys that were conducted in the late 1980's and early 1990's.

Assumptions

- While there are documented data gaps for virtually all aspects of recreational use on non-Wilderness portions of this watershed, information provided by the public and Forest Service employees on recreational use patterns is generally confirmed by the available information.

- There is little documentation concerning the effects of recreational activities on local economies. Various studies from around the nation, however, indicate that recreationists spend between $50 and $100 per day while participating in recreational activities. In general, use projections show moderate annual increases (1% to 2%) in most types of recreation activities over the next 20 years. The effect on the local tourist based economy would likely parallel the actual use trends.

- There are currently no plans to significantly expand or alter the current recreation or trail facilities.

Reference and Current Conditions - Recreation Facilities

Recreational development was minimal prior to the 1930's. One exception was in the Ohanapecosh area where a lodge and vehicle access were constructed to the Ohanapecosh Hot Springs in the mid-1920's. In 1931, this particular area was included in Mt. Rainier National Park. In the early and mid-1930's, much construction was done by the Civilian Conservation Corps (CCC). This included construction of CCC camps at Ohanapecosh and La Wis Wis, both of which were later developed into campgrounds. La Wis Wis Campground was dedicated in

1935. Soda Springs and Summit Creek Campgrounds, which were also built by the CCC, were built between 1934 and 1941. Ohanapecosh Campground was established in the late 1930's.

There are currently four developed campgrounds within this watershed. La Wis Wis and Ohanapecosh campgrounds are the largest campgrounds in the watershed, with 100 and 205 campsites, respectively. Both of these campgrounds have potable water systems. Soda Springs Campground (8 campsites) and Summit Creek Campground (6 campsites) do not have potable water systems. These two campgrounds are accessed by Forest Road 4510.

There are currently no proposals to significantly expand or alter developed recreation facilities.

Other developed sites include Palisades Viewpoint and Picnic Area, Knuppenburg Picnic Area and White Pass Ski Area and Lodge. There is a current proposal to expand the ski area by adding additional ski runs in the Pigtail Peak area (Subwatershed 01K). If the expansion occurs, it is anticipated that 18 to 24 new jobs would be created to serve a projected increase in skier days of 15% to 30% (15,000 to 30,000 additional skiers annually).

Table 3-1 lists and briefly describes existing facilities within the watershed.

Table 3-1: Recreational Facility Summary

Site Name	Agency	Sixth-field	Description
Ohanapecosh	NPS	01B	campground (205 units), visitor center, ranger station, trails
La Wis Wis	FS	01R	campground (100 units), historic guard station and picnic shelter, trails
Summit Creek	FS	01D	campground (6 units)
Soda Springs	FS	01D	campground (8 units), trail
Palisades	FS	01K	viewpoint and picnic area
Knuppenburg	FS	01K	picnic area
Box Canyon	NPS	01T	picnic area, trails
Shriner Peak	NPS	01S	lookout at 5,834 feet elevation
Stevens Canyon	NPS	01S	entrance station
Three Lakes	NPS	01S	backcountry ranger station
White Pass	FS/Private	01K	ski area, lodge, accomodations

Reference and Current Conditions - Roads and Trails

Prior to 1940, much of the area within the Clear Fork watershed was unroaded. Approximately 32 miles of road existed in the watershed. Highway 12 extended just beyond what is currently known as the Palisades Viewpoint and Picnic Area. Highway 123 extended northward from Highway 12 into Mount Rainier National Park and provided access to Ohanapecosh Campground and Cayuse Pass. At that time there was no road connection between Ohanapecosh and the Nisqually (West) Entrance of the Park as the Stevens Canyon portion of Highway 706 had not yet been constructed. Maps of this era indicate that the only other road that existed at that time was a Forest Road (currently known as Forest Road 4510) leading to Soda Springs Campground from near the junction of U.S. Highway 12 and State Highway 123.

The trail system prior to 1940 was fairly extensive with trails originating at the somewhat limited road system of that time. As the area became more heavily roaded, several trails were shortened including the Carlton, Clear Fork, Cortright and Bluff Lake Trails.

There are currently 35 trails which total 131 trail miles within the watershed. General maintenance for Forest Service trails is performed on a one-, two- or three-year cycle depending on the trail. Trails which have severe tread erosion problems such as trenching, rutting, sloughing, washouts, etc. are scheduled for reconstruction and/or heavy maintenance depending on funding and crew availability. See Map 6, Recreation, for trail locations.

The Packwood Access and Travel Management (ATM) Plan (1995), did not identify any Roads-to-Trails opportunities within the Clear Fork Watershed, although recent circumstances have created a defacto Roads-To-Trails opportunity on Forest Road 44. Forest Road 44 is entirely within a Late-Successional Reserve allocation (USDA, USDA 1994b) and has provided access to the Carlton Creek trailhead for many years. Heavy snowloads in the winter of 1996-97 severely damaged two road bridges and it is unlikely that these bridges will be replaced in the near future. Because of this, the Forest Service is investigating options to reestablish access to the Carlton Creek Trail. One option would be to utilize the current road bed as trail access and establish a new trailhead near where the first damaged bridge is located. Another option would be to utilize a portion of the road bed and establish a connector route to the Kincaid Trail to the south. Either option would add approximately 4 miles of trail, although much of the route would retain a road-like appearance for many years in the absence of Roads-To-Trails conversion activities. The project area is within sixth-field watersheds 01F (Lower Carlton Creek), 01G (Upper Carlton Creek) and 01H (Cyrenus Creek).

There are currently no other proposals to significantly alter or expand the current trail system.

Table 3-2 is a current listing of trails within the watershed.

Table 3-2: Trails Within Clear Fork Watershed

Trail	Agency	Sixth-field
Backbone #164	FS	01A
Box Canyon	NPS	01T
Bluff Lake #65 (portion)	FS	01M,01N
Carlton # 22 (portion)	FS	01G
Clear Fork #61	FS	01K, 01L, 01Q
Clear Lost #76	FS	01K, 01L, 01P
Cortright #57 (portion)	FS	01D, 01E, 01I, 01J
Cowlitz #44	FS	01D, 01E
Cowlitz #44A	FS	01E, 01H
Coyote #79 (portion)	FS	01L
Crossover #41	FS	01E
Dumbell Lake #56 (portion)	FS	01E
East Side	NPS	01S
Grove of the Patriarchs	NPS	01S
Hot Springs Interpretive	NPS	01B
Judkin #47	FS	01E
Jug Lake #43	FS	01E
Kincaid #42	FS	01E, 01G, 01H
Laughingwater Creek	NPS	01G, 01S
Longjohn #56A (portion)	FS	01E
Mazama Ridge	NPS	01T
Naches Loop/Dewey Lake	NPS	01S
Ollalie Creek	NPS	01S
Owyhigh Lakes	NPS	01S
Pacific Crest Nat'l Scenic Trail #2000	NPS/FS	01E, 01K, 01L, 01S
Pinnacle Peak	NPS	01T
Pothole #45	FS	01E
Riverview #162	FS	01R
Sand Lake #60 (portion)	FS	01J, 01L
Shellrock #1142 (portion)	FS	01E
Shriner Peak	NPS	01S
Silver Falls Loop	NPS	01B, 01S
Tatoosh #161 (portion)	FS	01A

Map 6
Clear Fork Watershed Analysis
Recreation

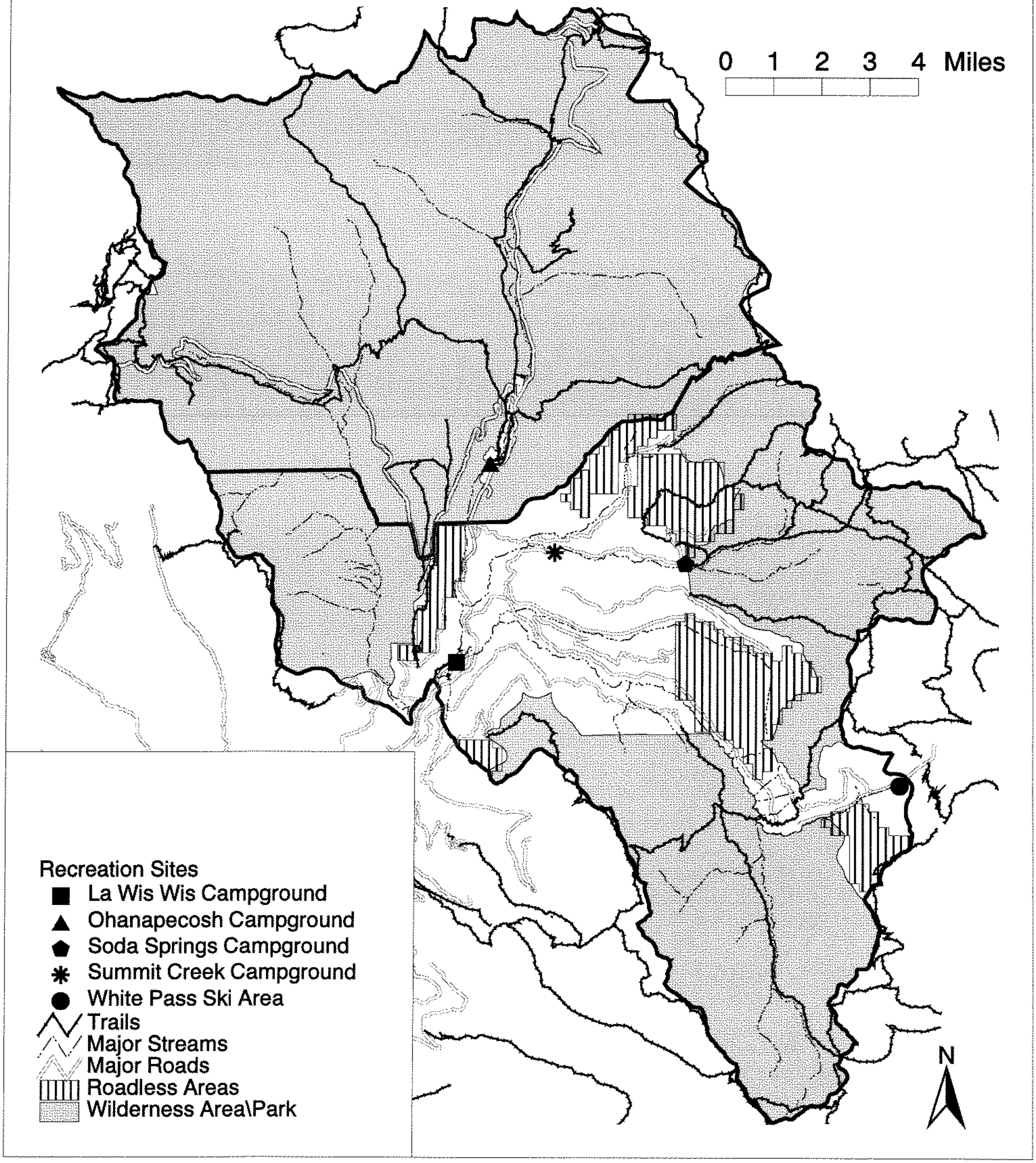


Table 3-2: Trails Within Clear Fork Watershed

Trail	Agency	Sixth-field
Tatoosh Lakes #161B (portion)	FS	01A
Tipsoo Access Trails	NPS	01S
Wonderland (portion)	NPS	01S, 01T

Trail miles by sixth-field watershed are given in Table 3-3.

Table 3-3: Trail Miles by Sixth-field

Sixth-field	Trail Miles
01A	5
01B	6
01D	1
01E	21
01G	5
01H	3
01I	1
01J	2
01K	7
01L	11
01M	2
01N	0
01P	2
01Q	2
01R	1
01S	42
01T	20
Total	131

Today, U.S. Highway 12 is a primary cross-state highway and is a designated National Scenic Byway that accommodates both commercial and passenger vehicles traveling to and from the southern Puget Sound area and eastern Washington. United States Highway 12 bisects the watershed and accommodates 1.7 million vehicles annually (4,800 daily). Highway 123, which is closed during the winter months, receives extensive vehicle use (commercial vehicles are prohibited) during the summer months as it provides access to Mount Rainier National Park and easier access to the Puget Sound area from east Lewis County. Stevens Canyon Road, which closes east of Paradise during the winter months, was opened in 1957. Table 3-4 shows relative use levels based on vehicle counts for the three major roads within the watershed (vehicle counts are not available for all roads).

Table 3-4: Vehicle Counts within the Clear Fork Watershed

Road	Average Daily Vehicle Count	Yearly Vehicle Count	% Change (since 1993)	Year of Last Vehicle Count
Highway 12	4,800	1,700,000 (1996)	+6%	1996
Highway 123*	--	104,660 (1997)	--	1997 count only
Stevens Canyon*	--	107,519 (1997)	--	1997 count only
Forest Rd. 45*	40	7,757 (ave. for 1985-1991)	--	1991
Forest Rd. 46*	48	9,352 (ave. for 1985-1991)	--	1991

* Closed during winter months

Reference and Current Conditions - Dispersed Recreation

Dispersed recreation use, which is use that occurs in non-developed areas, is generally not well documented. Road condition surveys that were conducted in this watershed, however, include documentation of fire rings/campsites along roadways. This information has been valuable in confirming that some areas have been heavily utilized for dispersed recreation activities. Two areas have been noted as having high levels of dispersed recreation activity. The Cortright area, accessed by Forest Road 45, is popular in the summer for berry picking and in the fall during hunting season. Forest Road 1270, which accesses the Jody's Bridge area at the confluence of the Muddy Fork of the Cowlitz River and the main branch of the Cowlitz River, is an extremely popular area throughout the year for camping, hiking and hunting. Regional demand projections indicate annual increases of approximately 1% to 2% per year could be expected for various dispersed recreation activities such as primitive camping, hiking, bicycling, water sports, driving for pleasure, etc. (USDA Forest Service 1993c).

Reference and Current Conditions - Roadless Areas

There are six Inventoried Roadless Areas within the watershed that were listed and evaluated in the Roadless Area Review and Evaluation (RARE II) process (see Map 6, Recreation). Five of the Roadless Areas are wholly within the watershed. All of them are relatively small with a total acreage of approximately 10,230 acres based on a 1986 inventory. Some changes in acreage may have occurred due to management activities since 1986. All of the Roadless Areas in this watershed are adjacent to Wilderness. Table 3-5 summarizes the status of each Roadless Area.

Table 3-5: Roadless Area Summary

Roadless Area	Acreage Based on 1986 Inventory	Sixth-field Location	Adjacent Wilderness
Backbone	1,210	01A, 01B, 01R	Tatoosh/Mt. Rainier
Cortright	3,380	01I, 01J, 01K	Wm.O.Douglas
Coal Creek Bluff (portion)	1,170	01M	Goat Rocks
Carlton Ridge	2,260	01D, 01H, 01F, 01G	Wm. O. Douglas
Laughing Water	1,050	01F, 01G	Wm. O. Douglas / Mt.Rainier
White Pass	1,160	01K	Goat Rocks
Total	10,230		

Reference and Current Conditions - Wilderness

The Wilderness Act of 1964 established the Goat Rocks Wilderness. Total acreage at that time was almost 83,000 acres. In 1984, the Washington State Wilderness Act expanded the Goat Rocks Wilderness to approximately 106,000 acres and added several new Wildernesses to the National Wilderness Preservation System. These new additions included the William O. Douglas Wilderness (over 166,000 acres) and the Tatoosh Wilderness (over 15,000 acres).

In 1988, almost 97% (228,480 acres) of Mount Rainier National Park was designated as Wilderness.

Table 3-6 shows average annual use estimates for each Forest Service Wilderness trail with a trailhead and/or registration box within the upper Cowlitz watershed. These estimates are based on permit registration information collected from 1992 through 1997 with adjustments for permit compliance. Moderate to heavy use has been documented on the Pacific Crest National Scenic Trail and Cowlitz Trails 44 and 44A. Tatoosh Trail #161 is the only major system trail within the Tatoosh Wilderness.

Flood and storm damage to roads and trails created access problems in 1996 which resulted in significant declines in use on several trails. The most significant effects were seen on the north trailhead of Tatoosh Trail #161, Lily Basin Trail #86.

Table 3-6: Trail Use on Forest Service Trails - Average Annual Day and Overnight Trail Use in the Clear Fork Watershed for 1992-1997

Trailhead	Sixth-field	Overnight Backpackers	Overnight Stock Users	Day Hikers	Day Stock Users
Backbone #164	01A, 01B	no data	no data	no data	no data
Bluff Lake #65	01M, 01N	64	7	254	21
Carlton Creek #22	01G	52	26	59	35
Clear Fork #61	01K, 01L, 01Q	109	31	157	15
Clear Lost #76	01K, 01L, 01P	23	0	42	4
Cortright #57	01D, 01E, 01I, 01J	18	3	37	13
Cowlitz #44 & 44A	01D, 01E, 01H	247	226	412	298
Kincaid #42	01E, 01G, 01H	1	2	5	11
Pacific Crest Nat'l Scenic Trail #2000(Wm.O.Douglas)	01E, 01S	482	166	604	347
Riverview #162	01R	no data	no data	no data	no data
Sand Lake #60	01J, 01K	19	0	110	4

Use statistics for Mount Rainier National Park indicate that overnight use is relatively low. Data from 1992 shows that 158 overnighters used the Deer Creek access point. Fewer than 100 overnighters used the Shriner's Peak, Ollalie Creek and Laughingwater Creek trailheads.

A considerable amount of day use has been documented within the Park. Patrol logs indicate many days during the summer months when some trails receive in excess of 100 people per day. The Forest Service WILDMON database includes an inventory of all known campsites within Wilderness and the associated physical impacts for each site. Information such as distance to the nearest trail and distance to the nearest water source are included along with eight site-specific indicators that are used to develop a site condition rating. The eight indicators are: 1) barren core of a site caused by impact of people; 2) fire scars; 3) campsite development; 4) vegetation loss; 5) root damage; 6) tree mutilation; 7) number of campsites visible; and 8) number of access trails.

Condition classes for each indicator range from 1 to 5. A site with no impacts in any indicator category would be given a rating of 1. An example of a site with a rating of 1 would be a reference site in an unimpacted area. A rating of 5 in any category would be an indication of considerable damage for that specific indicator. For each site, an overall condition rating is calculated using all eight indicators. In the Goat Rocks, for example, the average campsite rating for this watershed is 2.5.

Table 3-7 summarizes the number of campsites (excluding reference sites), average site condition and the percent of sites believed to be located within 300' of water sources by sub watershed. A very high percentage of sites are within 300' of water sources and this is typical of the situation in many areas. People are attracted to water for practical and aesthetic reasons and sites tend to get created and expanded in those areas of high use.

Table 3-7: Wilderness Campsites - Total Number of Wilderness Sites/Campsites, Average Condition Rating and % within 300' of Water Sources by Sixth-field

Sixth-field (Wilderness)	# of Sites	Ave. Condition Rating	% Within 300' of Water Sources
01A (Tatoosh)	20	2.3	50%
01E (Wm.O.Douglas)	83	3.9	96%
01F (Wm.O.Douglas)	0	-	-
01G (Wm.O.Douglas)	1	2.9	100%
01H (Wm.O.Douglas)	0	-	-
01I (Wm.O.Douglas)	0	-	-
01J (Wm.O.Douglas)	3	2.1	100%
01K (Wm.O.Douglas)	0	-	-
01K (Goat Rocks)	2	2.8	100%
01L (Goat Rocks)	12	2.4	100%
01M (Goat Rocks)	2	2.5	100%
01N (Goat Rocks)	7	2.3	71%
01P (Goat Rocks)	3	1.7	33%
01Q (Goat Rocks)	5	3.4	100%
01A (Mount Rainier)*	0(designated)		
01B (Mount Rainier)*	0(designated)		
01S (Mount Rainier)*	13(designated)		
01T (Mount Rainier)*	11(designated)		

* Overnight camping within 1/4 mile of system trails is prohibited except at designated sites within Mount Rainier National Park. The table only indicates the number of designated campsites. Site condition information and information on sites in cross-country areas was

unavailable at the time of this analysis. In the Mt. Rainier National Park Wilderness Management Plan (1989), however, it is indicated that there has been improvement with regard to human impacts in the backcountry. This has been attributed to the use of quotas and other use restrictions. Monitoring of conditions in the backcountry is ongoing along with site restoration efforts.

In Wilderness, the management objective is to allow natural processes to occur and this includes lightning-caused fires. Past suppression of lightning-caused fires is believed to have had some impact on ecosystem functions, although the actual effect is difficult to quantify. It is known that land management agencies have been fairly successful in suppressing lightning-caused fires at early stages of development. This prevents natural fire processes from occurring. Over time, these suppression activities will diminish the effect of fire on the creation and perpetuation of meadows and the overall vegetative mosaic that occurs when fires of varying intensity burn over large areas. Approved fire management plans are required before lightning-caused fires can be managed for resource benefits. To date, the Goat Rocks Wilderness is the only Wilderness in this watershed that has an approved plan. In the future, it is anticipated that some lightning-caused fires will be managed in a way that will allow them to more closely play their natural role in Wilderness.

Special Forest Products

Data Sources/Data Gaps

Information on the number of special forest product permits issued and the value of these products is summarized from information contained in the Cowlitz Valley Ranger District permit database. Only generalized information is known about where harvest is occurring on the district. This information is primarily from knowledge of where products grow, administration of Special Forest Product permits, law enforcement personnel and other forest users. The number of permits issued and amount of harvest specific to the Clear Fork watershed is not known.

Assumptions

A permit is required to remove any product from National Forest lands. Harvest of special forest products in Wilderness areas is illegal. For purposes of this analysis, it is assumed that no illegal harvest is taking place. Estimates of the amounts of harvest are based on permit sales.

Reference (Historic) and Current Conditions

Special forest products have been gathered throughout the Cowlitz Valley Ranger District and the watershed for at least the last 6,000 years. There are a wide variety of special forest products which may be harvested. Many of the products collected are not site-specific (i.e., they are harvested over wide-ranging areas within the Gifford Pinchot National Forest).

In the past decade, demand for traditional and non-traditional products has increased substantially. Many native plants, including trees, shrubs, forbs and mosses are currently harvested. Plants such as salal, sword-fern, evergreen huckleberry and beargrass have increased in popularity as floral greens. Doulgas-fir and noble fir are popular as Christmas greens and boughs. Huckleberries, mushrooms and fiddlehead fern are collected for consumption. Medicinals and herbs harvested on the district include Pacific yew, cascara, devil's club, prince's pine and stinging nettle. Oregon grape, red alder and Western red cedar are commonly used for dyes. Unusual burls, conks, stumps, cones and twigs are gathered for decoratives.

There are four types of collection "allowed" on the forest:

1. Tribal Use: Traditional noncommercial gathering by Native Americans affiliated with a federally recognized tribe.

2. Incidental Use: On-site product consumption/use, usually associated with recreation activities.

3. Personal Use: Collection of materials for personal use/consumption, not for sale or resale after any intermediate processing.

4. Commercial Use: Collection of materials for the primary purpose of sale, resale, or use in a manufacturing process resulting in a finished product that will be sold.

A permit is required to remove all forest products other than edible berries from the Gifford Pinchot National Forest. Nearly 4,000 permits were issued in 1997 on the Cowlitz Valley Ranger District, yielding approximately $305,000 in revenues. In addition, nearly 1,000 free-use permits were issued with an estimated value of $11,000. A total of almost one-third of a million dollars worth of products were removed from the Cowlitz Valley Ranger District in 1997.

Tables 3-8 through 3-10 list the primary special forest products commonly harvested on the Cowlitz Valley Ranger District. The number of permits issued and amount of harvest specific to the Clear Fork watershed analysis is not known, although it is known that all areas outside the Wilderness have an abundance of permitted use. Estimates of the amounts of harvest are based on permit sales. Most permits are sold on a per-day basis. Markets and weather conditions dictate the demand for permits to harvest these products.

Table 3-8: Commercial Use Special Forest Products - Primary Products Harvested on the Cowlitz Valley Ranger District

Product	Permits Issued (1997)	Year Permits First Issued	$ Value	Elevation Typically Found
Mushrooms	856	1991	$42,705	< 3,000 ft
Beargrass	267	1989*	$20,040	> 3,000 ft
Salal	673	1989*	$34,195	< 3,000 ft
Stewardship/ Boughs	26	1989*	$119,334	> 3,000 ft
Ferns	41	1989*	$802	1,000 - 1,500 ft
Moss	7	1989*	$90	Restricted to Timber sale areas

** First year data was recorded*

Table 3-9: Personal Use Special Forest Products - Primary Products Harvested on the Cowlitz Valley Ranger District

Product	Permits Issued (1997)	Year Permits First Issued	$ Value	Elevation Typically Found
Christmas Trees	937	1989*	$4,685	2,000 - 4,000 ft
Firewood	929	1989*	$11,865	1,000 - 4,500 ft

** First year data was recorded*

Table 3-10: Free-Use* Special Forest Products - Primary Products Harvested on the Cowlitz Valley Ranger District

Product	Permits Issued (1997)	Year Permits First Issued	$ Value
Mushrooms	906	1991	$9,060
Transplants	49	1989**	$675
Cuttings	20	1989**	$121

** Free-Use means no fee for the permit*
*** First year data was recorded*

Forest management activities affect availability and distribution of special forest products. The effects of management activities depend on site treatment. For example, Chantrelle mushrooms often take 20 to 30 years to return in abundance following stand treatments such as regeneration harvest or burning. Special forest product harvest can also benefit forest management goals. For example, the fungus that produces Chantrelles forms mycorrhizal relationships with trees that benefit the growth of trees by providing nutrients for the trees in forms that are easy to utilize. In addition, pruning white pine boughs may significantly reduce mortality form white pine blister rust.

Road access is a key factor in determining where forest products are harvested. Gatherers will walk to harvest products, but prefer not to carry forest products to a road. Harvesters often have to carry products a couple of miles out of the forest to a road. All Terrain Vehicles (ATVs) are used where roads are not passable to standard passenger vehicles or pickups.

Lands, Minerals and Special Uses

Mining Activities Assessment

Data Sources/Data Gaps

The primary data source for mining activities is the current (September 1996) USDI, Bureau of Land Management (BLM), Geographic Claims Listing for unpatented mining claims recorded with the BLM's mining claims office in Portland, OR. Although BLM's listings can sometimes be up to 6 months old, the current claims listing for the watershed analysis area is typical for activities in the watershed analysis area during the last several years (i.e., public records of active claims indicate little if any mining activities). While the Forest Service also deals with owners of claims not filed with BLM, few reports of such claims have been received by the Cowlitz Valley Ranger District.

Reference and Current Conditions

The areas encompassed by the Cowlitz Valley Ranger District, which include part of the watershed analysis area, have been open to mineral exploration for more than a century. Where areas with mineral deposits of commercial potential were found long ago, interest in those areas on the part of mineral prospectors has continued unabated to the present. Based upon a review of Cowlitz Valley Ranger District and BLM records, the National Forest lands in the watershed area are not areas where there has historically been, nor would there likely be, extensive interest in mineral prospecting and development. Within the National Forest lands of the watershed analysis area, we might expect to see an occasional filing of a mining claim for a minor amount of exploration at the pick, shovel, panning and maybe suction dredging levels. In addition to the latter activities, minor amounts of recreational gold panning and suction dredging not associated with formal mining claims may occur.

Wilderness Areas - New mining claims for locatable minerals cannot be established in National Forest Wilderness areas. While mining could take place if valid rights were established prior to the establishment of a National Forest Wilderness area, we have no records of such rights within the Goat Rocks or Tatoosh Wilderness Areas.

Mt. Rainier National Park - These lands were withdrawn from Federal lands open to mineral entry long ago.

Special Uses Assessment

Data Sources/Data Gaps

All private uses of National Forest lands, except for common recreational uses such as camping, hiking, fishing, and mining, require prior authorization through a special use permit. The primary data sources for Forest Service special use authorizations within the watershed analysis area are the Cowlitz Valley District's special use files.

Reference and Current Conditions

A review of Cowlitz Valley District files indicates that special use authorizations of relevance to watershed analysis include authorizations for underground utilities, and use of National Forest roads, rock quarries and other sites by other public agencies. There are also very minor uses made of National Forest roads for access to private lands. There are some special one-of-a-kind permitted activities including group events and minor amounts of commercial filming. A major use, by the Washington State Department of Transportation (WSDOT), is its management of U.S. Highway 12 and State Highway 123 within the National Forest (and National Park). A small part of the White Pass Ski Area is also located within the watershed analysis area (the ski area operates pursuant to a special use permit administered by the Wenatchee National Forest).

Utility Lines

There exists within sixth-field watersheds 01M (Purcell Creek), 01R (La Wis Wis), 01B (Lower Ohanapecosh River) and 01S (Upper Ohanapecosh River), short distances of buried utility lines on National Forest and National Park lands (power and communication - less than seven miles in length). These lines are located along the edges of Highways 12 and 123. They provide phone and electrical services to La Wis Wis Campground and to Mt. Rainier National Park's facilities at Ohanapecosh. The useful life of new underground utility lines is currently about 30 years. It may be expected, therefore, that the above-mentioned existing utility lines will have to be replaced periodically. Given the fairly rocky soil types to be found along U.S. Highway 12 and State Highway 123 in the watershed analysis area, new buried lines would have to be installed by backhoe trenching. All major stream crossings do/will involve placement of lines in conduit pipe attached to bridges. Underground utility lines come from the east along U.S. Highway 12 to provide power and communications for the White Pass Ski Area and WSDOT's White Pass shop and warehouse facilities.

Private Uses of National Forest Roads *

Existing National Forest roads within the watershed analysis area provide owner access to two small blocks of privately-owned lands located within the National Forest. These private inholdings include industrial forest lands, and lands held by private individuals for recreational purposes. Some of these private inholdings are old patented mining claims. By various Federal laws, the Forest Service must grant access across National Forest lands to an owner of such private lands, when the most reasonable access route to the owner's land is across the National Forest and/or along National Forest roads. Access authorizations are usually granted through a permit, and more rarely by easement. Most such authorizations in the watershed analysis area have involved use of existing and functional Forest Service roads. In rarer instances, the Forest Service may issue road use permits that also authorize minor amounts of new road construction, or reconstruction of existing National Forest roads.

The Cowlitz Valley Ranger District does receive occasional inquiries from telecommunications companies about the building and/or use of existing National Forest roads for accessing potential communication sites located at remote high-elevation sites, in such areas as Laurel Hill and Coal Creek Mountain (outside Wilderness). There are existing communication sites at White Pass and Pigtail Peak. The White Pass site is used by WSDOT and the U.S. Army; the Pigtail Peak site is used as the primary communication site for White Pass Ski Area.

* As opposed to use by recreational users of National Forest lands and Forest Service contractors.

US Highway 12 and State Highway 123

These highways, in and out of the watershed analysis area, are favored and highly-used travel routes used by east-west traffic crossing the southern Cascade Mountains for various commercial as well as recreational traffic. These highways are managed by the Washington State

Department of Transportation (WSDOT) pursuant to separate agreements between WSDOT and the National Forest and National Park Service. Maintenance and small reconstruction projects along U.S. Highway 12 are ongoing WSDOT activities in which the Forest Service's degree of involvement varies with the scope and intent of individual projects. Forest Service involvement has included supplying rock materials from National Forest quarries, authorizing use of National Forest sites for storage of excess construction excavation materials (rocks and dirt), and burning of construction-generated slash. WSDOT activities have ranged from surfacing and bridge replacement to the building of truck run-away ramps. The US Department of Transportation's Federal Highways Administration (FHWA), with conditioned Forest Service concurrence, has issued a number of small easements along U.S. Highway 12 to WSDOT, where FHWA has determined that land, or an interest in land, owned by the United States is reasonably necessary for highway right-of-way purposes.

Pursuant to a special use permit administered by the Wenatchee National Forest, WSDOT has maintained a garage, shop and warehouse facility for many years at White Pass. This facility is integral to WSDOT's maintenance activities for Highways 12 and 123 throughout the year.

Miscellaneous other Special, Road and Minerals Uses for Flood Control and Repair Activities

The heavy winter and spring precipitation events of the last few years have generated more area flooding, and in turn more multi-agency flood control and repair activities. Such activities have included repair of roads, and the building and rebuilding of Lewis County's Cowlitz River flood control revetments for protection of the High Valley subdivisions. To facilitate these repairs and flood control projects, the Cowlitz Valley Ranger District has authorized (on National Forest lands) the use of existing roads, building of a temporary road and bridge, and extraction of rip-rap materials from established quarries.

Lands Assessment

Data Sources/Data Gaps - Land Use Adjustments

The primary data sources for land use adjustments are the Cowlitz Valley Ranger District and Gifford Pinchot Forest Headquarters files for such activities.

Reference and Current Conditions

There are two small private inholdings located within the watershed analysis, specifically within sixth-field watersheds 01A, 01D and 01H. These two inholdings total less than 120 acres. They are accessible by existing National Forest roads. In years past, there have been occasional discussions between owners of some of these private lands, and the Forest Service, about government acquisition of these lands through either purchase or exchange.

Management of Adjacent Private Lands Assessment

Data Sources/Data Gaps

The primary data source for this subject area comes from the Cowlitz Valley Ranger District lands and special uses files pertaining to dealings with adjacent private landowners in the areas of road right-of-way, land exchange and special use permits.

Reference and Current Conditions

The terrain in the private inholdings located within the analysis area is moderately to very steep, only a minor portion of the acreage is conducive to development to residential purposes. In addition, access to this minor portion is only seasonal. The private inholding located in the Fish Ladder Falls area (Section 13, T.14N., R.10E.) is covered by immature stands of timber; harvesting would not likely take place soon in this area. The private inholding located within Section 31, T.14N., R.9E., ("Jody's Bridge" area) contains some stands of mature timber.

Terrestrial Elements

Disturbance Regimes - The Role of Fire

Data Sources/Data Gaps

Only high severity fires (stand replacement) can be mapped. Low to moderate severity fires cannot be traced through stand-age analysis or other methods for this fire regime. Age-class analysis also needs to compensate for the "lag time," that is, the additional amount of time for a stand to become established after a stand-replacing fire. These recruitment periods may range from 50-75+ years at higher elevations and harsher environments. Fire history must be placed in a 500+ year context in order to account for the majority of fire events. Data or research in this context is minimal, and the analysis, by necessity, is highly extrapolative. Although little is known about fire frequencies, live successional pathways, and the amounts of dead fuel loadings over time in the western hemlock zone, even less is known about these characteristics in the Pacific silver fir and mountain hemlock zones.

Fire history analysis for the Clear Fork watershed is based on stand age analysis. Stand age was determined by use of the Gifford Pinchot GIS vegetation database (GPVEG), which is based on stand exam information, professional judgement, personal on-the-ground knowledge, and aerial photo interpretation. Stand age data pertaining to Mt. Rainier National Park is displayed in broad age categories of 100 year groups. By using these large groups many fires on National Park land will be missed when using stand age analysis to determine fire history.

Assumptions

- Catastrophic disturbances permit the establishment of an identifiable, more or less even-aged class of early seral species. Historic large-scale disturbances (fires) are not desired today, and their effects can only be replicated on a small scale. The effects most easily created through human activities include the maintenance of certain stand structure characteristics, such as large down woody debris, snags, and a diversity of stand age classes.

- The designation of a land allocation (e.g. Late-Successional Reserve), is a management issue and/or decision. The resultant desired future condition in most cases does not reflect historic natural fire conditions. Only designated Wilderness areas, with an approved Prescribed Natural Fire Plan, closely approach fire disturbance effects. The scale needed to more accurately draw conclusions about past fire history and its effects is quite large and should be made only for the entire Cowlitz River watershed. No assumptions, interpretations, or recommendations can or should be made about historic fire disturbance at the sixth-field watershed scale. Potential natural vegetation can only be reached in the absence of fire or other disturbances. In most cases, the frequency and extent of natural fires precludes the attainment of this potential.

Reference (Historic) and Current Conditions

Historically, fire has been a very significant ecosystem disturbance mechanism in this watershed. Fires were low in frequency but high in severity, and had the potential to be quite large. Suppression activities since the 1930's have virtually eliminated natural wildfire effects in this watershed.

Historic fire events tend to be either very small (less than 5 acres) or very large (greater than 1000 acres). Prior to suppression, whether natural or human-caused, traceable fire events were very large. Large events probably mask scores of smaller events. More recent events mask older events or parts of older events.

Riparian areas, especially in the western hemlock zone, tend to have microclimates which somewhat protect them from many wildfire events. These areas tend to be associated with older or large tree stands. This effect is pronounced in steeper drainages.

The Clear Fork watershed, in general, is subject to greater marine climatic conditions than watersheds east of the Cascade crest, which are influenced by more continental (colder and drier) conditions.

Based on stand age analysis, four large fires have burned in the Clear Fork watershed analysis area between 1700 and 1900 (Map 7, Fire History as Determined by Stand Age).

Between 1700 and 1750 two large fires burned in the Clear Fork analysis area. A large fire burned in the Ohanapecosh River drainage from near the confluence of the Clear Fork Cowlitz River and the Ohanapecosh River up into what is now Mt. Rainier National Park. It is impossible to determine the exact acreage or perimeter because of incomplete data, but it appears that it may have burned as much as 9,000 to 10,000 acres. Much of the valley bottom of the Ohanapecosh River did not burn or only had a light under burn as the remaining stand in this area is quite old. The second fire was a 5,600-acre fire that burned a large portion of the Cortright Creek drainage. It burned from the Clear Fork Cowlitz River on the south across Cortright Ridge on the north.

During the time period from 1800 to 1850, a large fire burned much of the Cascade crest from White Pass to north of Jug lake. This fire burned approximately 6,400 acres of the analysis area, and may have also burned a large area in the drier vegetation east of the Cascade crest.

The largest fire burned approximately 14,200 acres in the analysis area. This fire burned much of the area north of the Cowlitz River from Hopkins Creek to the Ohanapecosh River, and burned up into Mt. Rainier National Park to timber line. It also burned a large portion of Skate Creek and north as far as the Nisqually River. The entire Muddy Fork Cowlitz River drainage was denuded by this fire. A report from a party on their way to climb Mt. Rainier described the area around Bear Prairie as blackened and full of snags in 1870. The fire is thought to have burned some time in the mid to late 1860's.

Several smaller 1,000 to 2,000-acre fires were noted in the planning area.

Between 1700 and 1900, an average of 16,300 acres of the analysis area burned every 50 years. After 1900, this 50-year average dropped drastically. From 1900 to 1960, 1,330 acres burned, and from 1960 to the present only 570 acres have burned. This is at least partially due to aggressive fire suppression that was started in the 1930's.

Two fires account for the acreage burned since 1960. They were the Summit fire (330 acres) which burned in the 1960's, and the Yellow Jacket fire (240 acres) which burned in 1990.

Based on stand age analysis, approximately 70% of the Clear Fork watershed analysis area was burned by stand-replacing fires during the 200-year period from 1700 to 1900. Approximately 28% of today's stands originated before 1700, and only 2% of the area had stand-replacing fires after 1900.

Fire Ecology Groups

Information on fire ecology groups has not been developed for Mt. Rainier National Park, so this report does not include fire ecology information on National Park land.

The vegetation communities found within the Clear Fork analysis area can be classified into five general fire ecology groups within which fire follows certain characteristics. These groups and characteristics are described below:

FireGroup 0: Miscellaneous Special Habitats

This fire group is made up of scree, forested rock, dry meadow, wet meadow, recent volcanic deposits, alder glades, and deciduous riparian communities. This group does not stand alone as a large mappable area, but is dispersed as small areas within the other fire ecology groups.

Scree, or talus, refers to slops covered with loose rock fragments, usually at or near the maximum angle of repose. Scree slopes rarely burn.

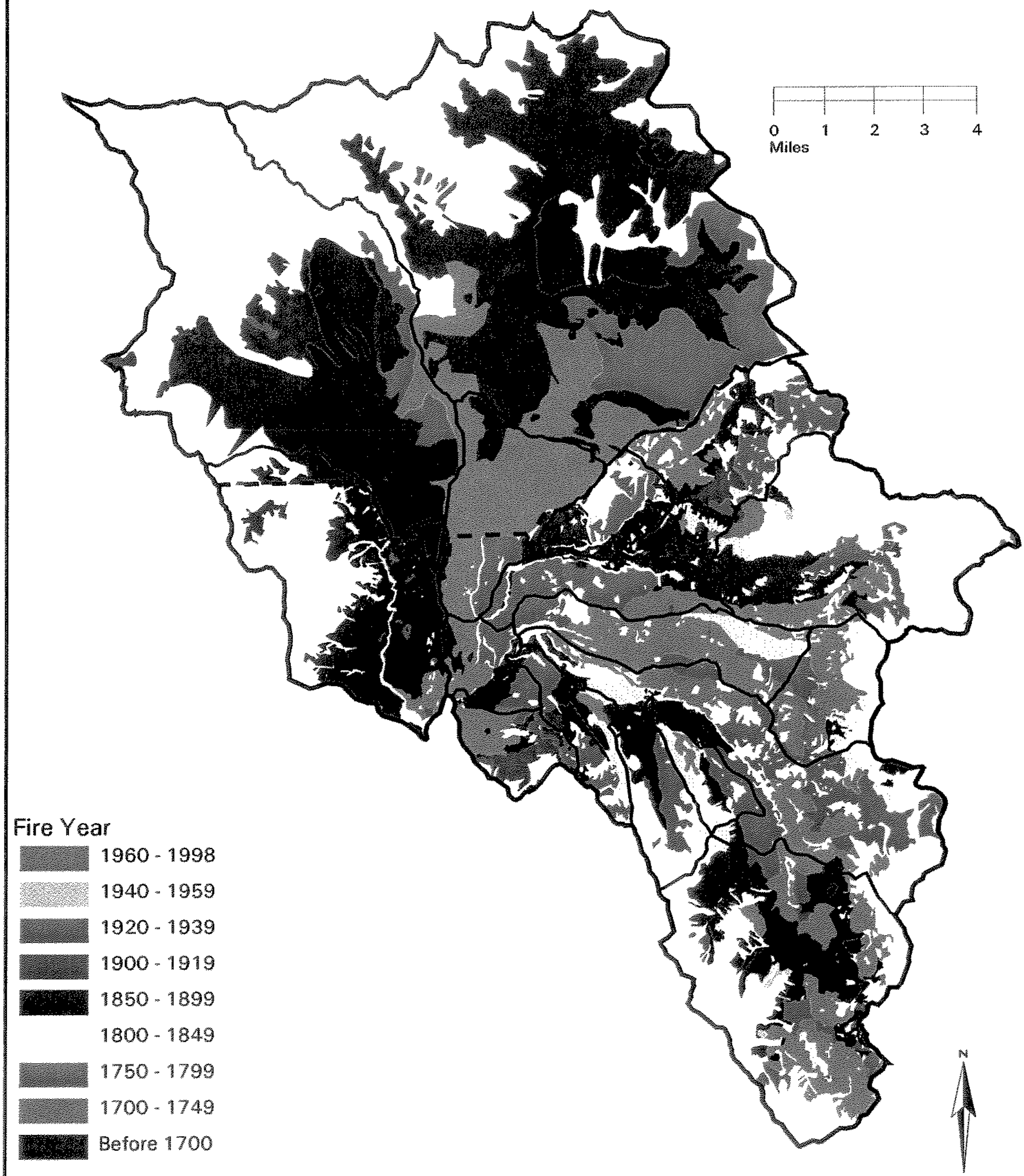
Forested rock consists of very steep canyon walls or mountain sides composed of rock outcrops or cliffs with occasional clumps of trees clinging to ledges and crevices. Surface fires usually spread slowly due to vertical and horizontal discontinuity of ground fuels. Crown fire probability depends on the density and arrangement of trees on the rock.

Grasses and bare soil characterize the dry meadows. Fire exclusion has allowed tree invasion into many high elevation meadows and into deeper pockets of soil in low elevation meadows.

Map 7

CLEAR FORK WATERSHED ANALYSIS

Fire History as Determined by Stand Age



Herbaceous vegetation and abundant water characterize wet meadows. Such sites may contain a fire-maintained grassland bordering the wet meadow. Fire exclusion has allowed conifers to invade the drier edges of meadows.

Extensive areas of rock, sand, or ash with varying amounts of vegetation characterize recent volcanic deposits. These sites may support a crown fire under extreme conditions, but would not support a surface fire that spreads beyond the point of origin.

Alder glades, openings dominated by various alder species, appear primarily in the lower Mountain Hemlock Zone and upper Pacific Silver Fir Zone. Alder glades remain moist throughout the summer and do not burn readily.

Deciduous riparian communities consist of sites dominated by deciduous trees and shrubs adjacent to perennial streams, seeps, and open bodies of water. Moist conditions and generally rapid decay of leaf litter and downed woody material generally reduce the potential of fire spread.

Fire Group 6: Lower Subalpine

Fire group six incorporates the wetter portion of the transition zone between the east side and west side of the Cascade crest, as well as cooler sites on the west side. This group occurs at a mix of higher and mid-elevations west of the Cascade crest.

Pacific silver fir, western hemlock and mountain hemlock dominate the overstory in older stands, but Douglas-fir, noble fir and Engelmann spruce also occur in significant amounts.

Associations in this fire group are warm enough that most smaller dead fuel decays almost as rapidly as it accumulates until later in the successional pathway. Most down woody fuel loading is in the greater than 3" diameter class. The abundant shrubs also provide a very large heat sink under normal conditions, greatly reducing the rate of fire spread. During prolonged drought, the shrubs and forbs can provide a significant fuel load.

Pacific silver fir, western hemlock, Engelmann spruce and noble fir exhibit a low resistance to fire. Douglas-fir resists fire well when the bark thickens and the crown gets high enough to resist crown scorch (approximately 40 years).

Fire history information for higher elevation forests is scarce. Fire history studies in similar stands in western Montana and southern Wyoming indicate average fire intervals of 140-400 years.

Recent fires on the Gifford Pinchot National Forest have tended to burn through the crowns with relatively limited surface fire. Aerial fuels, such as moss and lichens, have been the main carriers of the fire, since downed woody fuels are relatively light. In many cases, these fires would not have spread without strong, gusty winds which cause the fires to flash through the crowns in a matter of minutes. Once the winds died, burning became limited to snags and larger surface fuels.

Fire Group 8: Western Hemlock/Pacific Silver Fir

Fire ecology group eight includes most of the western hemlock and Pacific silver fir plant associations found in the Clear Fork watershed analysis area. As such, it includes a wide range of topographic positions, moisture regimes and temperature regimes.

Three conifer species, Douglas-fir, western hemlock and western redcedar, tend to dominate the overstory in the Western Hemlock Zone. The Pacific Silver Fir Zone includes a wider variety of overstory species, including Pacific silver fir, western hemlock, noble fir, western white pine and mountain hemlock.

This group generally lacks fine fuels through most of its stand history. "Classic" old-growth stand conditions (closed canopy overstory of large diameter trees and a lush understory) are common in undisturbed areas. Disturbances are infrequent. Fuel loadings build rapidly once the overstory begins to die from disease or insect attack and the canopy breaks up. Conditions become drier in these canopy gaps and can provide a suitable fuel bed for fire starts.

Western hemlock and Pacific silver fir are extremely fire sensitive due to thin bark, shallow roots, and highly flammable foliage. Western redcedar exhibits moderate fire resistance compared to western hemlock, but due to its thin bark, shallow roots, a low, dense branching habit, and highly flammable foliage, redcedar is vulnerable to even low intensity fire. Douglas-fir resists fire damage well. Fire frequency tends to be low because of the cool, moist habitats that western hemlock and Pacific silver fir generally occupy. Fire frequency varies from 150 to 400 years or more.

Fire Group 9: Dry Western Hemlock and Douglas-Fir

Fire ecology group nine occurs on north and south aspects of the Cowlitz, Cispus, and North Fork Cispus Rivers. Typical site characteristics include stony, rocky, gravely, or otherwise well drained soils, steep slopes, and generally dry conditions.

Fire group nine consists of dry western hemlock plant associations where Douglas-fir is the major seral species. Three conifers and one hardwood tend to dominate the overstory within this fire group: Douglas-fir, western hemlock, western redcedar, and big leaf maple. Western redcedar grows primarily in draws and other locations with deeper soils that hold more moisture. Shrubs, rather than forbs, tend to dominate the most common plant associations in fire group nine.

Fuel loadings in this fire group are highly variable, depending on individual stand and site conditions. Generally, fire group nine does not contain duff as deep as that found in fire group eight. Most sites in this fire group dry out sufficiently and contain enough fine fuels to carry fires in most years.

Douglas-fir is more fire resistant than many of its associates and can survive moderately intense fires. Moderately severe under burns in 50 to 60-year-old mixed and pure stands near Mount Rainier caused little cambial damage to Douglas-fir. However, most of the thin-barked western redcedar was killed. Douglas-fir is a primary component of moist forests experiencing infrequent, widespread, stand-replacing fires that occur at perhaps 400- to 500-year intervals. Where Douglas-fir is seral, its great longevity allows it to maintain itself as a canopy dominant until the next stand-replacement fire occurs.

Fire Group 10: Upper Subalpine and Timberline Forests

All stands within this group lie above the climatic limits of Douglas-fir habitat. Mountain hemlock is the most common tree species in all of the associations. Subalpine fir and whitebark pine are co-mixed with mountain hemlock in several associations. Engelmann spruce may also appear as a long-lived seral species. Trees tend to grow in clumps or as scattered individuals. Only a few species of shrubs and forbs tend to dominate most sites. Typical shrubs include red heather, huckleberries and juniper. Typical forbs include woodrushes, sedges, green fescue, asters, and fleeceflower.

Relatively sparse fine fuels and moderate to heavy loadings of large diameter woody fuels are typical. In the more continuous forest of this group, stand replacing crown fires can develop at long intervals, 200-300 years or longer. Such crown fires would develop under prolonged drought conditions and high winds in lower elevation forests and burn up into these upper subalpine and timberline stands.

Subalpine fir is one of the least fire resistant conifers in the western United States. Mountain hemlock exhibits a low resistance to fire. Whitebark pine is a semi-tolerant or intermediately-tolerant species.

Insects and Disease

Data Sources/Data Gaps

- The primary data sources for information on insects and disease were U.S. Forest Service Region 6 Forest Pest Management (FPM) aerial insect survey maps, the Gifford Pinchot National Forest Total Resource Inventory (TRI) Pest Management Subsystem, and Forest Pest Evaluations by Region 6 Forest Pest Management.

- The earliest data available from the aerial insect surveys for this watershed is from 1974 surveys, the latest is 1994. Survey maps are not available for every year from 1974 to 1994.

- Only a very small portion of the watershed has been surveyed and mapped for disease occurrence. Funding and priority to gather information concerning insects and disease has been low; consequently the amount of data available is limited and incomplete.

- There is no insect and disease data available for the private lands in the watershed. There is no disease data available for the National Park. Data from the FPM aerial insect survey maps did cover the National Park during the years 1989, 1992, 1993, and 1994, but not prior to 1989.

Assumptions

- A quick review of available data on disease and insect occurrences is sufficient to draw some conclusions about insect and disease activity in this watershed.

- Insect and disease activity on private/National Park lands is similar to that found on National Forest land.

Reference (Historic) and Current Conditions

We have no knowledge or data about historic insect and disease occurrence in this watershed prior to 1974. The only thing we can say with any certainty, is that most of the insects and disease present today were very probably here hundreds, if not thousands, of years ago. The only exceptions are the balsam woolley adelgid (an insect) and white pine blister rust (a disease). Both are introduced pests not present in the Pacific Northwest until the early part of this century.

Insects and disease are a natural part of the ecosystem and serve as agents of disturbance across the landscape. For the most part, native insects and diseases occur at endemic, or normal, levels and only occasionally appear as spectacular or seriously damaging epidemic outbreaks. However, even at endemic levels, damage to forests from some insects and diseases can, over time, be quite serious. The amount of disturbance caused by them can vary greatly from large conspicuous outbreaks to small, almost imperceptible outbreaks, with damage to trees being anywhere from light to severe. These agents of disturbance are essentially always present in the ecosystem at some level, their presence waxing and waning as the ecological conditions that affect them change over time.

Disease infections and insect infestations are an integral part of this forested ecosystem. Through their presence and actions they affect and participate in a wide range of ecosystem components and relationships. They foster diversity in the ecosystem by altering stand structure, and they can change the species composition of a stand over time. Through the killing or damaging of trees they: 1) create snags and down wood that provide habitat for a variety of wildlife species and serve as an important link in the cycling of nutrients, and 2) cause changes in the amount of sunlight that enters the canopy and reaches the forest floor, thus causing changes in the types, sizes, and amounts of vegetation. Insects and disease are also an important link in the ecosystem's food chain (e.g., wildlife feed on insects and the fruiting bodies of fungi that cause tree disease and decay).

Insects

Currently, based on FPM aerial surveys, the insects that have been observed causing the most notable damage to trees in the watershed over the past 25 years are the balsam woolley adelgid (in Pacific silver fir) and the Douglas-fir beetle (in Douglas-fir), with most of the beetle activity having occurred from 1989 through 1994. There are other insects at work in this watershed (e.g., fir engraver beetle [in all true fir tree species], mountain pine beetle [in western white pine]), but the level of their presence and activity is relatively small, very sporadic and scattered.

Balsam Woolley Adelgid (Adelges piceae)

This aphid-like insect feeds by sucking sap from cells beneath the bark of twigs, limbs, and boles of trees. As it feeds, it pumps a toxic salivary substance into the cells causing damage to them. The balsam woolley adelgid will attack all true fir trees (*Abies* spp.), but in this watershed its principle host is Pacific silver fir. Pacific silver fir susceptibility varies: on poor growing sites it is quite tolerant to the adelgid; on good growing sites it can be very susceptible.

The balsam woolley adelgid is probably the most serious enemy of true firs in the Pacific Northwest and had been shown to be a very damaging pest. It has tremendous reproductive capacity and epidemics can seemingly occur overnight. The degree of damage is greatest on dominant and co-dominant trees growing on the best growing sites. The most severe outbreaks occur at the lower ends of the host species' elevation range: from about 1500 to 3000 feet in Pacific silver fir. Stands along stream bottoms and in flat, terraces or benches (i.e., good growing sites) are highly susceptible to attack (Mitchell 1966).

Based on the review of the FPM aerial survey maps, balsam woolley adelgid activity is light to moderate in this watershed. The occurrences of this insect are generally scattered in a wide distribution across the watershed. It has been documented most often at the upper elevations in the Laughingwater Creek and Panther Creek drainages, as well as on the Cowlitz Divide, Coal Creek Mountain, Tatoosh Range, and White Pass.

The majority of the documented occurrences have been characterized as having caused light damage, with an occasional level of moderate damage. The nature of the damage/mortality in patches of infestation is such that not every tree in the patch is damaged or killed.

Douglas-fir Beetle (Dendroctonus pseudotsugae)

The Douglas-fir beetle is a native insect that occurs throughout the range of Douglas-fir. It is considered the most important bark beetle which causes mortality in Douglas-fir. Douglas-fir bark beetles attack a tree by boring a tunnel through the bark, where they live and mine between the bark and the wood. A tree is killed when a large number of beetles attack it and effectively girdle it.

The greater portion of tree mortality is a result of endemic infestations, continually present in mature forests, where the beetle inhabits diseased (especially root-diseased trees), felled, or damaged trees. This normal mortality can be large in number, but is usually widely scattered. Epidemic outbreaks generally develop when conditions are adverse for the host tree, as in drought periods or defoliation by other agents, or when an abundance of favorable breeding material is available to the beetles, as in extensive windthrow or large wildfires. Epidemic outbreaks can spread over large areas and kill vast numbers of apparently healthy trees. In the coastal Douglas-fir region of western Washington, outbreaks are sporadic and of short duration, but can kill large numbers of trees. These outbreaks are usually connected to windthrow or wildfire events, although relatively small outbreaks can be a result of localized root disease infections. Host tree resistance usually keeps the Douglas-fir beetle under control most of the time. But even when outbreaks occur, following stand disturbance by fire, wind, or disease, they abruptly subside because the beetles do not thrive in normal, vigorous trees (Furness, *et al.* 1977).

The occurrences of Douglas-fir beetle are generally scattered across the watershed where Douglas-fir is dominant. They have been documented most often at the middle to lower elevations in the Muddy Fork Cowlitz River, Ohanapecosh River, Laughingwater Creek, and Clear Fork Cowlitz River drainages, as well as the Backbone Ridge area separating the Muddy Fork Cowlitz River and Ohanapecosh River drainages.

The majority of the documented occurrences can be characterized as having caused light mortality, with an occasional level of moderate mortality. Most of the Douglas-fir beetle activity has occurred from 1989 through 1994. This activity is sometimes linked directly to laminated root rot infections.

Generally, the patches of Douglas-fir beetle mortality range from less than a quarter acre to 10 acres in size (rough estimates based on FPM aerial survey sketch maps and local experience), with most being less than one acre. Not every tree in these patches dies.

Disease

Currently, based on the TRI Pest Management Subsystem and Forest Pest Management Pest Evaluations, the disease that has been observed causing the most notable damage to trees in the watershed over the last 20 years is laminated root rot (caused by *Phellinus weirii*). There are, without doubt, other disease agents (e.g., Armillaria root disease, dwarf mistletoe, annosus root disease, white pine blister rust, and various butt/stem rots) present and working in the watershed, but there was not sufficient time and/or data to determine the level of their presence and activity.

Laminated Root Rot (Phellinus weirii)

This native disease is one of the most damaging and difficult diseases to control in Pacific Northwest conifer forests. Hundreds of thousands of acres are affected and it is estimated to cause an annual loss of 32 million cubic feet of tree volume. At least 5 percent, possibly as much as 10 percent, of the forested area of Oregon and Washington are thought to be infected (Hadfield 1985). Trees of all ages and sizes are susceptible to infection, but damage is most obvious in stands 20 to 150 years of age.

Laminated root rot is capable of infecting a wide range of conifer species, but in this watershed its most susceptible hosts are Douglas-fir, Pacific silver fir, and mountain hemlock. Laminated root rot can be considered a disease of the site. Because of its persistence and spread from one generation to the next, the fungus has the potential to greatly reduce site productivity.

Laminated root rot centers often appear as roughly circular patches of dead and dying trees, but in some stands may have a diffuse distribution that is difficult to detect. Infected trees may be windthrown or broken at the base, but usually die standing. Infection centers west of the crest of the Cascade Range are usually smaller than one acre, but it is not uncommon for them to be 5 to 10 acres in size, and sometimes even larger. The fungus survives for long periods (50 years or more) in infected stumps and snags. It spreads from tree to tree and to the next generation via root grafts and contacts.

The exact locations and extent of this disease in the watershed is not well known, with the exception of a few areas that have been surveyed and mapped (USDA Forest Service 1987). The Pest Management Subsystem currently documents its existence in young managed stands (previous clearcuts), as well as in older stands in the watershed. It is most common in the areas dominated by Douglas-fir below about 3000 feet in elevation, although it is also found occasionally in Pacific silver fir and mountain hemlock at the higher elevations in the watershed. Most of the documented infections on Forest Service land are in the central southwest portion of the watershed (Purcell Creek, Dam Creek, lower Muddy Fork Cowlitz River, lower Ohanapecosh River, lower Summit Creek, lower Carlton Creek, lower Cortright Creek, and lower Clear Fork Cowlitz River). There is no data on disease occurrence on the private lands in the watershed, but the amount of private land (109 acres total) is very minor. There is also no data on disease occurrence in Mt. Rainier National Park, but it's very probable that laminated root rot occurs there, especially in the lower portions of the Muddy Fork Cowlitz River and Ohanapecosh River valleys.

The Pest Management Subsystem records laminated root rot in 19 young managed stands in the watershed. In addition, it records 29 infection centers in older natural stands. Those natural-stand infection centers range widely in size (from less than 0.5 acres to 1 to 5 acres, to some being as large as 10 to 20 acres in size). These are the only recorded occurrences of laminated root rot, but it is an absolute certainty that more exists than is shown on the Pest Management Subsystem. The severity of the damage caused by the disease in the areas of documented infection varies from very low to severe, with approximately 42 percent being very low (incidental/insignificant damage) to moderate (intermediate damage), and approximately 58 percent being high (significant and increasing damage) to severe (extreme damage).

Windthrow

Data Sources/Data Gaps

- The primary data source for information on windthrow is aerial photo sets from 1973, 1985, 1989, and 1993. Those photos, covering discrete points-in-time, do not easily allow the discovery of windthrow that occurred between those points-in-time.
- The 1973 aerial photos are the earliest data available for this watershed. There is no reliable information (photographic or otherwise) concerning windthrow in the watershed prior to 1973.

Assumptions

- A quick review of past and current aerial photos is sufficient to draw some conclusions about windthrow activity in the watershed.

Reference (Historic) and Current Conditions

We have no knowledge or data about historic windthrow events in this watershed prior to the early-1970's. The only thing we can say is that windthrow events have very likely occurred in this watershed for as long as it has been forested.

Wind is a natural, but elusive, part of the forest ecosystem. It serves as an agent of disturbance across the landscape when it becomes strong enough to topple trees. In this manner, wind becomes a part of the natural recycling of forest stands; playing an important role in maintaining and renewing the forest ecosystem. Wind is always present in the ecosystem, usually at levels low enough not to cause the windthrow of trees. The amount of windthrow caused by the wind can vary greatly from a few, scattered individual trees to large, contiguous patches of several hundred acres.

The actions of the wind, manifested as windthrow, affect and participate in a wide array of ecosystem relationships. Windthrow fosters diversity in the ecosystem by altering stand structure. Windthrow can affect forest succession, soil, wildlife, fish, and the safety of people and structures.

Windthrow Events (location and size)

A quick review of the aerial photos revealed many separate windthrow patches in the watershed over the past 25 years. Windthrow patch size was less than 5 acres most of the time, with a few being 5 to 10 acres in size, and a few greater than 10 acres in size (one being approximately 20 acres in size).

In addition to identifiable patches of windthrow on the aerial photos, there have been a large number of single trees or very small groups of trees that have blown down in the watershed over the years (events not usually identifiable on the photos).

No attempt was made to determine patterns or concentrations (related to locations in the watershed) of windthrow to try and deduce where future windthrow is most likely to occur, but based on a quick review, it seemed to occur most often in the central southwest portion of the watershed where the majority of the clearcut harvesting has taken place. It most often occurred in the Cortright Creek drainage (sixth-field 01I), the Dam Creek (sixth-field 01N)/Lava Creek (lower portion of sixth-field 01K) drainages, and the Summit Creek drainage (sixth-field 01D). There have also been some small windthrow events in the vicinity of White Pass (upper end of sixth-field 01K).

Windthrow Events (weather and timing)

Storms associated with windthrow events in this watershed probably involved gale-force and storm-force winds during the fall and winter months (November through February), very often associated with heavy rainfall. There are several categories of gale-force winds and one category of storm winds. The wind speed associated with these categories ranges from 32 miles per hour to 72 miles per hour.

Information from Harris (1989) and Savill (1983) indicates that windthrow events generally begin to occur when wind speeds reach gale-force or higher. In addition to windspeed, wet, saturated soils from heavy or prolonged rainfall (preceding and during a storm) can be an important contributing factor to windthrow. Rain saturated soils can contribute to windthrow occurring at lower windspeeds, which under drier conditions probably wouldn't produce windthrow.

The occurrence of windthrow events is tied directly to storm events in the watershed. Determining the exact timing, intensity, and scope of storm events in the watershed is difficult at best because no local records have been kept documenting them, especially in relation to any windthrow that might have been associated with them. While many windthrow events west of the Cascade Range are usually linked to strong storms that blow in from the south or southwest, it is very possible that many of the windthrow events that have occurred in this watershed were a result of strong east winds, especially due to this area's proximity to the crest of the Cascade Range, and the east-west orientation of the drainages that have experienced most of the windthrow.

Windthrow and Management Activities

The principal management activities that have occurred in the watershed are timber harvest (mostly regeneration harvest by clearcutting, some partial cut salvage, some regeneration by shelterwood, and commercial thinning), road construction, precommercial thinning, and hiking trail construction. No windthrow was identified as being associated with precommercial thinning or hiking trails.

Based on local experience, a substantial amount of individual-tree and small-group-tree windthrow is probably associated with road edges. It is not known exactly how much of this type of road-related windthrow occurs, due to the lack of data. Harris (1989) indicates that other studies have shown that greater concentrations of windthrow are associated with roads. In a dense, 90-year-old spruce-hemlock stand at Cascade Head Experimental Forest in Oregon, McComb and Munger found in a 1940 study that over four times as much windfall occurred within 100 feet of roads as in the zone 100 to 200 feet from the roads.

The majority of the windthrow observed on the aerial photos (approximately 85%) was directly related to the edges of clearcuts. Only about 15% of the windthrow events occurred away from clearcut edges. There was no obvious windthrow identified (via aerial photo interpretation) as being associated with shelterwoods or commercial thinnings, but only minor amounts of those two types of harvest have occurred in the watershed.

Forest Vegetation

Forest Zones

Data Sources/Data Gaps

For Forest Service land, the data sources for production of the forest zones map were the Gifford Pinchot National Forest ecology plot data and the GPVEG (Gifford Pinchot Vegetation) database. For forest zone coverage of the private/National Park lands the data sources included Mt. Rainier National Park forest zone data, aerial photo interpretation, on-the-ground knowledge of Forest Service personnel, and knowing which forest zones are located on Forest Service lands immediately adjacent to the private/National Park lands.

Assumptions

For the purposes of this large-scale analysis, the forest zones are reasonably accurate given the time allowed and method used to determine their boundaries. It is assumed that the boundaries and acreages of the forest zones have not changed over the last several hundred years.

Reference (Historic) and Current Conditions

Terrestrial ecosystems develop and are affected by the influences of geology, landform, climate, and soils. Natural plant communities reflect these influences on the ecosystem. As a way of classifying these plant communities, forested ecosystems are divided into smaller systems (called forest series or forest zones) based on the climax tree species (i.e., potential natural vegetation) on a site. The four forest zones found in the Clear Fork Cowlitz River fifth-field watershed are typical of those found in the southern Cascades of Washington State. Those four zones are:

Western Hemlock Zone -- *Tsuga heterophylla* (TSHE)
Pacific Silver Fir Zone -- *Abies amabalis* (ABAM)
Mountain Hemlock Zone -- *Tsuga mertensiana* (TSME)
Subalpine Fir Zone -- *Abies lasiocarpa* (ABLA)

Table 3-11 below displays the number of acres (forest and non-forest) comprising each of the forest zones across the watershed. For a visual display of each zone's distribution across the watershed, see Map 8, Forest Zones.

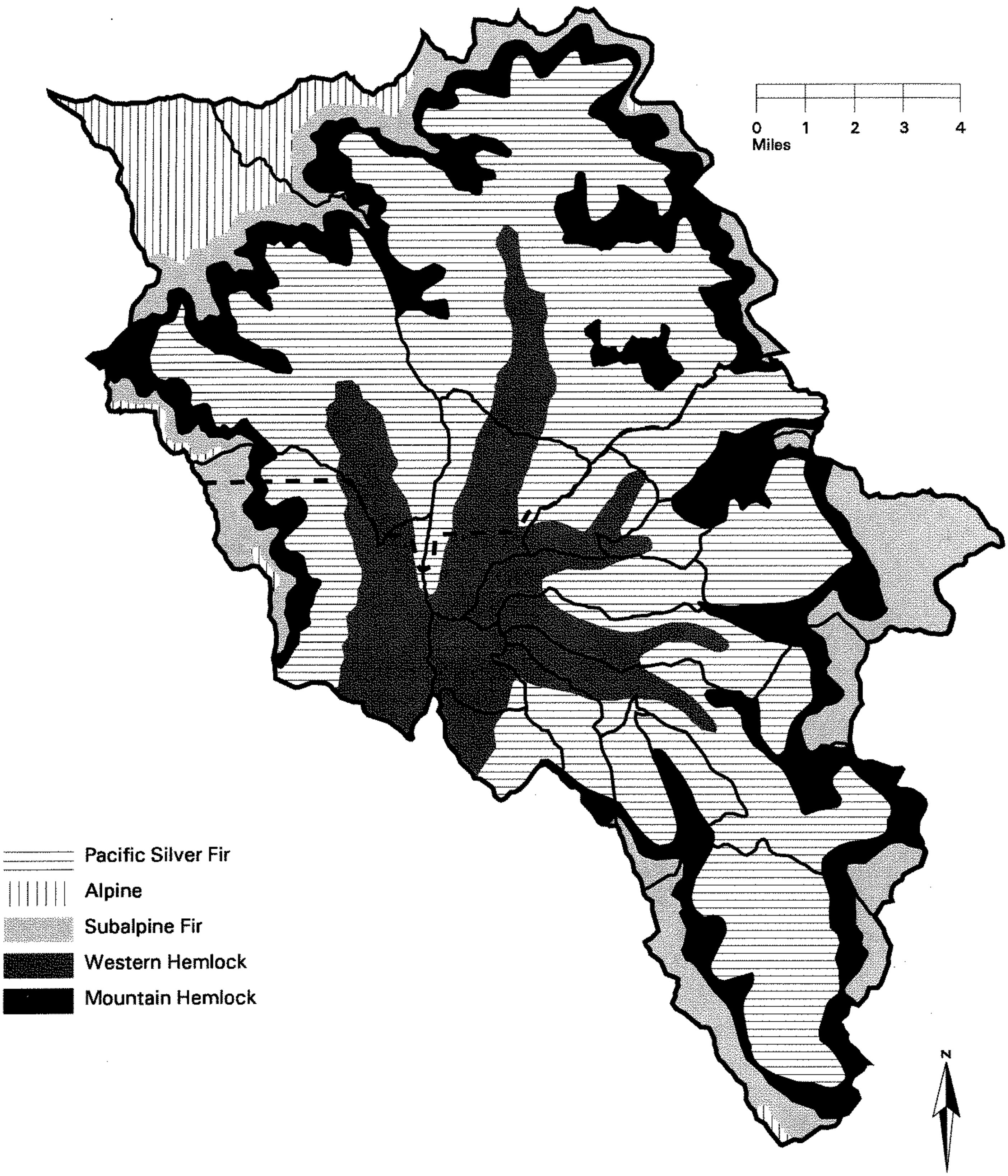
Table 3-11: Forest Zones by Forest and Non-Forest Acres

Zone	**Forest**		**Non-Forest**	
	Acres	(%)	Acres	(%)
Western Hemlock	17,743	13	2,117	1
Pacific Silver Fir	52,002	38	13,910	10
Mountain Hemlock	13,112	9	13,535	10
Subalpine Fir	5,603	4	11,885	9
Alpine	0	0	7,998	6
Totals	88,460	64	49,445	36

Map 8

CLEAR FORK WATERSHED ANALYSIS

Forest Zones



Western Hemlock Zone

This forest zone includes the lower elevation, warm and moist forests. It is the most environmentally moderate zone of the four forested zones found in this watershed. Its upper elevation occurs at about 3,000 feet where it begins to transition into the Pacific Silver Fir Zone. The Western Hemlock Zone covers the third largest portion of the watershed. It is located primarily in the central portion of the watershed around the confluence of the Muddy Fork Cowlitz, Ohanapecosh, and Clear Fork Cowlitz Rivers, with narrow arms extending up those river valleys, as well as a short way up Carlton Creek, Summit Creek, and Cortright Creek. It covers 19,860 acres (14%) of the watershed, with 17,743 of those acres being productive forest land, and 2,117 acres being non-forest land.

Pacific Silver Fir Zone

This forest zone includes the mid to upper elevation, cool and moist forests. It occupies sites of upper elevation between approximately 3000 to 4500 feet where it begins to transition into the Mountain Hemlock Zone. The Pacific Silver Fir Zone covers the largest portion of the watershed (Map 8, Forest Zones) and occurs throughout most portions of the watershed. It covers 65,912 acres (48%) of the watershed, with 52,002 of those acres being productive forest land, and 13,910 acres being non-forest land.

Mountain Hemlock Zone

This forest zone includes the upper elevation, cold forest environments. It occupies sites of high elevation between approximately 4,500 to 5,600 feet where it begins to transition into the Subalpine Fir Zone. The Mountain Hemlock Zone covers the second largest portion of the watershed. It is located primarily in narrow bands near the edges of the watershed in the Goat Rocks Wilderness, Tatoosh Wilderness, and Mt. Rainier National Park. It covers 26,647 acres (19%) of the watershed, with 13,112 of those acres being productive forest land, and 13,535 acres being non-forest land.

Subalpine Fir Zone

This forest zone includes the upper elevation forests in very cold environments. It occupies sites at very high elevations, from about 5,600 feet upward to the tree line. This zone covers the fourth largest portion of the watershed. It is located primarily in narrow bands on the edges of the watershed in the Goat Rocks Wilderness, Tatoosh Wilderness, and Mt. Rainier National Park.

It covers 17,488 acres (13%) of the watershed, with 5,603 of those acres being productive forest land, and 11,885 acres being non-forest land.

Alpine Zone

The non-forest communities that occur at elevations above tree line make up the remainder of the watershed acreage, covering 7,998 acres (6%). The alpine communities are located primarily in Mt. Rainier National Park on the upper southeast flanks of Mt. Rainier, with some minor alpine acreage also occurring in the Tatoosh Range and near Elk Pass in the Goat Rocks Wilderness.

For more detailed information on the four forest zones, refer to the Gifford Pinchot National Forest Plant Association and Management Guide for the Western Hemlock Zone (Topik *et al.* 1986), the Gifford Pinchot National Forest Plant Association and Management Guide for the Pacific Silver Fir Zone (Brockway *et al.* 1983), and the Gifford Pinchot National Forest Plant Association and Management Guide for the Mountain Hemlock Zone (Diaz *et al.* 1997).

Vegetation Structural Stages

Data Sources/Data Gaps

- The primary source for current vegetation descriptions on Forest Service land is the Gifford Pinchot National Forest GPVEG (Gifford Pinchot Vegetation) database. The GPVEG database was initially installed in 1993-94 and is updated annually. The GPVEG data is based on a mixture of stand exam data (of various ages), aerial photo interpretation (especially in the Wilderness areas), and on-the-ground knowledge of Forest Service personnel. The GPVEG database is reasonably accurate, but it is highly probable that some of the data is not accurate (due to such things as poor aerial photo interpretation, outdated stand exam data, input errors, etc.).

- The primary source for current vegetation descriptions on private/National Park lands is the Washington State Department of Natural Resources (DNR) GIS vegetation map classified by Pacific Meridian Resources. The DNR data is based on remote sensing using 1988 satellite photography that, because of its age, does not reflect changes in vegetation that have occurred since 1988. In addition, the classification of the vegetation is suspect in many cases.

- Reconstruction of historic vegetation conditions relied on known current stand information (e.g., stand year-of-origin), observation of aerial photos, and on-the-ground knowledge of

Forest Service personnel. There are very few sources of historic stand information available for this watershed, and what is available is of very limited usefulness.

Assumptions

- The GPVEG database (and the resultant vegetation classification based on that database) is reasonably accurate, while the DNR database is passably accurate; both providing a general description of current vegetation structure that is accurate enough for this large-scale analysis.
- Riparian vegetation is often different than upland vegetation in size, structure, and species composition; but for the purposes of this analysis it will be considered the same.
- Before 1930, fire (natural and man-caused) was the most significant disturbance that caused stands to revert to a grass/pole (early) structural stage in this watershed.
- The classification of historic vegetation structure is reasonably accurate for this large-scale analysis. There are undoubtedly errors in the classification due to the lack of historic vegetation information.

Reference (Historic) and Current Conditions

In this watershed analysis, we are describing forest vegetation structural stages at two points in time to illustrate and compare historic and current situations across the watershed. The year 1880 was chosen as the historic point in time, with 1998 being the current point in time. The historic forest vegetation structural stages were reconstructed by reclassifying the structural stages of the current vegetation polygons based on their current age, aerial photos, and on-the-ground knowledge of Forest Service personnel. The year 1880 serves as a "snapshot" of the vegetation in the watershed when the landscape had not yet been significantly altered by Euro-American settlers.

The range of vegetation characteristics and conditions in the watershed results from succession and disturbance (both natural and human-induced). Structural stages describe and define this range of vegetation characteristics and conditions. Four broad structural stages were defined for this watershed: grass/pole, small tree, large tree, and non-forest. The four stages are defined somewhat differently for Forest Service land and private/National Park lands. The definitions for both situations are described below.

Forest Service Land - The four structural stage categories on National Forest land are defined as follows:

Grass/pole forest - One-storied forest stands whose trees range in size from seedlings (less than 4.5 feet tall) to poles less than 9.0" dbh.

Small tree forest - One- or two-storied forest stands of 9.0" dbh up to 18.0" dbh (for the Pacific Silver Fir, Mountain Hemlock, and Subalpine Fir Zones) or 20.9" dbh (for the Western Hemlock Zone).

Large tree forest - One-, two-, or more-storied forest stands greater than 18.0" dbh, or equal to or greater than 21.0" dbh (depending on the forest zone).

Non-forest - Rock, water, avalanche chutes, administrative sites with little or no vegetation, meadows, grasslands, forblands, and shrublands.

Private/National Park Lands - The four structural stage categories on private/National Park lands are defined as follows:

Grass/pole forest - Forested stands with >10% crown closure of conifers, but <70% crown closure of conifers and <75% hardwood shrub cover, or other lands in forested areas with <10% crown closure of conifers or >75% hardwood crown closure.

Small tree forest - Forested stands with >70% crown closure of conifers, with <10% crown closure in trees greater than 21" dbh and <75% hardwood shrub cover.

Large tree forest - Forested stands with >70% crown closure of conifers, with >10% crown closure in trees greater than 21" dbh and <75% hardwood shrub cover.

Non-forest - Urban land, agricultural land, rangeland, barren, and glaciers.

Historic Vegetation: Amount, Distribution, and Location

The amount of historic (1880) grass/pole, small tree, and large tree forest vegetation (and areas of non-forest) in the watershed is shown by ownership in Table 3-12 below. In 1880, the acres of forest land in this watershed were dominated by stands with small tree and large tree structural stages.

Table 3-12: Historic (1880) Vegetation by Structural Stage and Ownership (USFS and Private/National Park)

Structural Stage	USFS Acres (%)	Private Acres (%)	National Park	Total Acres (%)
Grass/Pole	7,544 (10)	0 (0)	5,727 (9)	13,271 (10)
Small Tree	32,518 (46)	78 (71)	12,774 (19)	45,370 (33)
Large Tree	11,830 (17)	16 (15)	18,285 (27)	30,131 (22)
Non-Forest	18,900 (27)	15 (14)	30,218 (45)	49,133 (35)
Totals	70,792 (100)	109 (100)	67,004 (100)	137,905 (100)

For a more detailed listing of the amounts and distribution of historic vegetation structure by sixth-field subbasin see Appendix B: A Comparison of Historic and Current Vegetation by Structural Stage and Sixth-field Subbasins.

The amount of historic grass/pole, small tree, and large tree forest vegetation on productive forest land in the watershed is displayed by forest zone and ownership in Table 3-13 below. See Map 9, Historic (1880) Vegetation Structure, for a visual display of the historic vegetation structure.

Table 3-13: Historic (1880) Vegetation by Structural Stage and Forest Zone (USFS and Private/National Park)

Forest Zone	Grass/Pole Acres (%)	Small Tree Acres (%)	Large Tree Acres (%)	Total Acres (%)
W. Hem (FS)	3,483 (26)	7,407 (16)	1,354 (5)	
(P)	0 (0)	29 (<1)	0 (0)	
(NP)	1,845 (14)	2,207 (5)	1,454 (5)	17,779 (20)
P SilvFir (FS)	1,821 (14)	14,500 (32)	9,520 (32)	
(P)	0 (0)	48 (<1)	16 (<1)	
(NP)	3,866 (29)	8,272 (18)	14,020 (47)	52,063 (59)
Mt. Hem (FS)	887 (7)	6,759 (15)	932 (3)	
(P)	0 (0)	0 (0)	0 (0)	
(NP)	16 (<1)	2,212 (5)	2,515 (8)	13,321 (15)
SAlp Fir (FS)	1,353 (10)	3,853 (9)	26 (<1)	
(P)	0 (0)	0 (0)	0 (0)	
(NP)	16 (0)	83 (<1)	294 (<1)	5,609 (6)
Totals	13,271 (100)	45,370 (100)	30,131 (100)	88,772*(100)

* This represents the number of historic productive forest land acres in the watershed.
Total watershed acres = 137,905 Non-forest watershed acres = 49,133
(FS) = USFS land (P) = Private land (NP) = National Park land

Grass/Pole

At 13,271 acres, the grass/pole forest had the smallest number of acres of the three forested structural stages (15% of the watershed's productive forest land). Most of the grass/pole forest (43% or 5,687 acres) was located in the Pacific Silver Fir Zone and the Western Hemlock Zone (40% or 5,328 acres).

Grass/pole forest occurred in many of the sixth-field watersheds, but was most prominent (in terms of acres relative to other sixth-fields) in sixth-fields 01A (5,370 acres - Lower Muddy Fork Cowlitz River), 01T (5,190 acres - Upper Muddy Fork Cowlitz River), and 01J (1,173 acres - Upper Cortright Creek).

Grass/pole forest did not exist in sixth-fields 01H (Cyrenus Creek), 01I (Lower Cortright Creek), 01M (Purcell Creek), 01Q (Little Lava Creek), and 01S (Upper Ohanapecosh River) and was a very minor component in sixth-fields 01F (4 acres - Lower Carlton Creek), 01D (12 acres - Lower Summit Creek), 01G (14 acres - Upper Carlton Creek), and 01P (26 acres - Lava Creek).

Small Tree

At 45,370 acres, the small tree forest had the largest number of acres of the three forested structural stages (51% of the watershed's productive forest land). Much of the small tree forest (50% or 22,820 acres) was located in the Pacific Silver Fir Zone.

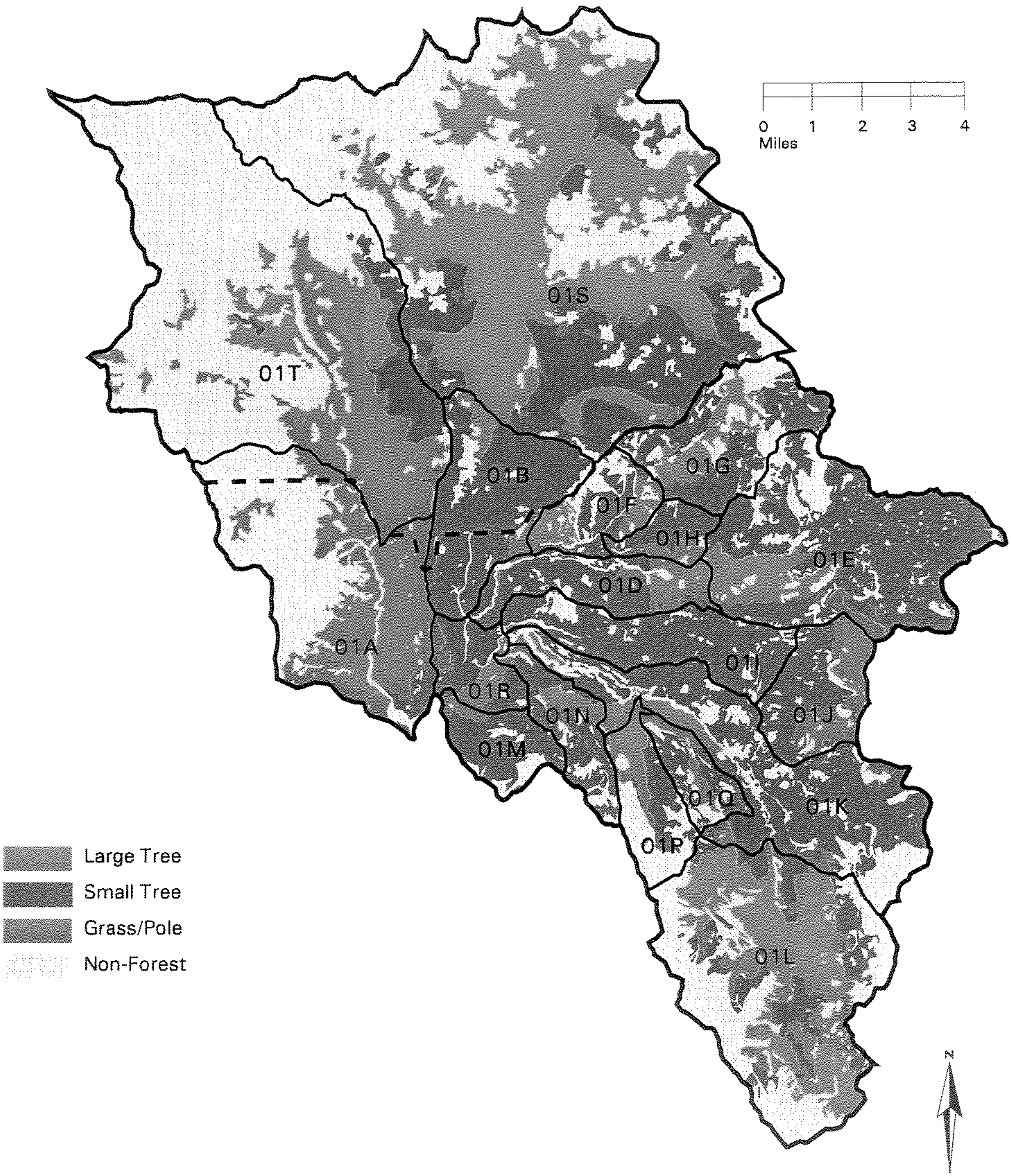
Small tree forest occurred in each of the sixth-fields, but was most prominent (in terms of acres relative to other sixth-fields) in sixth-fields 01S (8,069 acres - Upper Ohanapecosh River), 01E (6,712 acres - Upper Summit Creek), 01K (5,730 acres - Lower Clear Fork Cowlitz River), 01B (4,243 acres - Lower Ohanapecosh River), and 01I (3,474 acres - Lower Cortright Creek).

Small tree forest was least prominent in sixth-fields 01A (330 acres - Lower Muddy Fork Cowlitz River) and 01P (686 acres - Lava Creek).

Map 9

CLEAR FORK WATERSHED ANALYSIS

Historic (1880) Vegetation Structure



Large Tree

At 30,131 acres, the large tree forest covered 34% of the watershed's productive forest land; the largest patch being located in sixth-field 01S (Upper Ohanapecosh River) in Mt. Rainier National Park. Most of the large tree forest (78% or 23,556 acres) was located in the Pacific Silver Fir Zone.

Large tree forest occurred in all but two of the sixth-fields and was most prominent (in terms of acres relative to other sixth-fields) in sixth-fields 01S (15,953 acres -- Upper Ohanapecosh River) and 01L (5,046 acres -- Upper Clear Fork Cowlitz River).

Large tree forest did not exist in sixth-fields 01A (Lower Muddy Fork Cowlitz River) and 01J (Upper Cortright Creek), and was a very minor component in sixth-fields 01I (9 acres - Lower Cortright Creek) and 01M (157 acres - Purcell Creek).

Historic Landscape Patterns: Patch Size, Shape, Spatial Arrangement and Connectivity

No detailed analysis was performed to calculate statistics concerning historic vegetation landscape patterns. Therefore, a basically qualitative description is provided here, based on Map 9, Historic (1880) Vegetation Structure.

In 1880, small tree forest and large tree forest structural stages were the most dominant forest vegetation across the watershed, with the non-forest areas also being very significant.

Most of the small tree forest was located in the east-central portion of the watershed; east of Backbone Ridge, south of Panther Creek, and north of Knuppenberg Lake and Coal Creek Mountain. It was concentrated in one very large, somewhat contiguous matrix imbedded with several smaller (700-2,500 acres in size), somewhat linear patches of large tree forest, and even smaller areas of non-forest structure. The remainder of the small tree forest was located in relatively small patches (less than 500 acres in size) scattered throughout the southeast tip and northeast corner of the watershed.

Almost all of the large tree (late-successional) forest was spread widely across the watershed from north to south (east of Backbone Ridge and the Cowlitz Divide) in several well-defined, contiguous patches (many being somewhat linear in shape) separated by large swaths of small tree forest. The large tree patches ranged widely in size (from about 700 acres to several thousand acres), with some being imbedded within small areas of non-forest.

Most of the grass/pole forest was contained in one very large, somewhat linear patch (approximately 10,500 acres in size) located just west of Backbone Ridge and the Cowlitz

Divide. This large patch of grass/pole forest was the result of a wildfire in the 1860's. Much of the rest of the grass/pole forest was located in another linear patch of approximately 1,400 acres on the east boundary of the watershed in the vicinity of Sand Lake and Cortright Point. The remainder of the grass/pole forest was located in small patches (less than 200 acres in size) scattered throughout the southeast corner and near the west edge of the watershed.

Patches of forest vegetation in 1880 were often fragmented by areas of natural non-forest structure (rock, meadows, shrublands, wetlands, etc.). Most of the natural fragmentation by non-forest areas occurred in the small tree forest patches. The forest patches in 1880 were generally large with irregular shapes and irregular, sinuous edges. They tended to be somewhat linear in shape (but not in all cases) and mostly well-connected, although natural fragmentation by non-forest areas (non-forest areas represent a significant acreage in the watershed) reduced forest connectivity in some portions of the watershed. The larger forest patches ranged in size from about 2,500 acres to tens of thousands of acres. The smaller forest patches ranged in size from less than 10 acres to 1,600 acres.

Some additional descriptors of landscape pattern are stability, grain, edge, and contrast (Diaz and Apostol 1992). Stability of the landscape pattern is defined as the likelihood that the pattern will change significantly (in composition, physical features, etc.) over time, and the rate of that change. Grain is the average size of landscape elements: the "texture" of the landscape. Edge is the interface between landscape elements of different composition and structure. Contrast is the degree to which adjacent landscapes differ from each other, with respect to species composition and physical attributes.

The 1880 landscape pattern was a moderately stable, moderately-grained landscape pattern with moderate to moderately high amounts of edge and contrast. Much of the edge and contrast in this landscape is attributed to the amount, size, shape, and distribution of non-forest areas.

In 1880, much of the watershed east of Backbone Ridge and Cowlitz Divide was moderately diverse in terms of forest patch size, structural stages (mix of grass/pole, small tree, large tree, and non-forest), and patch shape, with the exception of a general lack of grass/pole forest. The watershed west of Backbone Ridge and Cowlitz Divide had much less diversity of patch size, structural stages, and patch shape and was dominated by two very large patches: one of grass/pole forest, the other a non-forest patch (the upper flanks of Mt. Rainier and Tatoosh Ridge).

Current Vegetation: Amount, Distribution, and Location

The amount of current (1998) grass/pole, small tree, and large tree forest vegetation (and areas of non-forest) in the watershed is shown by ownership in Table 3-14. Currently, the acres of forest land in this watershed are dominated by stands with large tree structure.

Table 3-14: Current (1998) Vegetation by Structural Stage and Ownership (USFS and Private/National Park)

Structural Stage	USFS Acres (%)	Private Acres (%)	National Park	Total Acres (%)
Grass/Pole	6,200 (9)	53 (48)	1,145 (2)	7,398 (5)
Small Tree	18,400 (26)	28 (26)	966 (1)	19,394 (14)
Large Tree	27,038 (38)	13 (12)	34,617 (52)	61,668 (45)
Non-Forest	19,154 (27)	15 (14)	30,276 (45)	49,445 (36)
Totals	70,792 (100)	109 (100)	67,004 (100)	137,905 (100)

For a more detailed listing of the amounts and distribution of current vegetation structure by sixth-field see Appendix B: A Comparison of Historic and Current Vegetation by Structural Stage and Sixth-field Subbasins.

The amount of current grass/pole, small tree, and large tree forest vegetation on productive forest land in the watershed is shown by forest zone and ownership in Table 3-15. See Map 10, Current (1998) Vegetation Structure, for a visual display of the current vegetation structure.

Table 3-15: Current (1998) Vegetation by Structural Stage and Forest Zone (USFS and Private/National Park)

Forest Zone	Grass/Pole Acres (%)	Small Tree Acres (%)	Large Tree Acres (%)	Total Acres (%)
W. Hem (FS)	2,870 (39)	2,616 (13)	6,723 (11)	
(P)	3 (<1)	12 (<1)	13 (<1)	
(NP)	0 (0)	137 (1)	5,369 (9)	17,743 (20)
P SilvFir (FS)	2,923 (40)	6,247 (32)	16,660 (27)	
(P)	49 (1)	16 (<1)	0 (0)	
(NP)	747 (10)	740 (4)	24,620 (40)	52,002 (59)
Mt. Hem (FS)	328 (4)	4,628 (24)	3,420 (6)	
(P)	0 (0)	0 (0)	0 (0)	
(NP)	393 (5)	89 (<1)	4,254 (7)	13,112 (15)

Table 3-15: Current (1998) Vegetation by Structural Stage and Forest Zone (USFS and Private/National Park)				
Forest Zone	**Grass/Pole Acres (%)**	**Small Tree Acres (%)**	**Large Tree Acres (%)**	**Total Acres (%)**
SAlp Fir (FS)	80 (1)	4,909 (25)	235 (<1)	
(P)	0 (0)	0 (0)	0 (0)	
(NP)	5 (<1)	0 (0)	374 (<1)	5,603 (6)
Totals	7,398 (100)	19,394 (100)	61,668 (100)	88,460*(100)

* This represents the number of current productive forest land acres in the watershed.
Total watershed acres = 137,905 Non-forest watershed acres = 49,445
(FS) = USFS land (P) = Private/State (NP) = National Park land

Grass/Pole

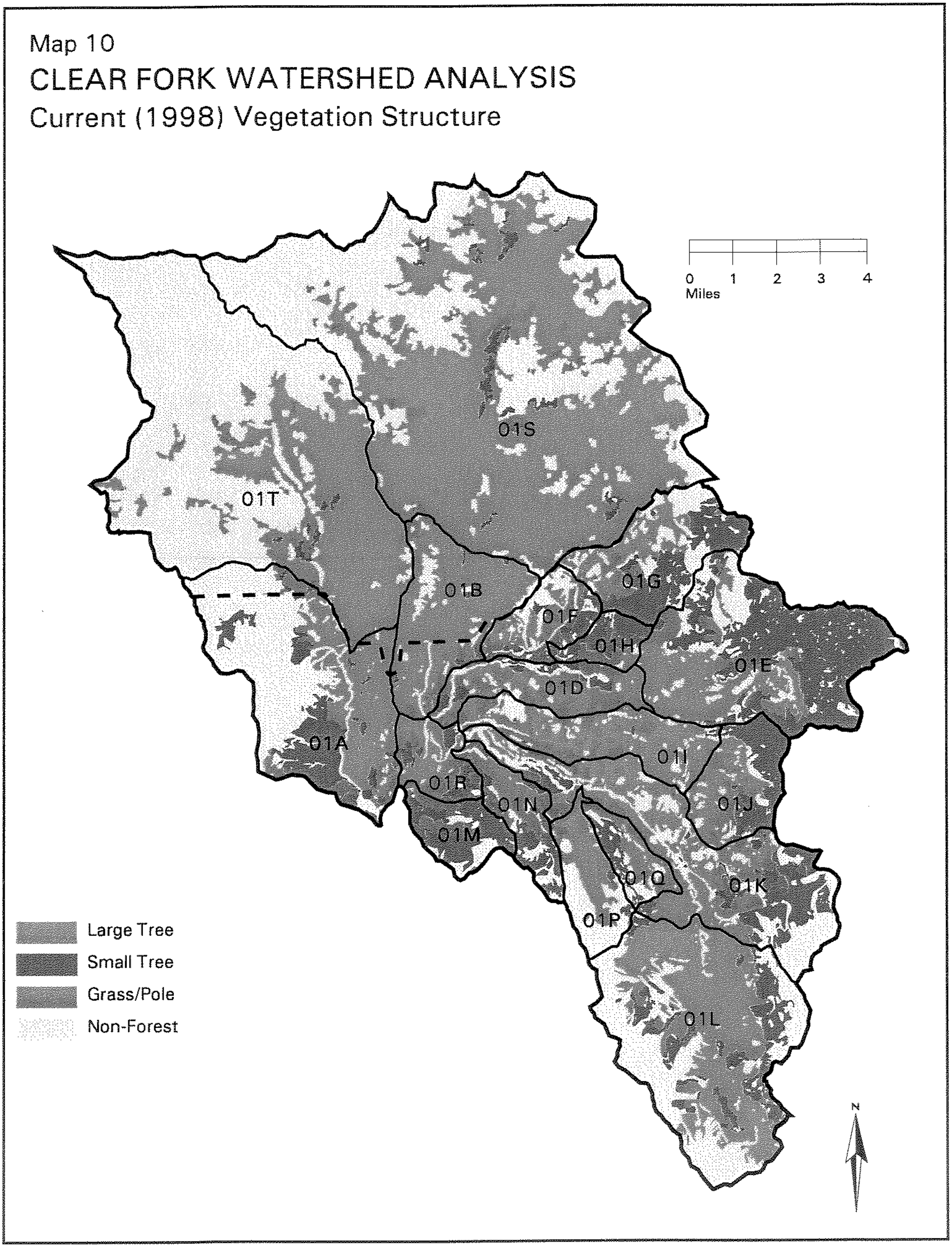
At 7,398 acres, the grass/pole forest has the smallest number of acres of the three forested structural stages (8% of the watershed's productive forest land). Grass/pole forest is concentrated on U.S. Forest Service land in the central southwest portion of the watershed (from Purcell Creek northeast to upper Carlton Creek). Most of the grass/pole forest is equally divided between the Pacific Silver Fir Zone (2,923 acres or 40%) and Western Hemlock Zone (2,870 acres or 39%).

Grass/pole forest occurs in each of the sixth-field watersheds, but it is most prominent (in terms of acres relative to other sixth-fields) in sixth-fields 01I (Lower Cortright Creek - 973 acres), 01D (Lower Summit Creek - 907 acres), 01S (Upper Ohanapecosh River - 881 acres), 01K (Lower Clear Fork Cowlitz River - 747 acres), and 01N (Dam Creek - 695 acres).

Grass/pole forest is the least prominent in sixth-fields 01L (Upper Clear Fork Cowlitz River - 51 acres), 01Q (Little Lava Creek - 70 acres), 01P (Lava Creek - 120 acres), 01G (Upper Carlton Creek - 132 acres), 01T (Upper Muddy Fork Cowlitz River - 197 acres), and 01A (Lower Muddy Fork Cowlitz River - 198 acres).

Small Tree

At 19,394 acres, the small tree forest covers 22% of this fifth-field watershed's productive forest land. Most of the small tree stands are scattered through the southeast half of the watershed, with the largest contiguous patch being located along the east edge of the watershed, just north of


Map 10
CLEAR FORK WATERSHED ANALYSIS
Current (1998) Vegetation Structure
0
1
2
3
4
Miles
01S
01T
01B
01G
01F
01H
01E
01D
01A
01I
01R
01N
01J
01M
01Q
01K
01P
01L
Large Tree
Small Tree
Grass/Pole
Non-Forest
N

White Pass in the William O. Douglas Wilderness. Much of the small tree forest is equally divided between the very high elevation Subalpine Fir Zone (4,909 acres or 25%) and Mountain Hemlock Zone (4,717 acres or 24%), with a substantial portion located in the high elevation Pacific Silver Fir Zone (7,003 acres or 36%).

Small tree forest occurs in each of the sixth-field subbasins, but it is most prominent (in terms of acres relative to other sixth-fields) in sixth-fields 01E (Upper Summit Creek - 5,081 acres), 01A (Lower Muddy Fork Cowlitz River - 1,936 acres), 01K (Lower Clear Fork Cowlitz River - 1,878 acres), 01L (Upper Clear Fork Cowlitz River - 1,863 acres), and 01G (Upper Carlton Creek - 1,856 acres).

Small tree forest is least prominent in sixth-fields 01I (Lower Cortright Creek - 58 acres), 01B (Lower Ohanapecosh River - 132 acres), 01P (Lava Creek - 149 acres), and 01T (Upper Muddy Fork Cowlitz River - 169 acres).

Large Tree

At 61,668 acres, the large tree (late-successional) forest has the largest number of acres of the three forested structural stages (68% of the watershed's productive forest land). The large tree stands are a result of wildfires that occurred prior to 1830. Much of the large tree forest (41,280 acres or 67%) is located in the Pacific Silver Fir Zone, with a fair amount (12,105 acres or 20%) also located in the Western Hemlock Zone.

Large tree forest is well dispersed across the watershed, occurring in each of the sixth-field subbasins, but it is the most prominent (in terms of acres relative to other sixth-fields) in sixth-fields 01S (Upper Ohanapecosh River - 22,420 acres), 01T (Upper Muddy Fork Cowlitz River - 8,488 acres), 01L (Upper Clear Fork Cowlitz River - 5,990 acres), and 01B (Lower Ohanapecosh River - 4,412 acres).

Large tree forest is the least prominent in sixth-fields 01M (Purcell Creek - 72 acres), 01H (Cyrenus Creek - 117 acres), and 01N (Dam Creek - 257 acres).

Non-Forest

At 49,445 acres, the areas of non-forest structure (rock, water, avalanche chutes, administrative sites with little or no vegetation, meadows, grasslands, forblands, shrublands, glaciers) cover 36% of the total watershed acreage. Most of the non-forest acreage (29,042 acres or 59%) is concentrated in Mt. Rainier National Park (along the watershed's west and north edges on the southeast flank of Mt. Rainier). Other substantial acreage occurs in the Goat Rocks Wilderness (along the edges of the watershed's southeast tip) and the Tatoosh Wilderness. Much of the non-forest structure is located in the Pacific Silver Fir Zone (13,910 acres or 28%) and Mountain Hemlock Zone (13,535 acres or 27%), with a substantial portion in the Subalpine Fir Zone (11,885 acres or 24%).

Non-forest structure occurs in each of the sixth-field subbasins, but it is most prominent (in terms of acres relative to other sixth-fields) in sixth-fields 01T (Upper Muddy Fork Cowlitz River - 15,285 acres), 01S (Upper Ohanapecosh River - 13,757 acres), 01A (Lower Muddy Fork Cowlitz River - 5,212 acres), 01L (Upper Clear Fork Cowlitz River - 4,640 acres), and 01K (Lower Clear Fork Cowlitz River - 2,675 acres).

Non-forest structure is the least prominent in sixth-fields 01H (Cyrenus Creek - 101 acres), 01R (La Wis Wis - 131 acres), 01J (Upper Cortright Creek - 334 acres), 01M (Purcell Creek - 340 acres), 01N (Dam Creek - 379 acres), 01D (Lower Summit Creek - 380 acres), and 01Q (Little Lava Creek - 381 acres).

Current Landscape Patterns: Patch Size, Shape, Spatial Arrangement and Connectivity

No detailed analysis was performed to calculate statistics concerning current vegetation landscape patterns. Therefore, a basically qualitative description is provided here, based on Map 10, Current (1998) Vegetation Structure.

The current size, shape, spatial arrangement, connectivity, and structural stages of vegetation patches in the watershed have been heavily influenced by U.S. Forest Service and National Park Service management policies concerning fire suppression (suppress most fires immediately) and timber harvest activities (allowed in most areas outside of Forest Service Wilderness, not allowed in Mt. Rainier National Park and Forest Service Wilderness). Since the 1930's, when fire suppression activities began in earnest, the role of fire as a significant, large-scale disturbance agent in the watershed has been reduced dramatically. With the advent of timber harvest in the Forest Service portion of the watershed in the mid-1950's, it became the disturbance agent (outside Wilderness) largely responsible for moving forest stands into the grass/pole structural stage, instead of fire. There have been three types of timber harvest activity in the watershed: regeneration harvest (mainly by clearcut), commercial thinning, and partial-cut salvage.

The grass/pole structural stage that currently exists in the watershed was largely created by regeneration harvest using the clearcut method (although a small number of small patches were created by lightning-caused wildfire). Regeneration harvest on Forest Service land in this watershed totals approximately 5,533 acres since it began in the mid-1950's. There has been no timber harvest on National Park land, except for the minor amount involved in constructing recreation areas/facilities, and hazard tree removal. Of the two small parcels of private land in the watershed (only 109 acres total), most of the acres were probably regenerated by the clearcut method in the 1950's or 1960's.

The estimated amount of regeneration harvest on Forest Service land, stratified by decade and sixth-field, is shown below in Table 3-16. The acreage is based on GPVEG completed harvest activities and year of activity.

Table 3-16: Regeneration Harvest Acres by Decade and Sixth-field (National Forest Ownership Only)

6th-field	1950's	1960's	1970's	1980's	1990's	Total	%
01A	0	206	0	0	19	225	4
01B	56	134	0	99	0	289	5
01D	59	280	247	131	0	717	13
01E	0	249	0	0	0	249	5
01F	40	120	163	113	0	436	8
01G	0	132	0	0	0	132	2
01H	0	80	1	62	14	157	3
01I	63	322	398	175	0	958	17
01J	0	60	0	0	196	256	5
01K	8	229	236	94	16	583	11
01L	0	0	0	0	0	0	0
01M	33	130	62	171	0	396	7
01N	0	369	65	168	0	602	11
01P	0	121	0	0	0	121	2
01Q	0	63	0	0	0	63	1
01R	146	56	43	104	0	349	6
01T	0	0	0	0	0	0	0
Totals	405	2,551	1,215	1,117	245	5,533	100
%	7	46	22	20	5	100	

Although commercial thinning does not alter stand structure as dramatically as regeneration harvest, it certainly has an affect on it. Commercial thinning (depending on the site specific prescription) can change stand structure in a number of ways: by causing the leave trees to grow larger faster, affecting the number of canopy layers, affecting canopy closure, affecting the number of snags and amount of down wood, affecting species composition, etc.

The estimated amount of commercial thinning harvest on National Forest land is minor, only 139 acres has been completed in this watershed; all of it occurred in the late-1970's, and all of it occurred in sixth-field subbasin 01A (Lower Muddy Fork Cowlitz River).

The amount of partial cut salvage harvest that has occurred in the watershed is unknown, but it has been a common practice since the 1960's. It has been linked primarily with the salvage of down or damaged trees related to windthrow/storm events. The number of partial cut salvage sites has been relatively moderate over the years; usually relatively small in size, and usually located along the edges of existing clearcuts or road prisms where windthrow has most often occurred. Changes in stand structure due to partial cut salvage is usually slight, compared to regeneration harvest and commercial thinning, but it does have an influence (something similar, but less impactive, than those mentioned for commercial thinning).

Today (1998), small tree forest and large tree forest structural stages are the most dominant forest vegetation across the watershed, with the grass/pole structural stage being a relatively minor component. Non-forest areas are a very significant feature in the landscape.

Many of the grass/pole forest patches tend to be small in size (less than 100 acres) and regular in shape (having been created by clearcut, they are often square or rectangular with straight edges of high contrast). There are some larger patches of grass/pole forest where regeneration harvest patches have been connected together over the years as leave blocks have been harvested. The larger grass/pole forest patches that currently exist are usually less than 300 acres in size, with the largest one approaching 700 to 800 acres in size. Most of today's grass/pole forest is structurally simple and homogenous; stands with a single tree layer, possessing few (if any) snags or large, live remnant trees, or pieces of large down wood.

The current small tree forest is largely comprised of natural fire-origin stands (generally irregular in shape and form) at middle to high elevations, with over half of it being located in Wilderness areas on Forest Service land (as well as some minor acreage in Mt. Rainier National Park). Small tree forest patches have a wide range of sizes (varying widely from less than 10 acres to a few thousand acres) and shapes with irregular, sinuous edges. The small tree forest has not been fragmented to any great degree by management activities because of its general inaccessibility and location in no-harvest management allocations. There are a few old clearcuts at lower elevations that have grown into small tree forest, but unlike their natural-origin counterparts, they are structurally simple and homogenous; stands with a single tree layer, possessing few (if any) snags or large, live remnant trees, or pieces of large down wood.

Much of the current large tree forest is located within Forest Service Wilderness and Mt. Rainier National Park. It provides significant, large patches of generally unfragmented and well-connected late-successional habitat in the watershed. These large tree forest patches have irregular, sinuous edges. The large expanses of large tree forest have some small patches (less than 200 acres) of grass/pole forest and small tree forest embedded in them, but not significant amounts. A single, extremely large patch of approximately 37,000 acres of large tree forest occurs in the National Park and south into National Forest land, dominating much of the landscape in the northwest half of the watershed.

The large tree forest located outside Wilderness and the National Park (generally located in the east-central portion of the watershed) has been heavily fragmented, with patch sizes dramatically reduced, and the shapes of those patches made generally more regular and angular. Most of the regeneration harvest over the past 45 years came out of this area of large tree forest, converting it to grass/pole forest in a staggered block pattern. Some of the later harvest began to remove some of the earlier large tree forest leave blocks to form larger, more connected patches of grass/pole forest. The large tree forest patches that currently exist in this area are often long, narrow, gangly strips less than one-half mile wide, many less than one-quarter mile wide. This area of highly fragmented large tree forest effectively breaks up the large tree forest connection between the large tree forest in the National Park (in the northwest half of the watershed) and the large patch of large tree forest in the southeastern portion of the watershed.

As in 1880, the patches of forest vegetation today are often fragmented by areas of natural non-forest structure. Most of the natural fragmentation occurs within or adjacent to the large tree forest patches. Natural fragmentation by non-forest areas (non-forest areas represent a significant acreage in the watershed) reduce forest connectivity in some portions of the watershed.

Currently, there are many areas across the watershed that have been little impacted by human management activities; the pattern of their forest vegetation being the most "natural" in terms of patch size, shape, and connectivity. Those areas are: Mt. Rainier National Park (sixth-fields 01S, 01T, and portions of 01A and 01B), Goat Rocks Wilderness (sixth-field 01L and portions of sixth-fields 01K, 01M, 01N, 01P, 01Q), Tatoosh Wilderness (portion of sixth-field 01A), and the William O. Douglas Wilderness (portions of sixth-fields 01D, 01E, 01I, 01G, 01J, 01K).

In the areas of high management use, today's landscape is a relatively unstable, fine-grained landscape with a high amount of edge and contrast, and with a much reduced connectivity when compared to the 1880 landscape. The drainages whose vegetation has been the most highly impacted by human management are in sixth-fields: 01D (Lower Summit Creek), 01F (Lower Carlton Creek), 01I (Lower Cortright Creek), 01N (Dam Creek), and 01R (La Wis Wis). The pattern of forest vegetation in the above drainages is the most "unnatural" in terms of patch size, shape, connectivity, and structural diversity.

Overall, the 1998 landscape pattern has moderately high stability because of its large amount of generally unfragmented large tree forest; being generally more stable than the 1880 landscape pattern. The landscape pattern is generally coarse-grained with moderate amounts of edge and contrast. The exception to all of this being the east-central portion of the watershed where the landscape pattern has a low stability, a fine grain, and high edge and contrast due to past regeneration harvest.

Botanical Species of Concern

Data Sources/Data Gaps

- The primary data source used in determining historic and extant populations of threatened, endangered, and sensitive (TES) plant species for this project is the Biological and Conservation Database (BCD) managed by the Washington Department of Natural Resources Natural Heritage Program. No long-term, comprehensive database exists for survey and manage species, although recently a regional database has been developed that catalogues some location information on these species groups. Records for noxious weeds are minimal and primarily based upon personal observations. Habitat information used in this report comes from maps and data produced and stored in a Geographic Information System (GIS) and National Wetland Inventory (NWI) maps.

Assumptions

- In most cases, the data stored in the BCD was originally recorded as points on U.S. Geological Survey Quadrangles and thus is only as accurate as the original mapper was. Since these data have been collected by a variety of individuals over a large timespan, it is expected that precision of individual locations will vary. It also must be understood that in some cases, individual locations were not reported as the result of a rare plant survey of that area, but were reported by an individual that came across the rare plant while in the course of some other activity. Thus, this data should only be interpreted as the status of our current knowledge, and in no way infers that intensive surveys have been completed within the analysis area unless otherwise stated. Likewise, no specific surveys have been conducted within the analysis area for survey and manage and noxious weed species. It is assumed that many undocumented sites exist for these three species groups within the analysis area.

- The use of GIS layers for predicting special habitat areas is limited by the accuracy of the methods and data used in creating those layers. The GIS vegetation layer is based heavily on aerial photograph interpretation and since small areas of special habitats are easily overlooked on aerial photographs they may not be well represented in GIS. The NWI maps are similarly produced using high altitude aerial photography, and similar interpretation problems exist. While the methods used are considered to generate a good approximation of habitat areas, there is no substitute for actual field work to verify these locations.

Reference and Current Conditions -TES Plant Species

No information on the historic condition of TES species was available for this report. It is likely that viable populations of some of these species occurred within portions of the analysis area that contained suitable habitat.

There are currently 51 species of Threatened, Endangered, and Sensitive (TES) plants on the Regional Forester's list for the Gifford Pinchot National Forest. Of these species, 31 are potentially found on the Cowlitz Valley Ranger District and thus, possibly occur within the analysis area.

Those species that have been documented on the Cowlitz Valley Ranger District, and those species that may occur there based on their published distributions, are listed in Table 3-17. At this time there are no federally listed (proposed, endangered, threatened) plant species known to occur on the Forest, however, one federally threatened species (*Howellia aquatilis*) is suspected.

Table 3-17: TES Plant Species Documented or Suspected on the Cowlitz Valley Ranger District

STATUS	SCIENTIFIC NAME	COMMON NAME	FS/GS*
Suspected	*Agoseris elata*	tall agoseris	-/s; 4/2
Known	*Botrychium lanceolatum*	lance-leaved grapefern	-/s; 5/3
Known	*Botrychium lunaria*	moonwort	-/s; 5/3
Known	*Botrychium minganense*	Mingan's grapefern	-/-;
Known	*Botrychium montanum*	mountain moonwort	-/s; 3/3
Known	*Botrychium pinnatum*	pinnate-leaved grapefern	-/s; 4?/3
Suspected	*Carex heteroneura (=C. atrata var. erecta)*	erect blackened sedge	-/s; 5T4/2
Suspected	*Carex densa*	dense sedge	-/s; 5/1
Suspected	*Carex interrupta*	green-fruited sedge	-/-;
Known	*Carex scopulorum* var. prionophylla	saw-leaved sedge	-/-;
Suspected	*Chrysolepis chrysophylla*	chinquapin	-/s; 5/2-3
Suspected	*Cicuta bulbifera*	bulb-bearing waterhemlock	-/s; 5/2
Known	*Cimicifuga elata*	tall bugbane	C/T; 2/2

Table 3-17: TES Plant Species Documented or Suspected on the Cowlitz Valley Ranger District

STATUS	SCIENTIFIC NAME	COMMON NAME	FS/GS*
Suspected	*Corydalis aquae-gelidae*	cold water corydalis	C/T; 3/2
Known	*Epipactis gigantea*	giant hellebore	-/s; 4/3
Known	*Githopsis specularioides*	common bluecup	-/s; 5/3
Suspected	*Howellia aquatilis*	Howellia	T/E; 2/1
Suspected	*Luzula arcuata*	curved woodrush	-/s; 5/1
Known	*Microseris borealis*	northern microseris	-/s; 3?/2
Suspected	*Montia diffusa*	branching montia	-/s; 3/1-2
Suspected	*Ophioglossum pusillum (=O. vulgatum)*	Adder's tongue	-/T; 5/1-2
Known	*Orobanche pinorum*	pine broomrape	-/s; 4/3
Suspected	*Parnassia fimbriata* var. hoodiana	fringed-grass-of-parnassus	-/s; 3T3/1
Suspected	*Pedicularis rainierensis*	Rainier's lousewort	-/s; 2/2
Suspected	*Platanthera sparsiflora*	canyon bog orchid	-/s; 4-5/1
Known	*Pleuricospora fimbriolata*	fringed pinesap	-/s; 4/3
Suspected	*Polemonium carneum*	salmon polemonium	-/T; 4/1-2
Suspected	*Polystichum californicum*	California swordfern	-/s; 4?/1-2
Suspected	*Saxifraga rivularis (=Saxifraga debilis)*	weak saxifrage	-/s; 4/3
Known	*Sisyrinchium sarmentosum*	blue-eyed grass	C/T; 2/2
Suspected	*Utricularia intermedia*	flat-leaved bladderwort	-/s; 5/2

*F/S; G/S refer to federal/state status and global/state rank respectively.
E = endangered; T = threatened; C = species of concern; s = sensitive; hyphen = not federally listed
#'s refer to standard ranking by The Nature Conservancy

A search of the Biological Conservation Database yielded five known sites of TES plants within the Forest Service portion of the analysis area representing the following two species:

Epipactis gigantea
Orobanche pinorum

No information on TES plant species is provided for the portion of the analysis area that falls within Mount Rainier National Park. The most recent of the *Orobanche pinorum* sites were reported in 1992, and the *Epipactis* site has not been re-verified since it was first reported in

1970. Additional sites for these species (and others listed in Table 3-17) are suspected within the analysis area within suitable habitats. Because many of these TES plant species are not confined to one specific habitat type, it is difficult to accurately delineate areas of suitable habitat for them within the analysis area. This was attempted at a broad scale by querying the existing vegetation layer in the GIS database for all ecoclass codes that represent unique plant habitats (i.e. meadows, red alder wetlands, rocky areas, etc.). Acreage of each of these habitat types and number of known sites of TES plant species found within the analysis area are summarized below by sixth-field watershed (Table 3-18).

Table 3-18: Acres of Habitats and Number of Known TES Sites by Sixth-field Watershed

6th-Field	Rocky Areas	Mead-ows	Shru-blands	Red Alder Wetlands	Lakes, Ponds, Rivers	# of TES sites
01A	3,450	214	641	5	33	0
01B	104	2	13	0	1	0
01D	288	2	80	0	0	1
01E	986	310	189	0	234	0
01F	557	2	15	0	80	0
01G	973	98	195	0	5	0
01H	72	1	14	12	2	0
01I	491	4	58	8	1	1
01J	181	52	83	0	15	0
01K	1,702	672	56	0	5	3
01L	3,388	1,110	133	0	6	0
01M	56	0	277	0	4	0
01N	270	0	108	0	1	0
01P	709	45	337	0	3	0
01Q	127	54	178	0	21	0
01R	94	0	14	0	0	0
01S	0	6,006	0	0	27	0
01T	10	3,869	0	0	54	0
Total	13,458	12,441	2,391	25	492	5

National Wetland Inventory (NWI) maps are another useful source of information regarding special habitats. Methods and criteria used in compiling data for the GIS vegetation layer and the NWI maps were different, thus the NWI data is provided separately from the GIS data shown above. It should be noted that in some cases, there will be overlap between the two different methods of classification (i.e., acres of wet meadows may be shown again as palustrine emergent wetlands). Table 3-19 is a summary of the NWI data.

Table 3-19: Summary of Acres of National Wetland Inventory Wetland Types by Sixth-field Watershed

6th-Field	Palustrine Emergent	Palustrine Aquatic Bed	Palustrine Scrub-Shrub	Palustrine Forested	Riverine	Other (includes open water)	Total
01A	1	0	4	1	49	26	81
01B	0	0	10	0	0	0	10
01D	0	0	3	0	0	0	3
01E	223	0	5	11	0	268	507
01F	1	0	0	0	0	0	1
01G	11	0	3	1	0	4	19
01H	0	0	1	0	0	0	1
01I	0	0	0	0	0	1	1
01J	7	0	0	0	0	18	25
01K	5	0	3	0	2	3	13
01L	7	0	9	0	5	5	26
01M	0	0	2	0	0	3	5
01N	0	0	0	0	0	0	0
01P	0	0	0	0	0	3	3
01Q	25	0	15	0	0	17	57
01R	0	0	0	0	0	0	0
01S	108	1	17	98	26	39	289
01T	41	5	24	0	92	68	230
Total	429	6	96	111	174	455	1,271

The distribution of special habitats within the analysis area are shown on Map 11, Special Habitats, and Map 12, National Wetland Inventory. These maps represent the data from the GIS vegetation layer ecoclasses that were included in Table 3-18 and the NWI wetland data from Table 3-19.

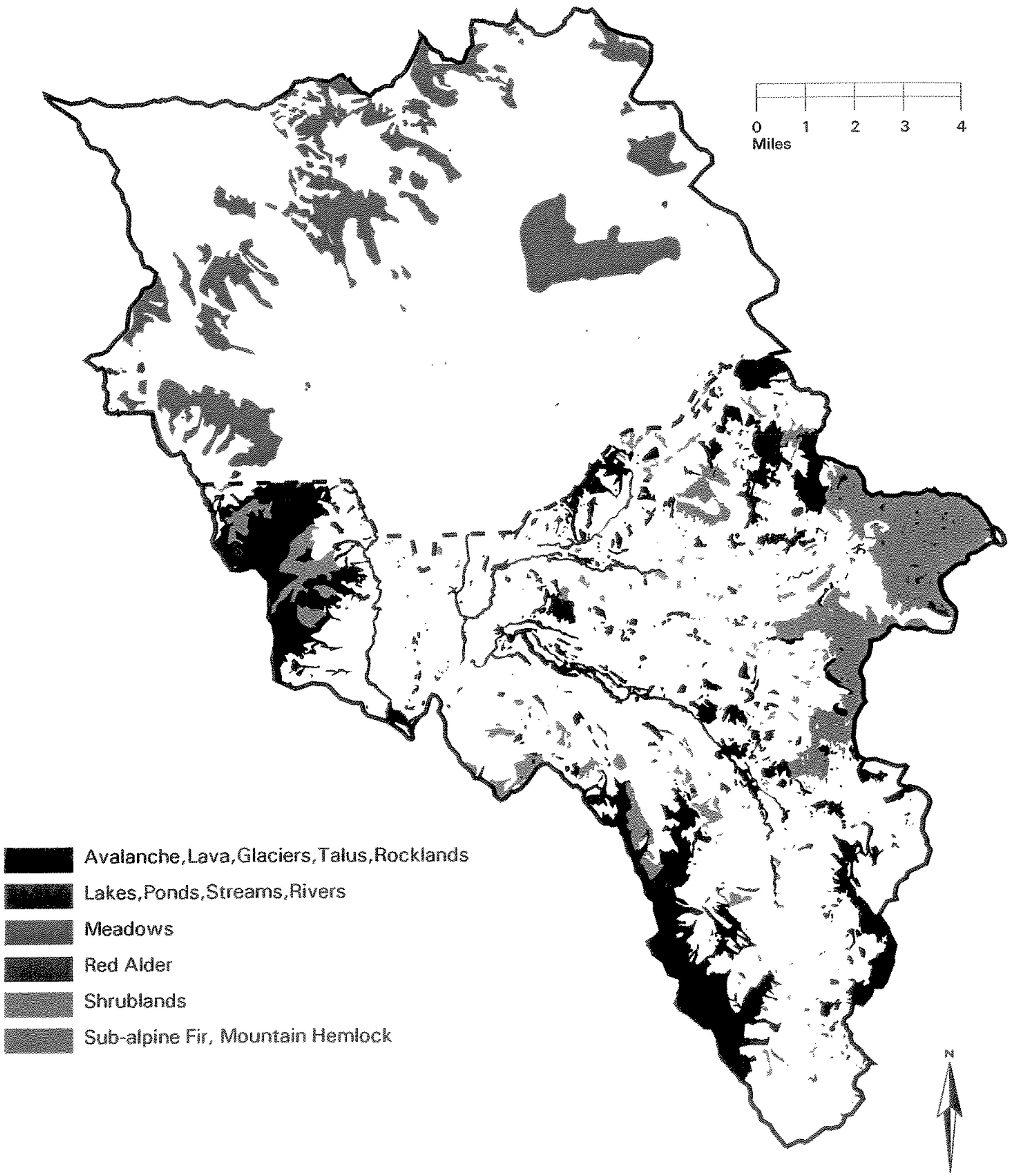
Reference (Historic) and Current Conditions - Survey and Manage Botanical Species

Survey and manage botanical species include those species of fungi, lichens, bryophytes, and vascular plants that are listed in Table C-3 of the *Northwest Forest Plan*. No information on the

Map 11

CLEAR FORK WATERSHED ANALYSIS

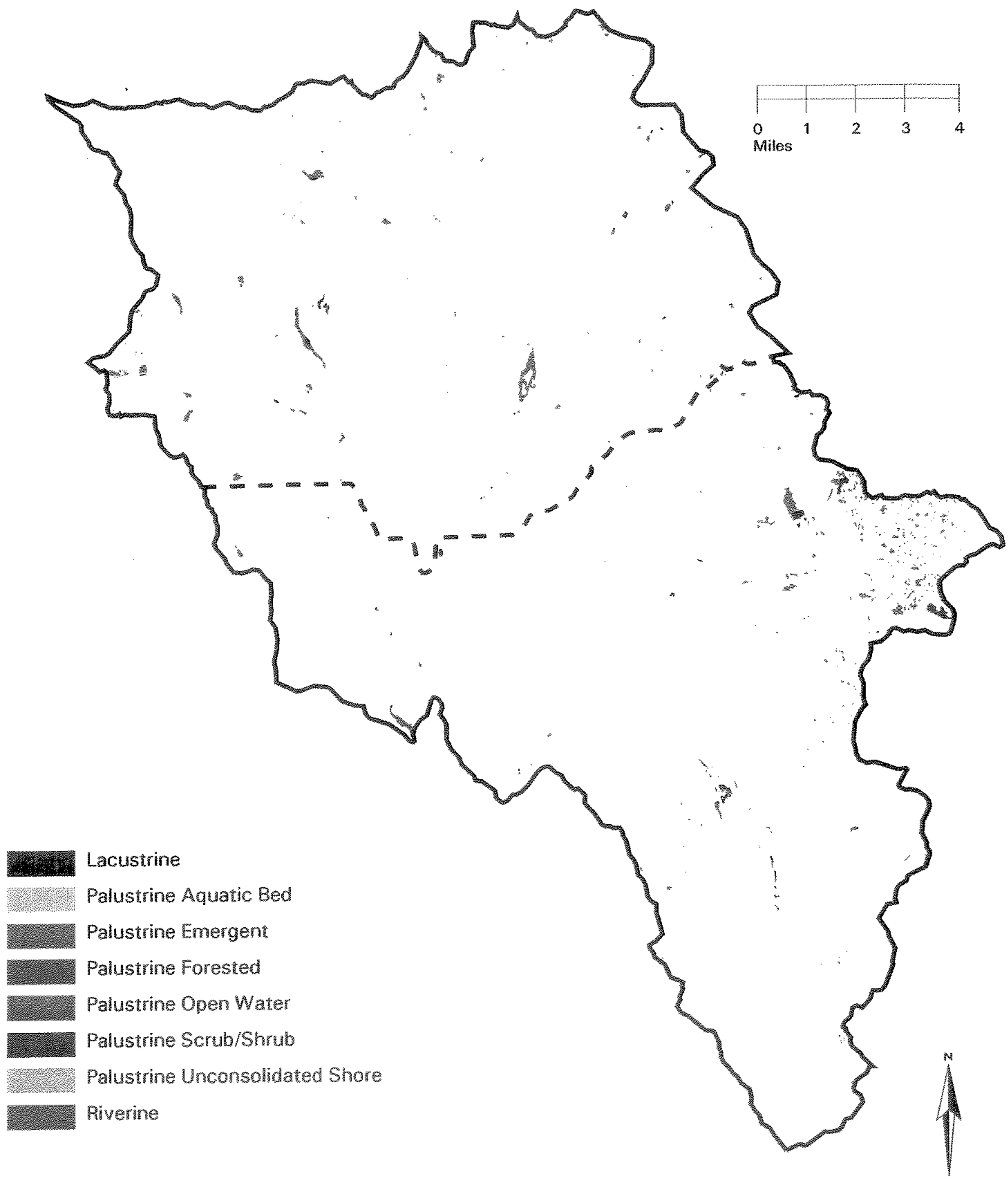
Special Habitats



Map 12

CLEAR FORK WATERSHED ANALYSIS

National Wetland Inventory



historic condition of these species groups was available for this report. It is likely that viable populations of some of these species occurred within portions of the analysis area that contained suitable habitat.

No new inventories were conducted for these species as a part of this watershed analysis, and because very little inventory or tracking has been done for these species locally, or on a regional level, a data gap exists regarding the actual distribution and location of many of these species.

Many strategy 4 species, especially those in the nitrogen-fixing lichen group, are found within the analysis area, though detailed site information is lacking. Species other than strategy 4, with documented sites within the analysis area are shown in Table 3-20.

Table 3-20: Known Sites of Botanical Survey and Manage Species

Species	Life Form	Strategy	Sixth-field
Allotropa virgata	Vascular Plant	1 & 2	01K
Glomus radiatum	Fungus	1 & 3	01K
Otidea onotica	Fungus	1 & 3	01R
Ulota megalospora	Bryophyte	protection buffer	01L

Without much available data on actual species locations, evaluation of habitat conditions can be useful in predicting which species may be present. Areas that may provide suitable habitat for survey and manage species were derived from the existing vegetation layer in GIS by querying the associated database for parameters that would identify old-growth or late-successional stands. Further stratification of this habitat was achieved by overlaying a map of potential vegetation that indicates the major vegetational zones (i.e. western hemlock, Pacific silver fir, etc.) with a map that shows late-successional stands, and another that shows riparian areas. Information on the habitat requirements for individual survey and manage species is compiled in Appendix J2 of the *Northwest Forest Plan* and is not repeated here. That information can be used in conjunction with the habitat data provided here to predict which species may be present within the analysis area.

Based upon the database query described above, acreages of potential habitat for survey and manage species within the analysis area can be summarized as follows in Tables 3-21, 3-22, and 3-23.

Table 3-21: Summary of Acres of Late-Successional Habitat Outside Riparian Reserves by Sixth-field Watershed and Potential Vegetation Zone

Sixth-field (Total Acres)	Western Hemlock	Silver Fir	Mountain Hemlock	Subalpine/ Alpine	Total LS Acres	% of Sixth-field
01A (10,908)	1,888	741	13	0	2,642	24%
01B (5,351)	1,962	1,679	0	0	3,641	68%
01D (3,060)	342	684	30	0	1,056	35%
01E (10,021)	0	1,107	777	52	1,936	19%
01F (2,230)	141	303	0	0	444	20%
01G (4,636)	0	761	20	0	781	17%
01H (1,163)	3	69	0	0	72	6%
01I (4,037)	550	1,126	110	0	1,786	44%
01J (3,102)	0	378	329	32	739	24%
01K (9,168)	532	1,502	595	8	2,637	29%
01L (12,544)	0	2701	596	69	3,366	27%
01M (1,965)	27	6	0	0	33	2%
01N (2,159)	23	156	0	0	179	8%
01P (2,387)	0	592	67	0	659	28%
01Q (1,497)	0	404	2	0	406	27%
01R (1,785)	639	0	0	0	639	36%
01S (37,771)	1,420	13,946	3,415	329	19,110	51%
01T (24,139)	1,025	4,885	588	34	6,532	27%
Total (137,905)	**8,552**	**31,040**	**6,542**	**524**	**46,658**	**34%**

Table 3-22: Summary of Acres of Late-Successional Habitat Inside Riparian Reserves by Sixth-field Watershed and Potential Vegetation Zone

Sixth-field (Total Acres)	Western Hemlock	Silver Fir	Mountain Hemlock	Subalpine/ Alpine	Total LS Acres	% of Sixth-field
01A (10,908)	762	158	0	0	920	8%
01B (5,351)	561	209	0	0	770	14%
01D (3,060)	124	228	1	0	353	12%
01E (10,021)	0	657	276	17	950	9%
01F (2,230)	109	78	0	0	187	8%
01G (4,636)	0	588	4	0	592	13%
01H (1,163)	0	45	0	0	45	4%
01I (4,037)	287	355	23	0	665	16%

Table 3-22: Summary of Acres of Late-Successional Habitat Inside Riparian Reserves by Sixth-field Watershed and Potential Vegetation Zone

Sixth-field (Total Acres)	Western Hemlock	Silver Fir	Mountain Hemlock	Subalpine/ Alpine	Total LS Acres	% of Sixth-field
01J (3,102)	0	258	117	12	387	12%
01K (9,168)	139	983	108	0	1,230	13%
01L (12,544)	0	2,243	335	45	2,623	21%
01M (1,965)	35	4	0	0	39	2%
01N (2,159)	4	74	0	0	78	4%
01P (2,387)	0	351	13	0	364	15%
01Q (1,497)	0	262	4	0	266	18%
01R (1,785)	0	0	276	0	276	15%
01S (37,771)	571	2,526	201	11	3,309	9%
01T (24,139)	685	1,221	50	0	1,956	8%
Total (137,905)	**3,277**	**10,240**	**1,408**	**85**	**15,010**	**11%**

Table 3-23: Summary of Acres of Late-Successional Habitat Within the Analysis Area by Potential Vegetation Zone

Total Acres in Analysis Area	Western Hemlock	Silver Fir	Mountain Hemlock	Subalpine/ Alpine	Total LS Acres	% of Area in Late Successional
137,905	11,829	41,280	7,950	609	61,668	45%

Reference (Historic) and Current Conditions - Noxious Weeds

No information on the historic condition of this species group was available for this report though it is assumed that these species have invaded the area concurrently with human disturbance. The history of road and trail development within the analysis area would likely provide an interesting look into the historic invasion of weeds into the area.

No surveys were conducted for noxious weeds within the analysis area in conjunction with this watershed analysis. Noxious weed species commonly encountered in large populations on the Cowlitz Valley Ranger District and likely to occur within the analysis area are shown in Table 3-24.

Table 3-24: Noxious Weeds Likely to be Found in Large Populations Within the Analysis Area	
Scientific Name	**Common Name**
Centaurea maculosa	Knapweed
Chrysanthemum leucanthemum	oxeye daisy
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Cytisus scoparius	Scotch broom
Hypericum perforatum	St. John's wort
Phalaris arundinacea	reed canary grass
Potentilla recta	erect cinquefoil
Senecio jacobaea	tansy ragwort

Primary corridors for noxious weed dispersal within the analysis area include roads, trails, and riparian areas. Disturbed sites, including parking areas, log landings, trailheads, quarries, etc., provide potential population centers for these species. Large segments of U.S. Highway 12 and other main thoroughfares within the analysis area currently support extensive populations of many of the above listed noxious weed species.

Wildlife

Data Sources/Data Gaps

This report was compiled from the knowledge of Forest Service and U.S. Fish and Wildlife Service biologists, Mt. Rainier National Park ecologists, wildlife sighting databases, aerial photograph interpretation, Geographic Information System (GIS) databases and literature reviews. There was no field reconnaissance conducted for this report.

The following data is either not presently available or was not collected for this analysis:

- Data on down log and snag densities, their size distribution, and decay class are generally unavailable. Available data present was taken from the Forest's Continuous Vegetation Survey although the sample size was small and contained a great deal of variability. Data collected in the Packwood LSR within stands greater than 80 years of age indicated the percent ground cover of down logs was around 6 percent. Within the same plots, snag data was also collected, with snags greater than 14 inches in diameter estimated at 38 per acre. There is no information on snag numbers or coarse woody debris levels in other land allocations of the watershed.

- Current and historical information about the location and population status for most wildlife species on federal lands.

- A complete GIS vegetation analysis for the entire 6,914 acres of Gifford Pinchot National Forest allocated mountain goat range.

- Wildlife sighting observations may not be totally reliable. Normally, a "confidence" factor such as confirmed, probable, etc. are attached to the report based on viewer experience, weather conditions, and habitat suitability for the species being reported.

Assumptions

The following assumptions were made for this analysis:

- Habitat conditions are a major determinant in defining wildlife distribution and abundance. Therefore, in the absence of a sighting record, a species may occur in the watershed if its habitat occurs in sufficient patch size. Species that require very large home ranges, such as the grizzly bear and wolverine, may also depend on suitable habitats being present on adjoining watersheds.

- Fire, volcanic events, timber harvests, and road construction have the greatest influence on wildlife presence and distribution.

- Wildlife species that presently occur in the watershed are assumed to have been present prior to European settlement in the valley, with the exception of introduced species.

- Wildlife species abundance is determined by several interacting factors, including habitat conditions, human use (i.e., hunting, trapping, both legal and illegal) and, in the case of wide-ranging migratory species, habitat and human factors far from the watershed area.

Reference and Current Conditions - General Wildlife and Habitats

The Middle and Upper Cispus River Pilot Watershed Analysis (USDA 1995a) listed 264 wildlife species potentially present in that watershed. The Clear Fork watershed includes these same species as well as the Lewis woodpecker, blue jay, and western kingbird. These three bird species are somewhat unique in that they are normally east-side Cascade Mountain Range species, but they have been documented in this watershed. Several introduced wildlife species are also assumed to occur in the Clear Fork watershed including: California quail, European starling, house sparrow, Virginia opossum, Norway rat, Eastern wild turkey, and bullfrog. The Eastern wild turkey is being introduced by the state fish and wildlife department into several counties of western Washington including Lewis County. There is also the possibility that the Rio Grande or Merriam species of turkeys introduced into Eastern Washington, may have migrated over White Pass into the Clear Fork watershed. Documentation on population estimates and the current range of introduced species in the watershed is not known. The species total is estimated at 271 although many have not been documented at this time. Not included in the estimated total are a number of mollusks which are assumed to occur within the watershed.

The Clear Fork Cowlitz watershed encompasses portions of three National Forest Wilderness areas and approximately 67,004 acres of Mt. Rainier National Park. The position of this watershed in the southwest Washington province is very important to a number of wildlife species. The vast expanses of land that are unroaded, with access limited to hiking trails, provides quality habitat for large ranging species such as the grizzly bear, gray wolf, California wolverine, and the North American lynx. Habitat for this unique group of species is very limited in this province. The high elevation lands also provide habitat for the white-tailed ptarmigan which is restricted to several watersheds in the province. Further discussion of some of these species are found in the threatened and endangered species section.

One species is assumed to have been extirpated from the watershed. Archaeological testing from the La Wis Wis Campground area has confirmed the presence of bighorn sheep in this area in the early 1600's. There is also a historical report of one of the last bighorn sheep in the area being shot around 1890 (McClure, personal communication 1998). It is not known when the last sheep disappeared from the watershed although hunting is presumed to have played a large role in their disappearance. At this time, the nearest bands of bighorn sheep are located approximately 20-25 miles east of the Clear Fork watershed boundary on Clemans Mountain in the Tieton River watershed.

Special or Unique Habitats

Special and unique habitats such as rock outcrops, cliffs, talus slopes, sub-alpine and alpine habitat, wet meadows, shrublands, avalanche chutes, lakes and ponds are present in the watershed and are displayed on Map 11, Special Habitats. Some of the wildlife species associated with sub-alpine habitat, alpine habitat, rock outcrops and talus include: mountain goats, marmots, and ptarmigan which are all present in the Goat Rocks Wilderness and Mt. Rainier National Park. One Larch Mountain salamander population has been confirmed in the watershed but other populations are suspected to occur based on the prevalence of talus slopes and boulder fields in many of the sixth-field watersheds. Cliff habitat is present which may provide suitable nesting ledges for peregrine falcons, however, none have been documented at this time. Elk calving areas have been documented in the Carlton and Cortright Creek drainages in regeneration harvest units. Calving grounds are also suspected to occur within many of the meadows of the Wilderness areas and Mt. Rainier National Park.

Reference and Current Condition - Proposed, Endangered, Threatened and Sensitive Species (PETS)

Fourteen wildlife species have been documented or have the potential to occur in the Clear Fork watershed that are listed as proposed, endangered, threatened, sensitive, or as a federal candidate. In addition, there are eight species designated as federal species of concern. Sensitive species are those on the Regional Forester's list requiring attention to prevent future federal listing. Federal candidates are those species for which the U.S. Fish and Wildlife Service has sufficient information to propose for listing as threatened or endangered under the Endangered Species Act. Species of concern are those species whose conservation standing is of concern to the Fish and Wildlife Service, but for which status information is still needed. Table 3-25 lists all threatened, endangered, sensitive, candidate, and species of concern that are known or suspected to occur within the Clear Fork watershed.

Table 3-25 : Threatened, Endangered, Sensitive, Candidate, and Species of Concern Documented (D) or Potential (P) To Occur in the Clear Fork Watershed

Species/Occurrence	Endangered	Threatened	Sensitive	Candidate	Species of Concern
Gray wolf (P)	X		X		
Peregrine falcon (P)	X		X		
Grizzly bear (P)		X	X		
Northern bald eagle (D)		X	X		
Northern spotted owl (D)		X	X		
Marbled murrelet (P)		X	X		
North American lynx (P)			X	X	
California wolverine (D)			X		X
Larch Mountain salamander (D)			X		X
Cope's giant salamander (P)			X		
Townsend's big-eared bat (P)			X		X
Western pond turtle (P)			X		X
Common loon (D)			X		
Oregon spotted frog (P)				X	
Northern goshawk (D)					X

Table 3-25 : Threatened, Endangered, Sensitive, Candidate, and Species of Concern Documented (D) or Potential (P) To Occur in the Clear Fork Watershed

Species/Occurrence	Endangered	Threatened	Sensitive	Candidate	Species of Concern
Olive-sided flycatcher (D)					X
Pacific fisher (D)					X
Long-legged myotis bat (P)					X
Long-eared myotis bat (P)					X
Fringed myotis bat (P)					X
Tailed frog (D)					X
Cascade frog (D)					X

The following section provides a brief summary of some of the species listed in the above table including habitat requirements, where it is located in the watershed, and if the species has been documented to occur.

Gray Wolf

Wolves were thought to be eliminated as a breeding resident in Washington by 1930 (Young 1944). However, based on numerous reported sightings, Laufer and Jenkins (1989) suggest that wolves may be re-colonizing former ranges. This is consistent with the increasing number of wolf sightings reported on the Cowlitz Valley Ranger District over the last 20 years. There are at least 10 sightings or wolf howling reports that have been reported to the district wildlife staff. Sightings have been of individual animals and, in several cases, multiple animals suggesting a wolf pack. Within Mt. Rainier National Park, there have been at least 8 sightings or track reports of wolf-like animals since 1988. The evidence suggests wolves are re-establishing themselves, although no one knows if the animals are pure wolves or hybrids. None of the sightings have been confirmed by biologists (class 1 confirmation), although the descriptions that have been provided have been fairly accurate in describing key physical characteristics of wolves. The presence of large tracts of land within Mt. Rainier National Park and National Forest Wilderness that are relatively undisturbed by people, along with an abundant deer and elk prey base widely distributed across the watershed, would provide ideal gray wolf habitat. At this time, there are no known wolf dens or rendezvous sites in the watershed.

Peregrine Falcon

Peregrine falcons typically breed near wetlands, lakes, rivers, or other water sources that provide an array of prey. Nests are normally found on high cliffs, although nesting on man-made structures such as highway bridges and skyscraper ledges is increasing. The Forest Service wildlife database lists one peregrine falcon sighting report from the William O. Douglas Wilderness in late summer of 1977. This bird may have been migrating through the watershed en route to coastal wintering grounds. One sighting of a peregrine has also been reported in Mt. Rainier National Park that was observed in September 1987. Re-introduction of peregrine falcons to the Pacific Northwest has been occurring over the last decade with several hack-sites (man-made structures where young are re-introduced and imprint on the site) selected on the Gifford Pinchot and adjacent Wenatchee National Forests. Between 1991 and 1993, fifteen young peregrines were released in the Middle Cispus River watershed, Cowlitz Valley Ranger District of the Gifford Pinchot National Forest. Two breeding pairs have been confirmed on the Gifford Pinchot National Forest though neither pair is within the Clear Fork watershed. The abundance of rocky, mountainous terrain would suggest potential nesting habitat is present in the Clear Fork watershed. Any proposed projects that may impact nesting habitat on National Forest land would require placement of a limited operating period to prevent disturbance during the nesting season. Cooperative funding approaches between state and federal agencies may provide necessary funding resources to conduct falcon occupancy surveys.

Grizzly Bear

Grizzlies have never been very common in Washington and were hunted to near extinction in the late 1880's. Grizzlies are the largest omnivores in North America with males reaching 400 to 800 pounds. Their diet includes vegetation and insects, along with a variety of forbs, berries, and grasses. These foods are supplemented by winter-killed ungulates and small mammals such as ground squirrels. Grizzly bears require large home ranges to encompass the various seasonal habitat types necessary to supply their diverse diet. Grizzlies are not territorial and home ranges of individual bears do overlap. Small remnant populations exists in the North Cascades and in the Selkirk Mountains in the northeastern part of the state. Both of these areas have been designated as recovery zones for the species. There have been no confirmed sightings on the Gifford Pinchot National Forest although suitable habitat is available. The nearest occupied grizzly habitat is on private timber company lands west of Mt. Rainier National Park. The tracks of two grizzlies were confirmed in 1993. Those grizzly tracks represented the first species confirmation south of Interstate 90. The majority of the Clear Fork watershed could be considered grizzly habitat because of the presence of Wilderness, National Park acreage, and the watershed's location along the Cascade Crest, forming a natural corridor for bear movement through this part of the southwest Washington province. While human use is prevalent in or near trail systems within the Wilderness areas and the National Park, huge tracts of land are still available to the bear relatively free of human disturbance. This watershed may provide the highest quality grizzly habitat on the Gifford Pinchot National Forest.

Northern Bald Eagle

Bald eagles are highly territorial and exhibit strong site tenacity, with paired birds returning to the same area year after year. A good territory for eagles has suitable nest trees, many perch trees within and along the perimeter of their territory, and foraging areas. In Washington, potential habitats are riparian areas along rivers, lakes, and streams. National Park records show several bald eagle sightings in the Clear Fork watershed, near Louis Lake and along the Ohanapecosh River. Several of the sightings were during the spring or late summer, although there is no evidence of a nesting pair. There are also no documented bald eagle nest sites on the Cowlitz Valley Ranger District of the Gifford Pinchot National Forest. Wintering bald eagles are relatively common, particularly along the Cowlitz River and Cispus River systems. Within the Clear Fork watershed, eagles are commonly seen in the Jody's Bridge area near the confluence of the Muddy Fork and Clear Fork Cowlitz Rivers where they feed on ungulate carcasses and dead or dying steelhead and salmon. The birds normally arrive by late October or early November and are present into March. Wintering eagles commonly roost in large groups, and studies from the Lewis River watershed in southern Washington suggest north facing slopes with older multi-canopied stands are preferred night communal roosting areas (Anderson and Ischisaka, 1986). There are no known communal night roosts in the watershed, although intensive surveys have never been conducted. Surveys at dusk would be needed to confirm communal roosting sites.

Northern Spotted Owl

While no suitable habitat acreage estimates were calculated for a historical reference, a review of the historic vegetation map indicates suitable owl habitat was present in large consolidated blocks. There are no historical population estimates or information pertaining to owl distribution across the watershed. The first intensive spotted owl surveys on National Forest lands in the watershed were conducted in the late 1970's. The last surveys completed to Forest Service protocol were done from 1992 to 1993. Over the last five years, however, some pairs have been checked to confirm site occupancy and to assess their nesting status. Mt. Rainier National Park personnel began surveying for spotted owls in 1983, although survey efforts were generally sporadic until 1996. Useful data was collected from surveys performed in 1986 to 1988. Beginning in 1997, National Park personnel began an intensive effort to inventory habitat, locate activity centers, determine relative abundance and productivity, and monitor "historic" activity sites. The survey effort is scheduled to continue into the field season of 1998.

There are 11 pairs or territorial single owls with activity centers on National Forest lands within the watershed and three pairs assumed to reside in the Ohanapecosh River drainage of Mt. Rainier National Park based on historical data. The amount of suitable owl habitat for each pair or single has been calculated for the home range radius of 1.82 miles for those pairs or singles that reside on National Forest lands. Threshold for "incidental take" status is determined by the U.S. Fish and Wildlife Service to be less than 500 acres within the 0.7 mile radius or less than 2,663 acres of suitable habitat within the 1.82 mile radius from the owl activity center. Table 3-26 displays the number of owl activity centers in the National Forest by *Northwest Forest Plan* allocation and those within the boundaries of Mt. Rainier National Park.

Table 3-26: Numbers of Northern Spotted Owl Pairs or Singles By Land Allocation Within The Clear Fork River Watershed

	Mt. Rainier Nat. Park	LSR	Wilderness	Matrix	Total
Pairs or Singles	3	6	5	0	14
Incidental Take	*	1	3	0	4*

* There is no information available on home range suitable habitat acreage for the three pairs within Mt. Rainier National Park.

Vegetation analysis indicates there are approximately 28,885 acres of suitable spotted owl habitat on National Forest lands in the Clear Fork watershed. Of that number, 22,960 acres (80 percent) would be classified as nesting, roosting, and foraging (NRF) habitat. There are also approximately 5,925 acres (20 percent) classified as foraging and dispersal habitat (FD). Foraging and dispersal habitat would be defined as those lands capable of providing prey base habitat and owl dispersal, but lacking the large diameter trees needed for owl nesting. Map 13, Northern Spotted Owl Habitat, displays the suitable spotted owl habitat on National Forest lands within the watershed. Suitable spotted owl habitat is also present within Mt. Rainier National Park. Approximately 68,000 acres of potential suitable spotted owl habitat is present within the entire National Park (Lechleitner personal communication 1998). The number of acres of suitable habitat within the Clear Fork watershed of Mt. Rainier National Park has not been determined.

The largest and most connected blocks of owl NRF habitat are contained within the 01B (Lower Ohanapecosh), 01E (Upper Summit Creek), 01G (Upper Carlton Creek), 01K (Lower Clear Fork Cowlitz), and 01L (Upper Clear Fork Cowlitz) sixth-field watersheds. Suitable NRF habitat is more fragmented in the 01D (Lower Summit Creek), 01I (Lower Cortright Creek), 01M (Purcell Creek), 01N (Dam Creek), and 01R (La Wis Wis) sixth-field watersheds due to regeneration timber harvests that have been conducted over the last 45-50 years.

There are approximately 331 acres of National Forest that currently meets the dispersal habitat definition of 11 inches average dbh and at least 40 percent canopy closure. The remaining National Forest acreage consists of alpine and sub-alpine lands, rock, talus, glaciers, bodies of water, and forested stands that have not reached an average 11-inch dbh. Habitat for dispersing owls is not a concern in this watershed because of the presence of connected NRF, FD, and dispersal habitat across the watershed. The number of acres of suitable spotted owl habitat by sixth-field watershed can be found in the analysis files.

Northern Spotted Owl Critical Habitat

Approximately 20,367 acres of designated spotted owl critical habitat unit CHU WA-37 is present in the watershed displayed on Map 13, Northern Spotted Owl Habitat. Of the 20,367 acres, 12,150 acres (60 percent) are classified as NRF habitat, and 1,044 acres (5 percent) are FD habitat, for a total 13,194 acres (65 percent) that are currently suitable habitat. There are also 206 acres of dispersal habitat within CHU WA-37. The majority of the CHU acreage overlaps with the Packwood LSR with the desired future condition of developing late-successional habitat. There is also about 429 acres of CHU that overlaps the *Northwest Forest Plan* Matrix allocation in the 01K (Lower Clear Fork Cowlitz) sixth-field watershed. Matrix lands within critical habitat units are not expected to contribute suitable habitat for the recovery of the spotted owl. The acres of CHU by sixth-field watershed can be found in the analysis file.

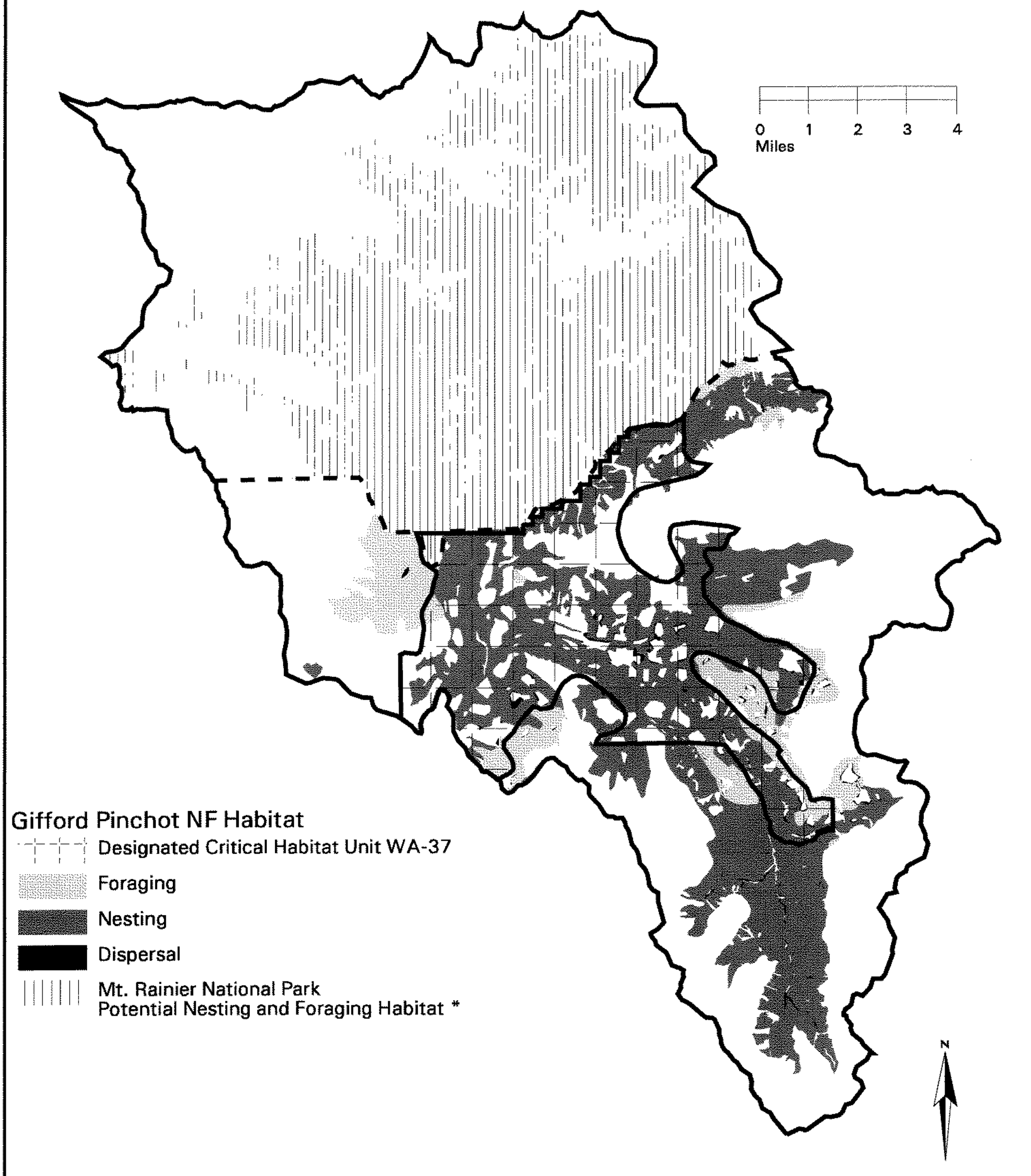
Marbled Murrelet

Portions of the northern and northwestern area of the watershed fall within Zone 2 of the marbled murrelet range (Map 14, Marbled Murrelet Range Zone 2). This zone is defined as those lands within 35 to 55 miles of saltwater, which for this area would be the southern Puget Sound. The majority of the murrelet acreage is within Mt. Rainier National Park and the Tatoosh Wilderness (sixth-fields 01T, 01S, 01A, and 01B). Approximately 3,727 acres on National Forest lands (sixth-fields 01A and 01B) could be classified as suitable nesting habitat for the murrelet. The only surveys for murrelets in the entire watershed were conducted by Mt. Rainier National Park personnel in 1994 where the Eastside Trail crosses the Ohanapecosh River (Lechleitner personal communication 1998). There were no murrelet detections during those surveys. The nearest designated marbled murrelet critical habitat is located approximately 2 miles west of the Clear Fork watershed western boundary near the Tatoosh Wilderness. Any projects on National Forest lands within the 55 mile murrelet range that may alter or modify suitable habitat would require a two-year survey effort to determine species presence. Any projects that may potentially disturb murrelet habitat during the nesting season would also require a two-year survey effort or the placement of a limited operating period. The confirmation of occupied

Map 13

CLEAR FORK WATERSHED ANALYSIS

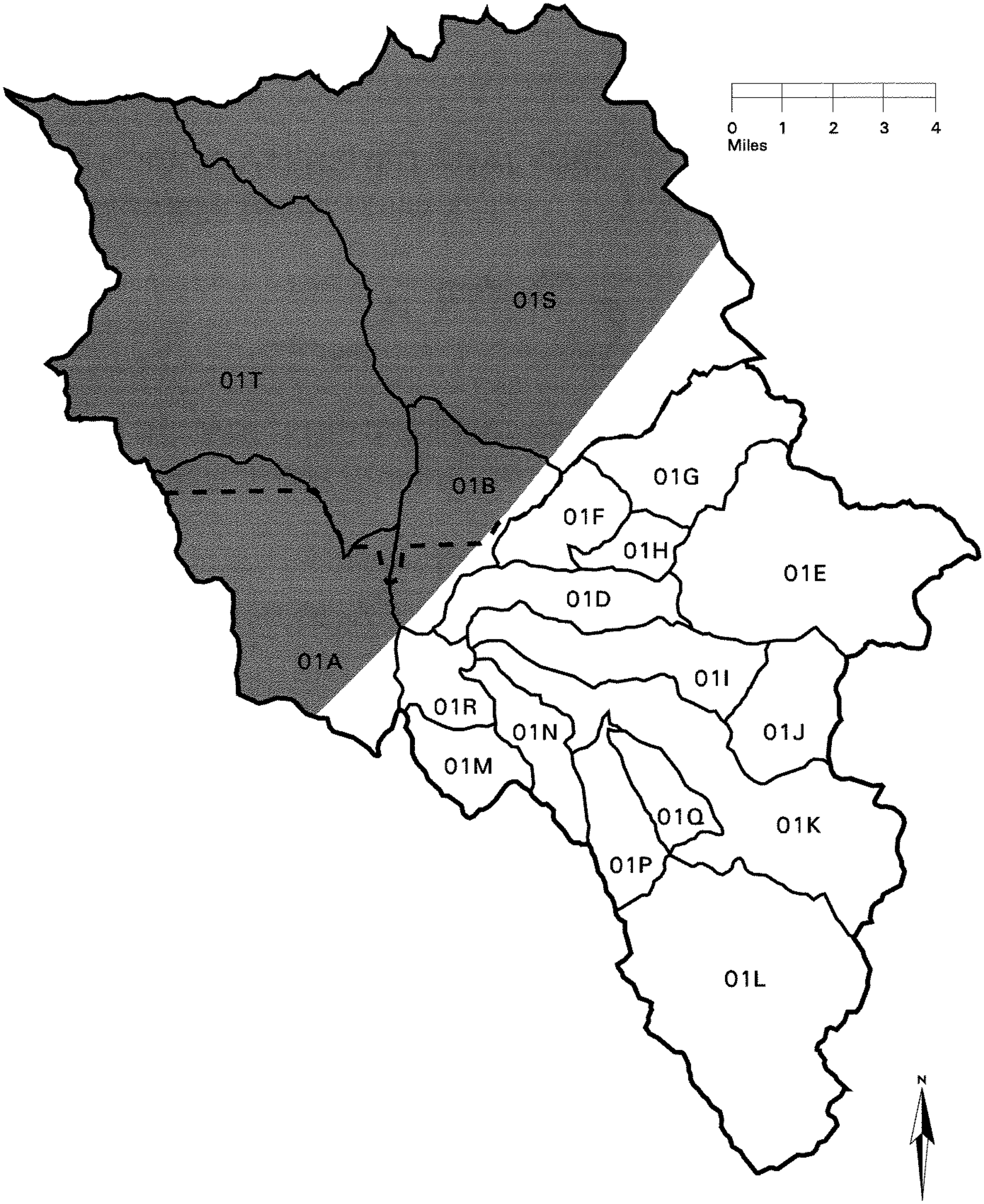
Northern Spotted Owl Habitat



Map 14

CLEAR FORK WATERSHED ANALYSIS

Marbled Murrelet Range - Zone 2



habitat would require that a 0.5-mile radius protective buffer be placed around the murrelet activity center before project implementation could occur.

North American Lynx

The lynx is a rare and locally endemic species in the Pacific Northwest and has recently been classified as a candidate species by the U.S. Fish and Wildlife Service. While historical data is not available on population estimates, the current population is estimated to be less than 200 animals, primarily occurring within or near the Okanogan and Wenatchee National Forests in Washington state. Lynx trapping and hunting was legal in Washington until November 1991. Habitat modifications that reduced the amount and availability of foraging and denning habitat, combined with fire suppression and the effects of prior trapping, may be the major reasons for the continuing population decline.

Lynx are associated with high elevation, boreal forests and are found primarily above 4,000 feet elevation in Washington. High quality lynx habitat is comprised of a mosaic of early-successional forests with high prey densities (snowshoe hares) for foraging and late-successional forests with an accumulation of down logs used for denning, and thermal and security cover (Koehler and Brittell 1990). There are no confirmed reports of lynx in the Clear Fork watershed, although habitat modeling indicates that suitable breeding and foraging habitat is present. Several thousand acres of habitat are present primarily in the Goat Rocks and William O. Douglas Wilderness areas with more limited availability in the Tatoosh Wilderness. No lynx habitat mapping has been completed for Mt. Rainier National Park, although suitable foraging and breeding habitat is present.

The North American lynx is listed as a strategy 3 survey and manage species. Surveys within the region are being conducted and include portions of the Gifford Pinchot National Forest. At this time, survey areas on the Gifford Pinchot National Forest have been designated, but survey results will not be available until December 1998.

California Wolverine

The wolverine is the largest member of the terrestrial mustelid family, with males reaching 12-18 kg. and females averaging 8-12 kg. The skull and teeth are robust and the musculature, especially of the head, shoulders and neck, is well developed. These adaptations allow the wolverine to feed on frozen flesh and bone. Studies have indicated that large mammals are important food sources for wolverines year-round and that they are too large to survive entirely on small sized prey such as snowshoe hares. Berries, squirrels, and insect larvae are also included in their diet on a seasonal basis. The wolverine is one of the rarest and least known mammals in North America. Within their geographic range, the wolverine occupies a variety of habitats, however, a general trait defining occupancy is remote lands with little human disturbance. The majority of winter habitat use occurs in montane coniferous forest. Known wolverine natal dens in Idaho were found in high elevation basins with talus of large boulders where tunnels were dug beneath the boulders.

Wolverines have been documented in the Tatoosh Wilderness of the watershed. This included tracks of two individuals in 1980 and a visual sighting in 1981. It is assumed that the Goat Rocks and the William O. Douglas Wilderness areas also provide suitable habitat for this species. National Park Service records list seven sightings of wolverines, primarily along the State Highway 123 corridor and Stevens Canyon area. As similarly described for the grizzly, this watershed may provide the highest quality wolverine habitat within the entire southwest Washington province.

Pacific Fisher

Fishers are members of the mustelid family, similar in body form to weasels. Males average 3-6 kg. and are twice as large as females. Their diets are typically diverse and studies indicate snowshoe hares, ungulate carrion, squirrels, chipmunks, and voles as primary food sources. They are vulnerable to trapping and are frequently caught in the sets for other species. Home ranges can be as large as 41 square kilometers for females and 85 square kilometers for males. In the western United States, fishers seem to prefer conifer-dominated forests and are closely associated with forested riparian areas. Research by Aubrey and Houston (1992) show fishers to be a relatively low elevation species on the west side of the Cascade Mountains. There are no documented fisher sightings in Cowlitz Valley Ranger District databases, however, tracks were noted in the Summit Creek drainage in 1991.

In 1996, the Gifford Pinchot National Forest entered into an agreement with the Washington State Department of Fish and Wildlife to conduct surveys for forest carnivores. The technique used is to suspend or attach a bait, normally a deer or elk quarter, to a tree, and position a camera which would photograph any activity near the bait. At this time, these surveys have occurred for three winters, but there have been no detections of lynx, fisher or wolverine. Marten, bobcats, weasels, spotted skunks, and red-tailed hawks have been photographed on the bait. Populations of the three carnivores may be so low that photographing a target species may be very difficult. Camera sets have been used in several locations of the Clear Fork watershed including lower elevation areas near the Muddy Fork Cowlitz River and the Ohanapecosh River.

Common Loon

The common loon is known to breed at only a few locations in western Washington. From September to May, the loon frequents estuarine and suitable marine habitats along the Pacific coast. This species requires deep freshwater lakes with an abundance of fish for breeding areas. Nests are usually on the ground very close to water, concealed by vegetation or rocks. The species is also very susceptible to human disturbance during the nesting period. One common loon sighting was reported on a lake within Mt. Rainier National Park in July 1987. There are no records of other sightings, and nesting of loons has not been confirmed.

Northern Goshawk

In September 1997, the U.S. Fish and Wildlife Service (FWS) announced that the status of the northern goshawk in the western United States warrants further review to determine if it should be listed as threatened or endangered under the Endangered Species Act. As part of this status review, the FWS is seeking information on loss or modification to forested habitats of potential use to goshawks. The status review will be conducted over a full field season to provide sound information on goshawk nesting and foraging habitat, and on population numbers. A decision on whether the goshawk will be proposed for listing is expected in the fall or winter of 1998.

In Washington, evidence suggests that goshawks nest in mature forests with large, tall trees and dense canopies. Criteria adapted from Fleming (1987) indicated that potential nesting habitat would be defined by: average dbh $\geq$ 30cm; average tree height $\geq$ 24 m, tree density between 250 and 750 stems/acre, and conifer composition of at least 70 percent. However, work by Bosakowski and Vaughn (1996) in Washington suggests that habitat suitability models need to be designed from regional or local data wherever possible because of some variability observed in the choice of nesting locations. A simplified model using only forest age, with greater than 35 years being the lower limit, may be adequate for mapping goshawk nesting habitat.

Goshawks forage in mature forests having stand openings and structural diversity which are essential in allowing the birds to maneuver as they pursue prey. Dense, large tree stands that have not developed adequate openings and understory as a result of past harvest practices provide little foraging habitat for goshawks. Goshawks feed on a diverse range of prey, primarily medium-sized birds such as grouse, Stellar' s jays and robins, and mammals such as rabbits, hares, and squirrels. Goshawks may hunt from a perch or while flying through the forest.

The northern goshawk has historically been considered uncommon throughout its range. Goshawks experience population fluctuations due to variable nesting success, and possibly in response to varying prey availability. Primary threats to goshawk populations will be evaluated during the status review, and will probably include loss or degradation of mature forests used for nesting and foraging. Habitat quality and quantity can also decrease as a result of fire suppression.

National Park Service records show eight goshawk sightings in the Ohanapecosh River drainage, although no nest sites have been documented at this time. Several of the sightings were recorded in 1997 as National Park personnel were conducting northern spotted owl surveys. There have been no northern goshawk surveys conducted on National Forest lands within the Clear Fork watershed, although the species is assumed to be present. At this time, no surveys to determine goshawk presence are anticipated to occur. However, any nest site discovered on National Forest lands in the future would be protected with a 660-foot radius buffer around the nest site, or to whatever standards and guidelines of the GP Forest Plan are in effect at the time of discovery.

Reference and Current Condition - Survey and Manage Amphibians and Mollusks

Survey and manage amphibians and mollusks are listed in Table C-3 of the Northwest Forest Plan. Of that extensive list, two amphibian species and eight mollusk species are either known to occur or are presumed to occur on the Gifford Pinchot National Forest. This list represents those mollusks that have been documented on the National Forest or have been confirmed on adjacent private lands. There is no information available on the historic presence or distribution of any of these species. The ten survey and manage species and a brief habitat description of suitable habitat are listed in Table 3-27.

Table 3-27: Known Or Suspected Survey and Manage Amphibians and Mollusks

Species	Suitable Habitat
Larch Mountain salamander	Steep, talus slopes, cave entrances, mature and old growth forest
Van Dyke' s salamander	Streams, seeps, cave entrances, lake shores
Columbia Duskysnail	Cold, well oxygenated springs
Puget Oregonian Snail	Moist conifer forest with hardwoods
Evening fieldslug	Forested areas below 2000 feet .
Warty jumping slug	Mesic to moist conifer forest
Malone jumping slug	Moist conifer plant associations
Panther jumping slug	Deep forest floor litter below 3000 feet
Blue-gray tail-dropper slug	Conifer forests
Papillose tail-dropper slug	Conifer forests with hardwood component

At the present time, there have been no surveys or inventories conducted for any of the species listed in the above table. However, one known population of Larch Mountain salamanders has been documented in the 01K (Lower Clear Fork Cowlitz River) sixth-field watershed. Based on the relative abundance of steep talus slopes in the watershed, it is quite likely that other populations of Larch Mountain salamanders exist. The "special and unique habitat" map shows rock outcrops and talus slopes where this species may occur. To comply with current guidelines, surveys would be required where ground disturbing activities may occur and have an impact on suitable Larch Mountain habitat. There is one known location of Van Dyke's salamanders in Mt. Rainier National Park.

Northwest Forest Plan Protection Buffer Species

The *Northwest Forest Plan* afforded extra protection for a selected group of wildlife species that were considered rare or locally endemic. Of this group of species, those with the potential for occurrence in the watershed include: North American lynx, great gray owl, black-backed woodpecker, fringed myotis bat, silver-haired bat, long-eared myotis bat, long-legged myotis bat, and the pallid bat. None of these species have been documented to occur, however, surveys have not been conducted.

The North American lynx is listed as a strategy 3 survey and manage species. Surveys within the region are being conducted and include portions of the Gifford Pinchot National Forest. At this time, survey areas on the Gifford Pinchot National Forest have been designated, but survey results will not be available until December 1998. For additional information, see lynx discussion under the threatened and endangered species section.

Habitat modeling for the great gray owl has been completed for the entire Gifford Pinchot National Forest. Suitable nesting habitat in the Clear Fork watershed has been identified in the Goat Rocks and William O. Douglas Wilderness areas. Surveys for the great gray owl have not been conducted on National Forest lands. National Park Service records list one great gray owl sighting near Cayuse Pass in 1986.

The *Northwest Forest Plan* lists five species of bats (fringed myotis, silver-haired, long-eared myotis, long-legged myotis, and pallid bat) requiring special attention. Within the *Northwest Forest Plan* matrix and adaptive management areas, surveys are required of caves, mines, abandoned wooden bridges and buildings to determine the presence of roosting bats. None of these species have been documented to date.

Reference and Current Condition - Big Game Habitat

Black-tailed Deer and Roosevelt/Rocky Mountain Elk

Black-tailed deer have always been present in the Clear Fork watershed, although historical records on elk presence indicate that they were rather scarce until the 1950's. Historically, populations of these species were dictated by natural or man-caused fires which would provide expanses of open forage habitat. The native people were experienced hunters and gatherers, but it is unknown what effect they may have had on deer and elk populations. As European settlers began moving into the Cowlitz Valley in the late 1800's, they also practiced subsistence hunting.

The first Forest Service inventory of fish and game resources on the National Forest occurred in 1936. Andy Roth, biologist, assisted by district rangers, CCC employees and other Forest Service personnel, hiked, snowshoed, skied and drove approximately 5,600 miles across the entire Columbia National Forest as it was named at the time. Their inventory delineated summer and winter ranges, estimated numbers of animals, defined forage conditions, and made some projections on animal mortality. The inventory of range conditions and species presence indicated that few elk were present in the watershed and were primarily confined to areas near the crest of the Cascade Range. It was assumed that these Rocky Mountain elk wintered in the Tieton River drainage east of the Clear Fork watershed. Within the next several decades, Rocky Mountain elk and Roosevelt elk from the Mt. St. Helens herd began occupying and establishing themselves throughout the watershed, particularly as regeneration timber harvest provided additional foraging habitat.

Currently, deer and elk are still an important ecological and recreational resource in the watershed. They are a major viewing attraction for forest visitors and have value to hunters. It is difficult to estimate how many forest visitors recreate in the watershed with the specific purpose of viewing wildlife. Big game hunting, however, does provide a substantial boost to the local economy in the Cowlitz valley. Data is available from the Washington Department of Fish and Wildlife on big game hunting within this area. From 1986 to 1996, the number of deer legally harvested annually ranged from 350 to 470 animals (bucks and does) and for elk the annual legal harvest has ranged from 135 to 295 animals (bulls, cows, and calves). Weather conditions typically have the greatest effect on harvest rates. Included in these harvest figures are animals that summer within Mt. Rainier National Park and begin migrating south on to National Forest winter range during the hunting season. Within this same ten-year period (1986-1996) an average of 29,500 hunter-use days were spent annually in the Cowlitz Valley Ranger District including the Tatoosh and Goat Rocks Wilderness areas during the combined deer and elk hunting seasons. These figures would suggest a boost in the local economies of Packwood and Randle from the purchases of restaurant meals, motel lodging, and other supplies during the months of September through November.

Deer and elk have been designated as management indicator species, and the GP Forest Plan has specific guidelines for the management of deer and elk winter range habitat. Approximately 5 percent of the watershed (6,791 acres) is within the elevational range defined as big game winter range (below 2,200 feet in elevation). This acreage is located in the Muddy Fork and lower Clear Fork of the Cowlitz River and the lands along the Ohanapecosh River as displayed on Map 15, Deer and Elk Biological Winter Range. Table 3-28 displays the current habitat condition of the deer and elk biological winter range. To Summarize this data, winter range cover/forage conditions within National Forest, Mt. Rainier National Park and private lands have been combined. Approximately 109 acres (2 percent) of the winter range is on private land, 1,220 acres are within the National Park, and 5,462 acres are on National Forest.

Table 3-28: Deer and Elk Biological Winter Range Acres and Percent By Cover Condition for the Clear Fork Watershed

	Optimal Cover	Thermal Cover	Hiding Cover	Open Forage	Total
Acres	4,633*	1,204	683	271	6,791
Percentage	68%	18%	10%	4%	100%

* These acres were developed from a vegetation database and have not been field verified.

Optimal cover would be defined as those forested stands averaging greater than 21 inches dbh with four canopy layers and an overstory generally exceeding 70 percent canopy closure. Thermal cover stands are defined as forested stands averaging 9-20 inches dbh and greater than 60-70 percent canopy closure. Hiding cover is usually reached when forested stands are tall enough to screen animals, approximately four and a half feet tall. Open forage include both natural openings (meadows, shrublands etc.) and regeneration harvest openings up until about age 20. Occasionally, heavy commercial thinnings can also be considered as temporary forage openings if the retention trees have a canopy closure less than 50 percent.

Land allocations within the winter range include portions of the Tatoosh Wilderness, Mt. Rainier National Park, and the Packwood Late-Successional Reserve (LSR). Approximately 160 acres of winter range are within the Matrix allocation in sixth-field 01A (Lower Muddy Fork Cowlitz River), and would permit very limited regeneration timber harvest. Any timber harvest within the LSR acreage would be limited to commercial thinning of forested stands less than 80 years of age.

Road densities in deer and elk winter range should not exceed 1.7 miles of open road per square mile of land. There are approximately 29.5 miles of road within the biological winter range which is equal to 2.8 miles of road per section of land. Almost 10.5 miles of that amount is either state or federal highway. Several road closures are in effect during the winter months that reduce the total open road mileage to approximately 24.5 miles during the winter months or 2.3 miles per square mile. There may be opportunities in the future to propose some additional road closures to decrease the amount of National Forest roads open during the winter months.

Mountain Goat Habitat

Archaeological data indicate that mountain goats have resided in the Clear Fork Cowlitz watershed for at least the last 400 years. The native people hunted mountain goats long before the first European settlers arrived in the Cowlitz River valley. It is unknown what impact the Native Americans may have had on goat populations. The earliest data collection on goat populations was not conducted until the 1920's and populations were assumed to be relatively stable from that period until 1961 (Scharpf, 1993). Timber harvest, road construction into goat range, and legal and illegal hunting after 1961 contributed to a reduction in goat numbers, primarily on National Forest lands. Mountain goat populations are thought to be stable at the present time as a result of road closures, reduced timber harvest in goat range, and a reduction in the number of goats annually harvested. Goat numbers are estimated at 230-300 animals on the Gifford Pinchot National Forest, with the majority located in the Clear Fork Cowlitz River and adjacent Upper Cowlitz River watersheds.

Similar to deer and elk, mountain goats are an important wildlife resource in the watershed. They are a major viewing attraction, particularly for National Park visitors. Within the National Forest lands, viewing opportunities from road systems are rather limited, however, goats may occasionally be seen during the winter months on the cliffs above the Ohanapecosh River near the entrance to Mt. Rainier National Park.

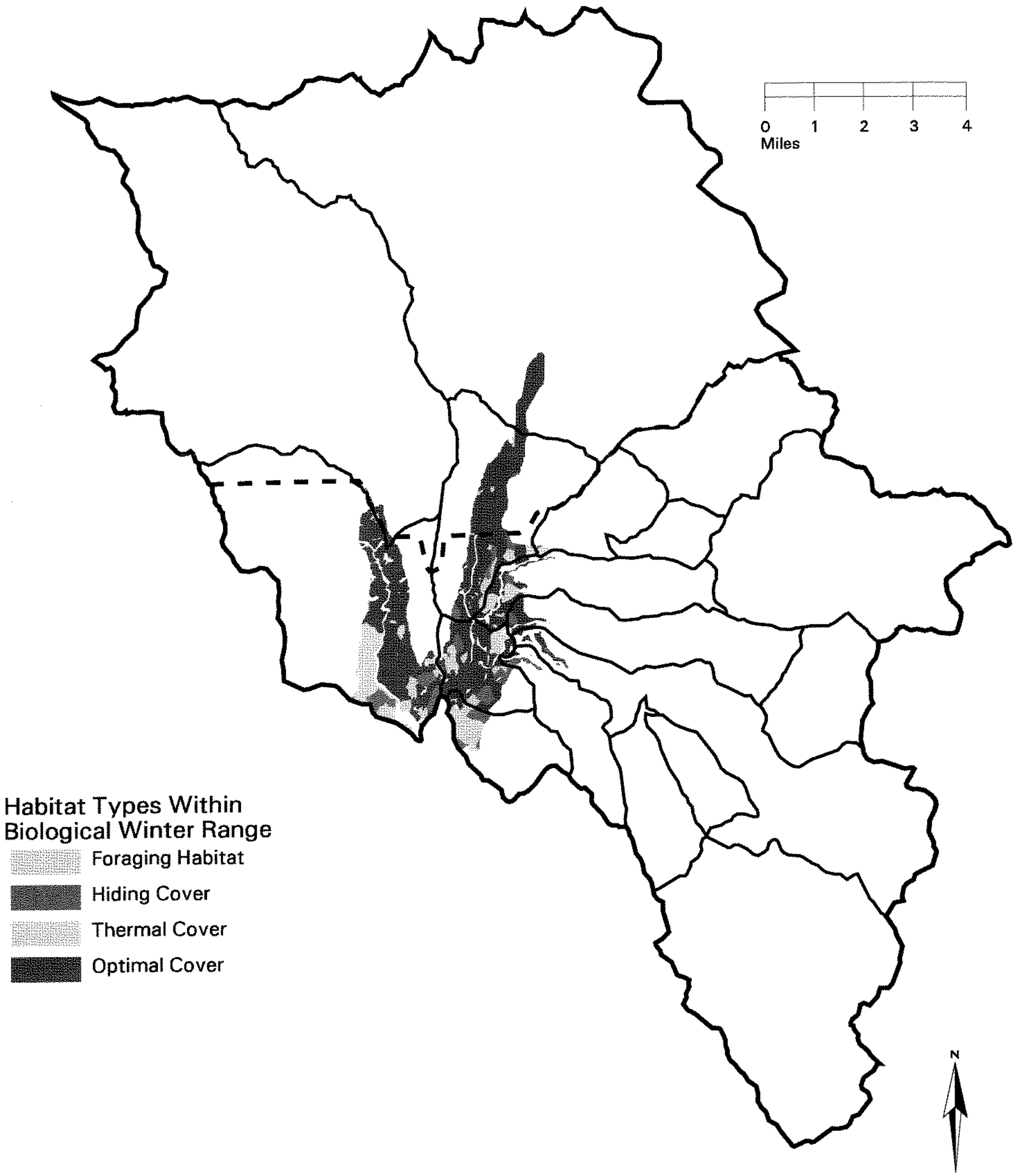
Mountain goats are a "game" species and are managed by the Washington Department of Fish and Wildlife through strictly regulated hunting seasons. The department establishes hunting seasons, defines hunting methods (archery, muzzle loader, or modern rifle), and sets the annual allowable harvest rate. Over the last 10-year period, there have been 10 permits issued annually for the Goat Rocks Wilderness and 5 permits for the Tatoosh Wilderness. Success rates are typically very high for those applicants receiving a permit (Huang, personal communication 1998). No hunting is permitted within the boundaries of Mt. Rainier National Park.

The Gifford Pinchot National Forest has designated the mountain goat as a management indicator species. Within the Clear Fork watershed there are five areas that have been allocated as summer or winter range habitat for mountain goats. There have been a total of 3,875 acres allocated as mountain goat summer range, of which approximately 2,312 acres (60 percent) are currently functioning as thermal or optimal cover stands. The remaining summer range acreage would be classified as hiding cover and openings including avalanche chutes, meadows, rock outcrops, and regeneration harvest units. There have been a total of 3,039 acres allocated as

Map 15

CLEAR FORK WATERSHED ANALYSIS

Deer and Elk Biological Winter Range



mountain goat winter range, of which approximately 2,062 acres (68 percent) are currently functioning as optimal or thermal cover stands. The remaining winter range acres would be classified as hiding cover and openings including avalanche chutes, meadows, rock outcrops, and regeneration harvest units.

Reference and Current Condition - Habitat Connectivity

Connectivity can be defined as the measure of the extent to which the landscape pattern of the late-successional/old-growth ecosystem provides for biological and ecological flows that sustain late-successional/old-growth animal and plant species (FEMAT 1995). Connectivity is species specific and is related to each species' mobility, population size and distribution, and degree of dependence on a particular habitat type. Animals interact with the landscape at three different scales: within the home range, within a population, and between populations. If habitat patches are not large enough to support self-sustaining populations, connectivity can compensate for the deficiency.

From a historical perspective, connectivity was influenced primarily by fires, volcanic events, and floods. Fire events ranged from less than one acre burns to those involving thousands of acres which could drastically alter connectivity between patch types.

Riparian Connectivity

Table 3-29 displays the current and historical vegetative condition of the riparian zones within the Clear Fork watershed.

Table 3-29: Riparian Zone Vegetation Composition

Year	Large Tree Acres (%)	Small Tree Acres (%)	Grass / Pole Acres (%)	Non-Forest Acres (%)	Total Acres
1998	15,010 (42%)	6,134 (17%)	1,645 (5%)	12,911 (36%)	35,700
1880	7,404 (21%)	11,936 (33%)	3,516 (10%)	12,844 (36%)	35,700

Historically, where forested riparian zones were present, the majority of the sixth-fields were generally well-connected. The exceptions were two sixth-fields, 01A (Lower Muddy Fork Cowlitz River) and 01T (Upper Muddy Fork Cowlitz River), in which the riparian areas were in a grass/pole condition in 1880 that resulted from a fire. The lack of small or large tree character in these riparian areas would have severely restricted dispersal capability for those species dependent on mature or late-successional forest riparian habitat within those two sixth-fields.

Currently, small and large tree riparian habitat connectivity is excellent within the sixth-fields in Mt. Rainier National Park. Large tree connectivity is poor, however, in several sixth-fields including 01D (Lower Summit Creek), 01F (Lower Carlton Creek), 01H (Cyrenus Creek), and 01N (Dam Creek). Poor connectivity in these areas is primarily due to regeneration timber harvests, with the replanted stands not having reached a large tree condition yet.

Terrestrial Connectivity

Ridgetops provide travel corridors for species associated with higher elevations including mountain goats, lynx, and wolverine. Ridges may also function as migration routes for deer and elk moving between summer and winter ranges. Historically, small tree stands comprised the largest acreage category of forested stands and were the most well-connected across the watershed. Over 45,000 acres (33 percent) of the watershed was classified as small tree stands in 1880. Large tree stands encompassed about 30,000 acres (22 percent) of the watershed and were most prevalent in sixth-fields 01L (Upper Clear Fork Cowlitz River) and 01S (Upper Ohanapecosh River). Patches of large tree stands ranged from 1,000 to about 7,500 acres in size, but were not connected to each other except by small tree stands. It is likely that this combination of connected small and large tree stands did not present much of a problem for species dispersing through the watershed. Approximately 13,000 acres (10 percent) of the watershed was classified as grass/pole stands primarily resulting from a fire previous to 1880. These stands were primarily located in sixth-fields 01A (Lower Muddy Fork Cowlitz River) and 01T (Upper Muddy Fork Cowlitz River). About a dozen smaller grass/pole stands were present in the watershed as a result of small fire events.

The current condition shows a reduction in small tree stands to approximately 14,000 acres (14 percent) of the watershed, and these stands are mostly in blocks averaging 1,000 to 3,000 acres in size. Large tree stands have increased to approximately 62,000 acres (45 percent) of the watershed. Large tree stands are connected from north to south through the watershed although some narrow constrictions are present in the Lower Summit Creek (01D), Lower Carlton Creek (01F), and Lower Cortright (01I) sixth-fields as a result of regeneration timber harvest. Grass/pole stands have been reduced to about 7,500 acres (6 percent) of the watershed. This is primarily the result of the grass/pole stands in 1880 maturing into small tree and large tree stands. Most of the current grass/pole stands are the result of regeneration timber harvests, although some small fires have also occurred in Wilderness and Mt. Rainier National Park. The amount of non-forest acreage has basically remained the same at 35 percent or approximately 48,000 acres.

Roads

There is a total of 150.9 miles of road within the Clear Fork watershed. When divided by the 137,905 acres of land (215.5 sections) the average road density per section of land is 0.7 miles. Road densities by sixth-field ranges from 0.0 miles per square mile of land in 01L (Upper Clear Fork Cowlitz River) to 3.9 miles of road per square mile of land in 01R (La Wis Wis). Many of the sixth-field watersheds are partially or completely within Wilderness or Mt. Rainier National Park with road densities less than 1.0 miles of road per square mile of land (01A, 01E, 01G, 01J, 01P, 01Q, and 01S). These low road density sixth-fields are the most suitable habitats for species such as the gray wolf, grizzly bear, California wolverine, and North American lynx, which avoid areas with high levels of human disturbances.

Pileated Woodpecker and American Marten Network

To meet management objectives for these species, the Gifford Pinchot National Forest Land and Resource Management Plan required the establishment of dedicated land allocations for the marten and pileated woodpecker. There were no allocated areas set aside for these species within the Clear Fork watershed.

Aquatic Elements

Disturbance Regimes - Geological Processes

Data Sources/Data Gaps

- Information regarding seismic activity was taken from the literature, and from data stored in the Pacific Northwest Seismograph Network (PNSN) database housed at the University of Washington Geophysics Department, and is given a high degree of reliability at the scale of the total project area. Information related to volcanic activity in the study area is taken from the literature, the USGS Cascade Volcanic Observatory (CVO) web page, and from field visits with Norm Banks and other members of the US Geological Survey (CVO) during 1996-1997.

- Locations for mass wasting events were identified using a GIS coverage called ``GeoHaz" (see Map 16, Mass Wasting Inventory). Three major flood events have occurred since the original version of GeoHaz was completed early in 1994; these floods occurred in December 1994, November 1995, and February 1996. The GeoHaz coverage has subsequently been updated using special flight photography, aerial video and still photographic footage, and site visits. GeoHaz is generally accurate, meaning that most landslides out on the ground have been identified by GeoHaz, and most of the slides shown by GeoHaz would be found on the ground. However, a known weakness of GeoHaz is that small failures along stream channels and roads are under-represented; more of these small failures exist on the ground than are shown on the coverage. Due to time limitations, neither a field review nor a complete aerial photograph review of the entire watershed was conducted for the Mass Wasting portion of this watershed analysis; this is an office exercise, with information derived from the most readily available data sources. Where possible, the writer's past field experience from various projects in the study area was also applied.

- Due to time limitations, aerial photograph sequencing to compare the rate of "naturally occurring" mass wasting events to "human-caused" mass wasting events was not undertaken for this project. However, qualitative determinations regarding the rate of human-related mass failures compared to naturally-occurring mass failures throughout the rest of the watershed during a given time span were made using the existing GeoHaz coverage and aerial photograph reviews for past projects in this study area. This time span, referred to below as Reference Conditions, usually refers to the 1973-1993 period of aerial photograph coverage, and sometimes extends back to 1959 aerial photographs when noted. This brief time span is entirely too short to use in determining a *Range of Natural Variability* for mass wasting, therefore, it is referred to as Reference Conditions. When discussing the comparison of management-related mass wasting events to historic conditions, the following qualitative descriptions were used:

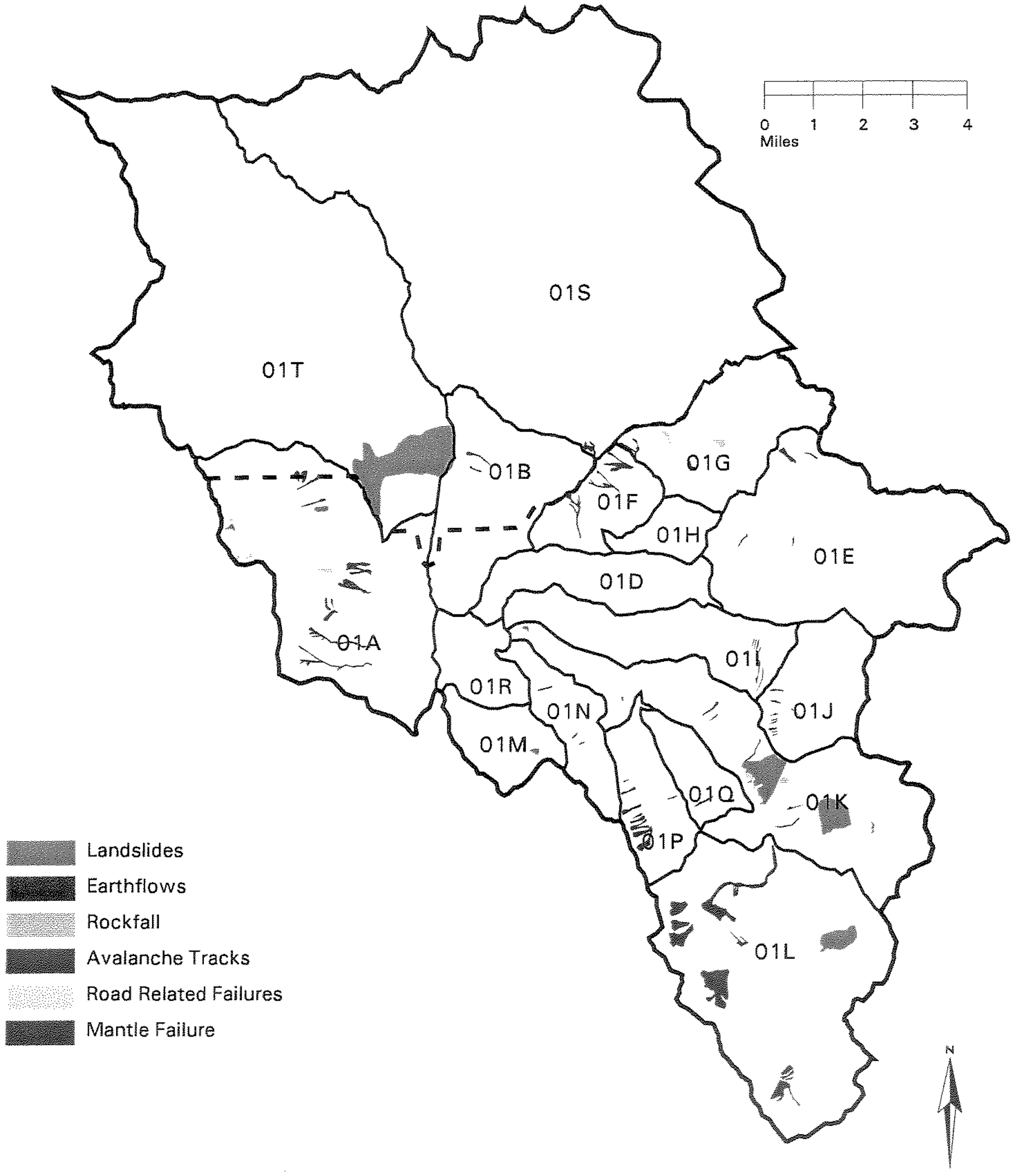
  Slight: a few small road- and harvest-related failures have occurred, separated in both time and space; these occurrences are virtually indistinguishable from the background rate of mass wasting.
  Moderate: several road- and harvest-related failures have occurred over space, with some of these being repeat failures in the same location through time.
  High: numerous road- and harvest-related failures have occurred over space, with several of these being repeat failures in the same location through time.
  Severe: numerous road- and harvest-related failures have occurred over space, with numerous repeat failures occurring chronically at the same location through time.

- Information for hillslope erosion was taken from the forest GIS coverage Soil Resource Inventory (SRI) map. Note: A descriptor for "Potential Soil Erosion" was not available for soils maps from Mount Rainier National Park. Polygons delineating soil types are thought to be accurate at the watershed scale, although details will vary in accuracy at the site level. Interpretations of ``surface soil erosion potential" were taken from the SRI handbook, and applied across the watershed as a rating of "Low", "Moderate", or "High". No information on historic levels of hillslope erosion is known to exist for this watershed. It is surmised that

Map 16

CLEAR FORK WATERSHED ANALYSIS

Mass Wasting Inventory



hillslope erosion has been an important process following fires known to have burned in the area, but no data is currently available with which to quantify those changes.

- Road condition surveys (Access and Travel Management, Phase II) are only available for small portions of this watershed and , therefore, were not used consistently across the watershed. Another source of information that was used regarding road conditions was the flood damage assessment forms on file in the Engineering Department, Cowlitz Valley Ranger District. A summary of these reports lists flood damage sites from high water events in 1977-1997, and estimated costs to repair these sites to a similar standard as before the flood events.

Reference (Historic) and Current Conditions - Volcanic Eruption and Seismic Activity

Mount St. Helens has deposited ash and pumice across the Clear Fork watershed at least twice over the last 500 years; once during the eruption of 1480 AD that produced the Wn tephra layer (Yamaguchi 1983), and again in Spring/Summer, 1980. The eruption of about 3,500 years ago (Mullineaux, *et al.* 1975) also left thin but recognizable deposits of the Yn layer. Fine pumice and ash covered much of this study area to a depth of less than 1 inch following the 1980 eruption (Pfeifer and others, personal communication 1997); erosion of this ash into streams accounts for a substantial proportion of the fine sediment delivered to streams for several years afterward. Mount St. Helens has erupted about once every century for the last 500 years, and is expected to follow a similar pattern into the centuries ahead (Crandell and Mullineaux 1978).

Mt. Rainier is a historically active, though currently dormant, stratovolcano that dominates the northern part of the watershed, and forms the headwaters of the Muddy Fork Cowlitz River. At least ten tephra-producing eruptions have occurred over the last 6,550 years, with additional mudflow deposits found that do not correlate with known eruptive events (Banks *et al.* 1998; Scott *et al.* 1995, Crandell 1971). At least six substantial mudflows from Mount Rainier have travelled some distance down the Cowlitz River valley to as far as Riffe Lake. The oldest of these mudflows appears to have been deposited 9,000-11,000 years ago, while the youngest runout deposit from a lahar has been dated at about 550 BP (Banks *et al.* 1998). "Mt. Rainier is potentially the most dangerous volcano in the Cascade Range because of its great height, frequent earthquakes, active hydrothermal system, and extensive glacial mantle. Many debris flows and their distal phases have inundated areas far from the volcano during postglacial time" (Scott *et al.* 1995). According to recent hazard maps published for the area (Scott and Vallance, 1995), most of the Cowlitz River valley downstream of this study area could be inundated by a mudflow to a depth of 60-200 feet, with or *without* an associated volcanic eruption (Map 17, Areas of Inundation by Potential Mudflows from Mount Rainier). Field studies by Banks *et al.*

(1998) have documented mudflow deposits along the Cowlitz River upstream and downstream from Packwood that reached depths of at least 10-15 feet above the current river level.

Seismic activity in the form of small earthquakes (most less than 2.0 magnitude on the Richter scale) occurs on the average of approximately 6-20 per decade underneath the planning area, with occasional larger earthquakes of magnitude 4 to 5. The very limited information available suggests that larger earthquakes (magnitude 6 and greater) appear to occur in western Washington on the order of once every several centuries. It is possible that some of the large, deep-seated landslides in this study area were caused or reactivated during these large seismic events. Just to the west of this watershed, drowned trees in two lakes formed by landslides, Packwood Lake and Glacier Lake, have been radiocarbon dated at about 1,120 and 660 years BP respectively.

Reference (Historic) and Current Conditions - Mass Wasting

01A Numerous avalanche tracks are present on the west side of the Muddy Fork Cowlitz River, draining down off the steep and dissected Tatoosh Range. The rate at which avalanches occur in this watershed has not yet been determined. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. This watershed also has an additional source of mass wasting in the form of mudflows from Mount Rainier that may be associated with volcanic eruptions, or may occur when unstable portions of this massive volcano simply give way to gravity. There are a few small road failures known to occur within this watershed.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01B A few avalanche tracks exist in this watershed. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. The existing road system (State Highway 123) often uses bridges over major stream crossings, and no road failures are known from this watershed.

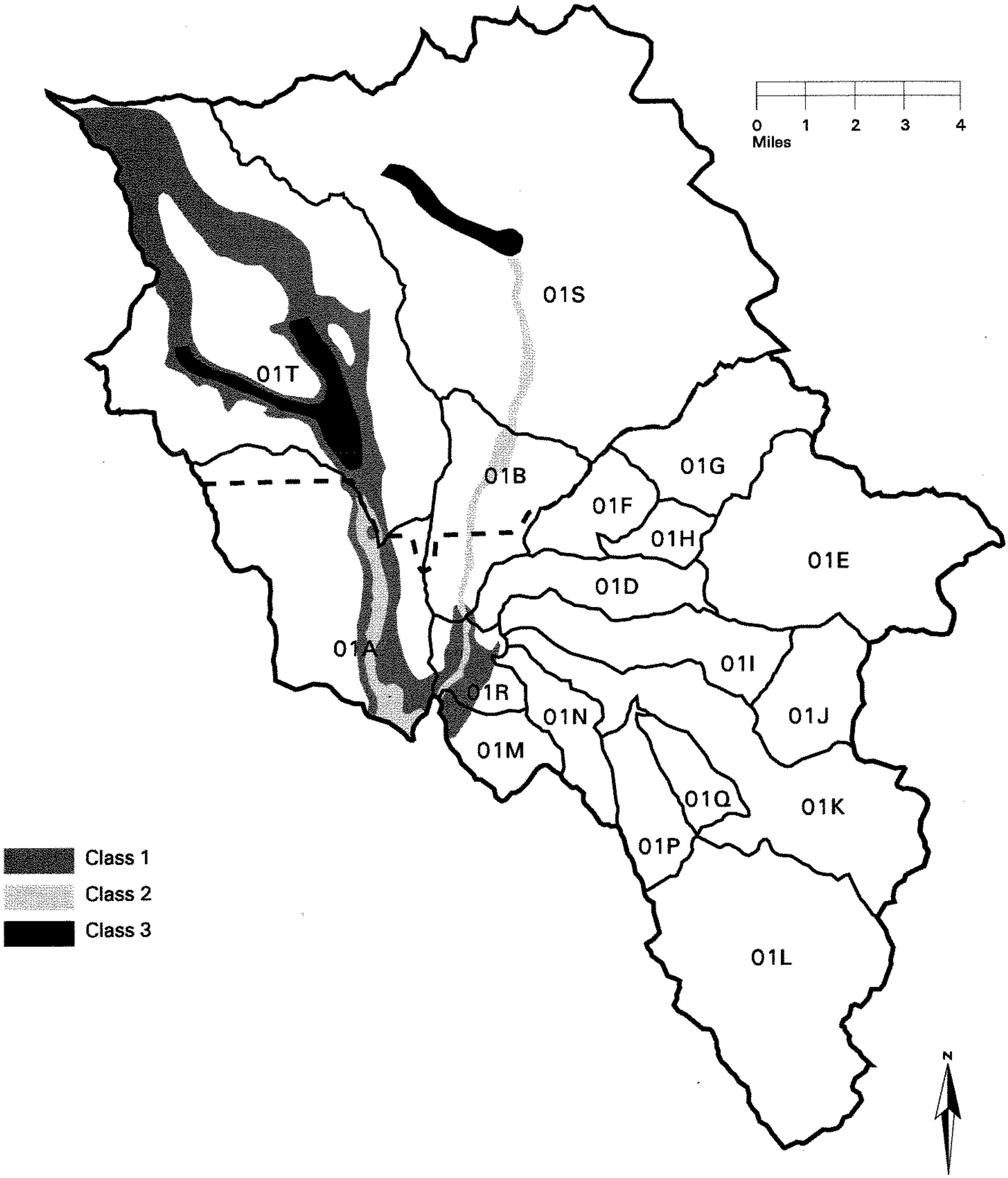
Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01D There are no avalanches or landslides mapped in Lower Summit Creek, although a number of small, unmapped landslides and debris flows, not readily visible in aerial

Map 17

CLEAR FORK WATERSHED ANALYSIS

Area of Inundation by Potential Mudflows from Mt Rainier



photographs, are believed to occur under the forest canopy and along steeper stream channels. There have been a few road-related failures along the Forest Road 4510 system, usually in the form of washed-out culverts and cutbank failures.

Mass failures related to management activities occur at a *Moderate* rate compared to reference conditions in this watershed.

01E There are a few avalanche tracks and naturally-occurring earth flows mapped in the Upper Summit Creek watershed. Talus slopes also contribute coarse sediment to streams in places. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01F Several avalanche tracks have been mapped in the Lower Carlton Creek watershed, although the rate at which these events occur is not known. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. A few road-related failures have occurred along the Forest Road 44 system, usually in the form of washed-out culverts and small cutbank failures.

Mass failures related to management activities occur at a *Moderate* rate compared to reference conditions in this watershed.

01G Several avalanche tracks, earthflows, and areas of rockfall are mapped in the Upper Carlton Creek drainage. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01H No avalanche tracks or landslides have been mapped in the Cyrenus Creek drainage, although a number of small, unmapped landslides and debris flows not readily visible in air photos are believed to occur under the forest canopy and along steeper stream channels. There are also no road failures mapped in this watershed.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01I Several small avalanche tracks are mapped in the Lower Carlton Creek drainage. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. There have been a number of small culvert washouts, cutbank failures, and fill failures along the Forest Road 45 system.

Mass failures related to management activities occur at a *Moderate* rate compared to reference conditions in this watershed.

01J Numerous small avalanche tracks have been mapped in the Upper Cortright Creek drainage. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. A couple of small road failures have also occurred along the Forest Road 45 system in this watershed.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01K Two large, deep-seated landslides have been mapped in the Lower Clear Fork Cowlitz River drainage. Both appear to have occurred in prehistoric times, and both appear to have affected the channel of the Clear Fork Cowlitz River. The level of activity within these slides is unknown, but areas of repeated maintenance along U.S. Highway 12 are known to occur within these areas. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. Several additional areas of sidecast failure have also been mapped along U.S. Highway 12.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01L Numerous avalanche tracks off of the Goat Rocks volcanic complex are mapped within this sixth-field. A large, deep-seated landslide is also mapped to the west of Hogback Ridge. A large, natural landslide occurred in the winter of 1996; this slide translated into a massive debris flow that travelled down Coyote Creek to enter the Clear Fork Cowlitz River. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01M One small, naturally-occurring landslide has been mapped in the headwaters of Purcell Creek. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. There have been several road-related failures within this watershed.

Mass failures related to management activities occur at a *Moderate* rate compared to reference conditions in this watershed.

01N A few small avalanche tracks and debris flows have been mapped along Dam Creek. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. A few small road failures have occurred along the Forest Road 46 system.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01P Numerous avalanche tracks have been mapped along the west side of the Lava Creek drainage. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. No road-related failures have been mapped in this watershed.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01Q A few small avalanche tracks have been mapped in the Little Lava Creek drainage. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. No road-related failures have been mapped in this watershed.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01R No avalanche tracks or landslides have been mapped in this watershed. However, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur under the forest canopy and along steeper stream channels. There have been a few road-related failures along U.S. Highway 12, and the Forest Road 46 and 1270 systems.

Mass failures related to management activities occur at a *Moderate* rate compared to reference conditions in this watershed.

01S A number of avalanche tracks are known to occur within this large and rugged drainage, although a map of these is not known to exist. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur along steeper stream channels, and under the forest canopy (where present). A few road-related failures are known to have occurred along State Highway 123. This sixth-field also has a source of mass wasting in the form of mudflows from Mount Rainier that may be associated with volcanic eruptions, or may occur when unstable portions of this massive volcano simply give way to gravity. Class 1, 2, and 3 mudflows have occurred, and will occur again, within this watershed.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

01T A large, deep-seated landslide has been mapped within this watershed; it appears to have occurred during prehistoric times and travelled west of the Cowlitz Divide to displace the course of the Muddy Fork Cowlitz River. In addition, a number of small, unmapped landslides and debris flows, not readily visible in aerial photographs, are believed to occur along steeper stream channels, and under the forest canopy (where present). A few road-related failures are known to have occurred along the Stevens Canyon turnoff from State Highway 123. This sixth-field also has a source of mass wasting in the form of mudflows from Mount Rainier that may be associated with volcanic eruptions, or may occur when unstable portions of this massive volcano simply give way to gravity. Class 1, 2, and 3 mudflows have occurred, and will occur again, within this watershed.

Mass failures related to management activities occur at a *Slight* rate compared to reference conditions in this watershed.

Reference (Historic) and Current Conditions - Hillslope Erosion

Hillslope erosion occurs at low levels when bedrock is hard, sideslopes are shallow (less than 30%), and/or vegetative cover is dominant. Hillslope erosion increases as the sideslopes increase, when the bedrock is weak and crumbling, when vegetative cover is removed, and/or when flowing water is routed onto hillsides where water does not ordinarily flow. Based on the SRI, most map units for the Clear Fork watershed were rated with a "Low" or "Moderate" surface erosion potential. There were several sixth-field watersheds along the crest of the Cascades, however, where some map units with a "Severe" erosion potential were noted; those watersheds include 01E, 01I, 01J, 01K and 01P.

Reference (Historic) and Current Conditions - Road Conditions

Erosion and mass wasting associated with roads have been identified as primary contributors of both coarse and fine sediments above the natural (background) rate to streams in this watershed. Note: There is no historic equivalent for erosion or mass wasting from roads. The natural processes of erosion continue, and all road-related sediment produced is *additional* to the background rate.

Approximately 150.9 miles of road currently exist on private and federally administered land within the watershed. There are 9 flood damage sites along the existing road system on federal land in the Clear Fork watershed. These sites are listed by watershed in Chapter 6, Management Recommendations.

Table 3-30: Road Condition and Flood Damage Information

Sixth-field	Size (acres)	Size (sq.mi.)	Rd. Density (mi./sq. mi.)	Flood Damage # Sites/est. cost
01A	10,908	17.0	0.5	
01B	5,351	8.4	2.3	
01D	3,060	4.8	3.4	3/$22,707
01E	10,021	15.7	0.1	
01F	2,230	3.5	1.6	
01G	4,636	7.2	0.2	
01H	1,163	1.8	1.5	
01I	4,037	6.3	2.8	1/$11,136

Table 3-30: Road Condition and Flood Damage Information				
Sixth-field	**Size (acres)**	**Size (sq.mi.)**	**Rd. Density (mi./sq. mi.)**	**Flood Damage # Sites/est. cost**
01J	3,102	4.8	0.5	
01K	9,168	14.3	1.7	
01L	12,544	19.6	0.0	
01M	1,965	3.1	1.9	1/$18,475
01N	2,159	3.4	1.7	
01P	2,387	3.7	0.4	
01Q	1,479	2.3	0.5	
01R	1,785	2.8	3.8	
01S	37,771	59.0	0.3	
01T	24,139	37.7	0.3	

Hydrology

Data Sources /Data Gaps

- Data sources include previous Forest Service field reviews done on National Forest land, stream surveys, and water quality data collected by the Forest Service.

Assumptions - Precipitation Events

- Best available data sources were used regarding historic precipitation events and how the areas affected by these events are impacting the Clear Fork watershed.

- Past stream flow studies, which have displayed the alterations in stream channel flows at different elevations, have given the Forest Service an understanding of the areas where alterations in the canopy cover (both stand age complexity and density) are most strongly expected to bring about changes in the release of high flows during storm events.

Precipitation and Rain-on-Snow Zones

The four precipitation zones within the analysis area consist of: rain-dominated, rain-on-snow, snow-dominated, and highland. These zones vary in the amount of annual precipitation, snow melt-off rates, and site specific geographic and climatic influences.

- *Rain-dominated zone*: Geographic zone at lower elevations where rain occasionally falls on small amounts of snow (Brunengo *et al.* 1992) which does not accumulate or last very long. This zone accounts for less than 1% (677 acres) of the analysis area and is primarily located in the lower basin area of the Lower Muddy Fork Cowlitz River (01A) sixth-field watershed.

- *Rain-on-snow zone:* In the Cowlitz River subbasin, the largest flows occur between December and February resulting from "rain-on-snow" events. Warm pacific maritime air masses moving into this area provide the moisture and energy to rapidly melt existing snow packs. In general, there are two scenarios most likely to produce undesirable effects. The first is where openings result in differences in snow water equivalent and snow depth. These differences result from eliminating canopy interception and melt, and the redistribution of the snowpack. Consequently, the opening would accumulate more snow, and be able to contribute more water during a subsequent rain-on-snow event. In the second case, greater wind speed and turbulence in an opening could increase the transfer of sensible and latent heats to the snow pack allowing the snow pack to release water during a rain-on-snow event (Harr 1986). In these transient zones, it is not unusual for shallow snow packs to melt completely during rainstorms. While the largest flows are rain-on-snow events, these events originate in elevations ranging from 1,500 to 3,500 feet. This zone accounts for a total of 10% (13,386 acres) of the analysis area and is primarily centralized in the lower elevations of the Muddy Fork Cowlitz River (01A), Ohanapecosh River (01B), La Wis Wis (01R), Lower Clear Fork Cowlitz River (01K), Lower Cortright Creek (01I), Lower Summit Creek (01D), and Purcell Creek (01M) sixth-field watersheds. Table 3-31 displays the percentage of rain-on-snow zone by sixth-field watershed.

- *Snow-dominated zone:* Geographic zone where normal winter precipitation is snow and deep snow pack accumulations occur. Consolidation of the snow pack is a result of warm winter storms. This zone accounts for 25% (34,995 acres) of the analysis area and is typified as a zone where melt occurs during rain-on-snow events (especially during early season storms), but effects can be mitigated by the lag time of percolation through the existing snow pack (Brunengo *et al.* 1992). Therefore, rain-on-snow events in this zone do not produce the same runoff responses that are produced in the rain-on-snow zone. This zone is most dominant in the Lower Summit Creek (01D), Lower Carlton Creek (01F), Cyrenus Creek (01H), Lower Cortright Creek (01I), Dam Creek (01N), and Little Lava Creek (01Q) subwatersheds (Table 3-31).

- *Highland zone:* Geographic zone consisting of higher elevations where deep snow packs accumulate. Winter rain is rare and normally will not contribute to rain-on-snow runoff rates. Effects of harvest on moisture runoff rates are minimal (Brunengo *et al.* 1992). This zone accounts for 64% (88,847 acres) of the analysis area and is most dominant in the Upper Muddy Fork Cowlitz River (01T), Upper Ohanapecosh River (01S), and Lower and Upper Clear Fork Cowlitz River (01K and 01L) basins as well as the Upper Summit Creek (01E), Upper Carlton Creek (01G), Upper Cortright Creek (01J), and Lava Creek (01P) sixth-field watersheds (Table 3-31).

TABLE 3-31: Precipitation Zones in Sixth-field Watersheds within the Analysis Area

Sixth-field Watershed	Sixth-field Number	Acreage	% Rain-dominated	% Rain-on-Snow	% Snow-dominated	% High-land
L. Muddy Fork	01A	10,908	6%	30%	24%	40%
U. Muddy Fork	01T	24,139	0%	4%	18%	78%
L. Ohanapecosh	01B	5,351	0%	45%	35%	20%
U. Ohanapecosh	01S	37,771	0%	5%	22%	73%
L. Summit Creek	01D	3,060	0%	29%	47%	24%
U. Summit Creek	01E	10,021	0%	0%	8%	92%
L. Carlton Creek	01F	2,230	0%	12%	71%	17%
U. Carlton Creek	01G	4,636	0%	0%	28%	72%
Cyrenus Creek	01H	1,163	0%	0%	64%	36%
L. Cortright Creek	01I	4,037	0%	15%	51%	34%
U. Cortright Creek	01J	3,102	0%	0%	2%	98%
L. Clear Fork	01K	9,168	0%	10%	34%	56%
U. Clear Fork	01L	12,544	0%	0%	22%	78%
Purcell Creek	01M	1,965	<1%	29%	38%	33%
Dam Creek	01N	2,159	0%	16%	52%	32%
Lava Creek	01P	2,387	0%	<1%	30%	70%
Little Lava Creek	01Q	1,479	0%	0%	68%	32%
La Wis Wis	01R	1,785	<1%	85%	1%	14%

Of these precipitation zones, events in the rain-on-snow zone pose the greatest threat to aquatic resources because they can produce very large and rapid runoff responses. These responses often exceed the channels ability to process the flow and can result in channel instability. Events in the highland zone pose the least risk to aquatic resources because these events generally result in an accumulation of "water" not an immediate release. In these areas, spring snow melt is the primary runoff mechanism. This type of runoff can generally be processed by the streams.

Flow Regime (WAR and ARP)

Data Sources/Data Gaps

- Flow data used in this analysis was collected by the Packwood Ranger District (U.S. Forest Service) and the U.S. Geological Survey (USGS).

- Two methods for predicting peak flow sensitivity for the subwatersheds in this area have been calculated for this analysis. The first, entitled WAR or Water Available for Runoff is detailed in the Washington State Standard Methodology for Conducting Watershed Analysis Handbook (Washington Forest Practices Board 1993). This method calculates predicted increase in stream flow associated with changes in vegetative cover based on rainfall, tree size, temperature, antecedent snow accumulation and elevation. The other method for predicting peak flow sensitivity, ARP (Aggregate Recovery Percentage), is detailed in the Gifford Pinchot Cumulative Assessment Process Final Report (1988). This method calculates a predicted hydrologic recovery for a basin based on stand year-of-origin, tree species, and site class, assuming that a stand is 100% hydrologically recovered once it reaches an average diameter at breast height (dbh) of 8 inches. This method does not rely on rainfall, temperature, or antecedent snow accumulation, and assumes non-forest forest land is at 100% hydrologic recovery. Aggregate Recovery Percentage (ARP) and Water Available for Runoff (WAR) peak flow models were developed by the Forest Service and the State of Washington. WAR was run in March 1996, and ARP was run in September 1998.

Assumptions

- The WAR model should only be used if 25% or more of a subbasin is located within the rain-on-snow zone (WFPB, 1993). For the remainder of the subbasins, this model is not appropriate because these drainages have spring snowmelt or rain-dominated hydrographs, and this model does not evaluate these flow regimes. For unmodeled sixth-fields, a low rain-on-snow risk is assigned (unless other evidence warrants a higher risk). For non-forested areas, including rock outcrops and meadows, this model assumes rapid runoff and greater snow accumulation and melt. WAR on National Forest and private lands was calculated using the current Gifford Pinchot National Forest GIS vegetation database and a digital elevation terrain model. WAR on National Park lands was calculated using vegetation data supplied by the Washington State Department of Natural Resources (DNR), and the following broad assumptions made about the elevations of each precipitation zone: the average elevation of the rain-dominated zone is 1,000 feet, rain-on-snow zone is 2,400 feet, snow-dominated zone is 3,500 feet, and highland zone is 4,100 feet. It is observed that the rain-on-snow zone is approximately 1,500 to 3,500 feet for this area. Therefore, WAR measurements are most likely to be low.

- When using WAR, errors in stream flow measurements are often on the order of 10%. This means that a change of <10% would be immeasurable and statistically insignificant. Therefore, given the inherent error in the peak flow prediction method, and the fact that peak flows up to 10% are generally below the detection limit, we expect no adverse effects from increases of this magnitude (low risk). A WAR value greater than 10% have the potential for adverse effects and require further analysis (moderate or high risk). The "Washington State Methodology for Conducting Watershed Analysis" (Washington Forest Practices Board 1993) assumes that a 5-year event is sufficient to cause deep bed scour in forest streams where fish typically spawn. It is also determined that fish habitat is significantly affected when either (1) the shear stress increases significantly, or (2) the discharge associated with a 5-year event occurs significantly more often. Although the volume of water necessary to move from a two-year to a 5-year event varies, an increase of 20% can be used as a "rule of thumb" for establishing a concern threshold. Since fish habitat is our primary beneficial use, a 20% increase in a two-year event makes a good starting point when assigning a high risk.

- The ARP calculated for National Park lands uses the following specific assumptions: the productivity class of the rain-dominated zone is high and this zone consists primarily of a Western Hemlock (CH) ecoclass; productivity for the rain-on-snow zone is moderate and this zone also consists of ecoclass CH; the productivity class for the snow-dominated zone is moderate and this zone consists of the Pacific Silver Fir (CF) ecoclass; and the productivity class for the highland zone is low and this zone consists of ecoclass CF. Estimated ages of the various stand types are assigned as follows: non-forest vegetation type is assumed to be agricultural, therefore, it is estimated at age 0; DNR grass/pole vegetation type is assumed to be age 20; DNR small tree is assumed to be age 50; and DNR large tree is assumed to be hydrologically recovered.

- Neither of the peak flow models account for soil compaction resulting from such activities as road construction and skid road use, or for the interception of subsurface flow and increased drainage density caused by road construction. Thresholds for each model are noted below.

    - WAR: 20% or greater - threshold for possible downstream flood damage and scour to fish spawning and rearing areas and stream channel degradation.

    - ARP: - 85%: National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) threshold of concern (low risk rating)

      - 70 to 85%: moderate risk rating

- 70% or less: threshold for seeing adverse effects including water quality and stream channel degradation (high risk rating).

- Rain-on-snow: 0-10% of a sixth-field watershed within the rain-on-snow zone is considered a low risk, 10-30% is considered a moderate risk, and >30% is considered a high risk (potential concern zone).

- Regional flood frequency regression equations used in WAR, including their estimate of confidence, provide a reasonable framework for evaluating the effects of forest harvest on peak flows over a watershed. The equations were based on data collected under a variety of land uses and forest patterns, including undisturbed, disturbed and mixed conditions. The effects of historically changing forest characteristics on the regional regression equations can not be evaluated.

- It is assumed that the snow regression equation used in WAR is derived from measurements representing hydrologically mature conditions. Snow measurements recorded by the Cooperative Snow Survey and the National Weather Service, are made under a variety of forest stands, although the climatic and topographic conditions of most measurement stations are unknown. The snow melt equation derived by the U.S. Army Corps of Engineers is thought to be appropriate for estimation of melt under rain-on-snow conditions.

- Increases in the magnitude of peak flows can affect aquatic resources through channel incision, bank erosion, and increased sediment transport capacity. Increasing the size of peak flows in small watersheds has several implications for both on site and downstream processes. Higher peaks can directly affect sediment routing in first and second order watersheds. If sediment and bedload is available, greater water velocities associated with the higher flows could move more material than would otherwise be the case. This is also true with suspended material and turbidity. Troendle and Olsen (1994) found that off-site sediment levels were highly dependent on flow, with stored sediments being released during large events. A second implication is that higher peaks in several small watersheds can have a cumulative effect downstream. Finally, the rate of melt can be altered leading to localized soil saturation and increases in pore water pressure sufficient to trigger landslides. Harr (1986) suggested that the presence or absence of vegetation may indeed be a critical variable in many situations.

Peak Flow Alterations

Table 3-32 displays peak flow ratings by rain-on-snow zone, WAR and ARP. "Peak flow rating" is interpreted as follows:

Low - Existing conditions would produce a runoff response close to normal

Moderate - While "normal" precipitation events will likely produce normal runoff response, large events can produce very large runoff responses. These responses could affect channel conditions.

High - Existing runoff response is likely highly altered. Very large rapid peaks exceeding those that would occur under natural conditions would likely affect channel conditions during "normal" precipitation events.

Table 3-32: Peak Flow Ratings by Rain-on-Snow Zone, WAR, and ARP

Sixth-field Watershed	% of Sixth-field Watershed in the Rain-on-Snow Zone	WAR - % Increase in Peak Flow during a 2-year Unusual Event	% ARP	Peak Flow Rating
L. Muddy*	30%	10.7	99%	Low
U. Muddy	4%	N/A	100%	Low
L. Ohanapecosh	45%	11.6	92%	Low
U. Ohanapecosh	5%	N/A	100%	Low
L. Summit*	29%	12.0	80%	Moderate
U. Summit	0%	N/A	98%	Low
L. Carlton	12%	N/A	86%	Low
U. Carlton	0%	N/A	98%	Low
Cyrenus*	0%	N/A	86%	Low
L. Cortright	15%	N/A	87%	Low
U. Cortright	0%	N/A	88%	Low
L. Clear Fork	10%	N/A	90%	Low
U. Clear Fork	0%	N/A	100%	Low
Purcell	29%	11.5	87%	Low
Dam	16%	N/A	81%	Low
Lava	<1%	N/A	97%	Low
Little Lava	0%	N/A	97%	Low

Table 3-32: Peak Flow Ratings by Rain-on-Snow Zone, WAR, and ARP				
Sixth-field Watershed	**% of Sixth-field Watershed in the Rain-on-Snow Zone**	**WAR - % Increase in Peak Flow during a 2-year Unusual Event**	**% ARP**	**Peak Flow Rating**
La Wis Wis	85%	11.8	86%	Moderate

* Private land or non-Forest Service land considered to be not recovered due to human influences such as road placement, housing development, and timber harvest, and are considered to have an ARP value age class 0.

If channel conditions indicate that the stream is not processing current stream flows or is in a declining condition, a high risk should be assigned. Concerns related to actual channel conditions always override information derived from either of the models. On the other hand, if the existing channel conditions show stability while the models indicate a high risk, a moderate risk could be assigned. Overall, only Lower Summit Creek (01D) and La Wis Wis (01R) have a "Moderate" peak flow rating, while the rest of the sixth-field watersheds have "Low" ratings. Therefore, it is expected that the runoff responses of this fifth-field watershed would be close to natural.

Flood Frequency

While a large portion of the Clear Fork watershed is within Wilderness or the National Park (approximately 80%), the history of major flooding should be addressed. The peak flow record for the Cowlitz River at the Packwood gauging station was divided into three periods for analysis: prior to 1955, 1955-1968, and 1969-1996. The flood flow frequencies for the Cowlitz River were calculated for these time periods and are shown in Table 3-33 (HARZA Northwest, Inc. 1997). The size of flows at all recurrence intervals has increased in each progressive time period.

Table 3-33: Flood Flow Frequencies, Cowlitz River at Packwood (USGS 14226500)						
Period	**Number of Peaks Analyzed**	**Recurrence Interval (years)/Flow (cfs)**				
		2	**5**	**10**	**20**	**100**
Pre-1955	34	12,800	18,700	23,100	27,500	38,800
1955-1968	15	12,800	19,400	24,900	31,000	48,600
After 1968	27	15,300	24,300	30,800	37,400	53,400

As the basin above Packwood has developed, larger flood events are becoming more frequent. For example, during the time period between 1955 and 1968, the 20-year event was 31,000 cfs. For the period after 1968, 30,800 cfs was a 10-year event (HARZA Northwest, Inc. 1997). Therefore, this same flow is now twice as frequent as it was in the earlier time period.

Water Quality

Data Sources /Data Gaps

- Data sources include previous Forest Service field reviews done on Forest Service land and private timber company lands, stream surveys, and water quality data collected by the Forest Service.

Assumptions

- Current habitat and channel conditions are assumed to have changed since stream surveys were conducted, due in part to the November 1995 and February 1996 floods.
- At this time multiple-day stream channel temperatures have only been collected in Cortright and Carlton Creeks. Data collected for stream temperatures within this report vary from max-min thermometer readings to instantaneous readings.
- Widths and depths included in this report are mostly observational and not necessarily measured at bankfull.

Reference (Historic and Current Conditions)

Detailed information on the Carlton Creek and Cortright Creek stream temperature measurements is presented below in Table 3-34. It should be noted that only 1 year (1997) of temperature measurements is available.

Table 3-34: Carlton and Cortright multi-day temperature measurements

Stream Name	Water Year	1-day maximum	7-day maximum
Carlton Creek	1997	13.5 degree Celsius	12.7 degree Celsius
Cortright Creek	1997	12.1 degree Celsius	11.2 degree Celsius

These temperatures are likely very near natural temperatures, and meet state water quality standards.

Riparian Areas and Stream Channels

Data Sources/Data Gaps

- Data sources for stream channels include previous USFS field reviews done on Forest Service land, and stream surveys conducted by the Forest Service. Refer to Map 18, Stream Classes.
- The source materials for riparian condition, both historic and present, are very limited in scope. The information contained in this document has been gathered from watershed analyses done on Forest Service land and private timber company lands; stream surveys conducted by the Forest Service; and using Forest Service SMART, Aquarun, and GPVEG databases.
- A riparian inventory was completed using 1993 aerial photographs to display both stand age and distribution of the existing species for individual streams. Refer to Map 19, 1998 Vegetation Structure in Riparian Reserves, for a display of the riparian vegetation within the analysis area.

Assumptions

- The data used to determine the currently existing riparian stand age contains some errors and is not 100% perfect. Errors are most likely to occur when estimating stand age based on aerial photograph interpretation.

Reference and Current Conditions - Connectivity and Fragmentation

Pre-1880 Conditions

Within National Forest and National Park lands, the oldest stands in the Riparian Reserves correspond to those areas that burned in the fires at or before 1700 A.D. (Map 7, Fire History). Areas for which there is no evidence of riparian fire for almost 300 years are present in the Upper Ohanapecosh River (01S), Lava Creek (01P), and Little Lava Creek (01Q) sixth-field watersheds. Early- to mid-seral stages were maintained in the riparian areas of these sixth-fields due to snow and debris avalanches in steep terrain. This affected many of the class III and IV stream channel riparian areas. Large woody debris is expected to have been common throughout these riparian areas. Along the lower reaches of streams, large trees killed or weakened by the 1860's fire may have fallen into the Ohanapecosh River or Muddy Fork Cowlitz River or some of the smaller class III streams.

Current Conditions

The stream fauna, flora, organic matter, nutrients, and physical and chemical environment form the structure of a dynamic, open ecosystem, closely linked to riparian habitat and changing progressively from headwaters to river mouth (Murphy and Meehan 1991). A critical function of intact Riparian Reserves is to maintain the spatial and temporal connectivity within and between watershed areas. There are lateral, longitudinal, and drainage network connections between wetlands, up slope areas, headwater tributaries, and intact refugia. One of the Aquatic Conservation Strategy Objectives (USDA, USDI 1994b) states that "[t]hese connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species".

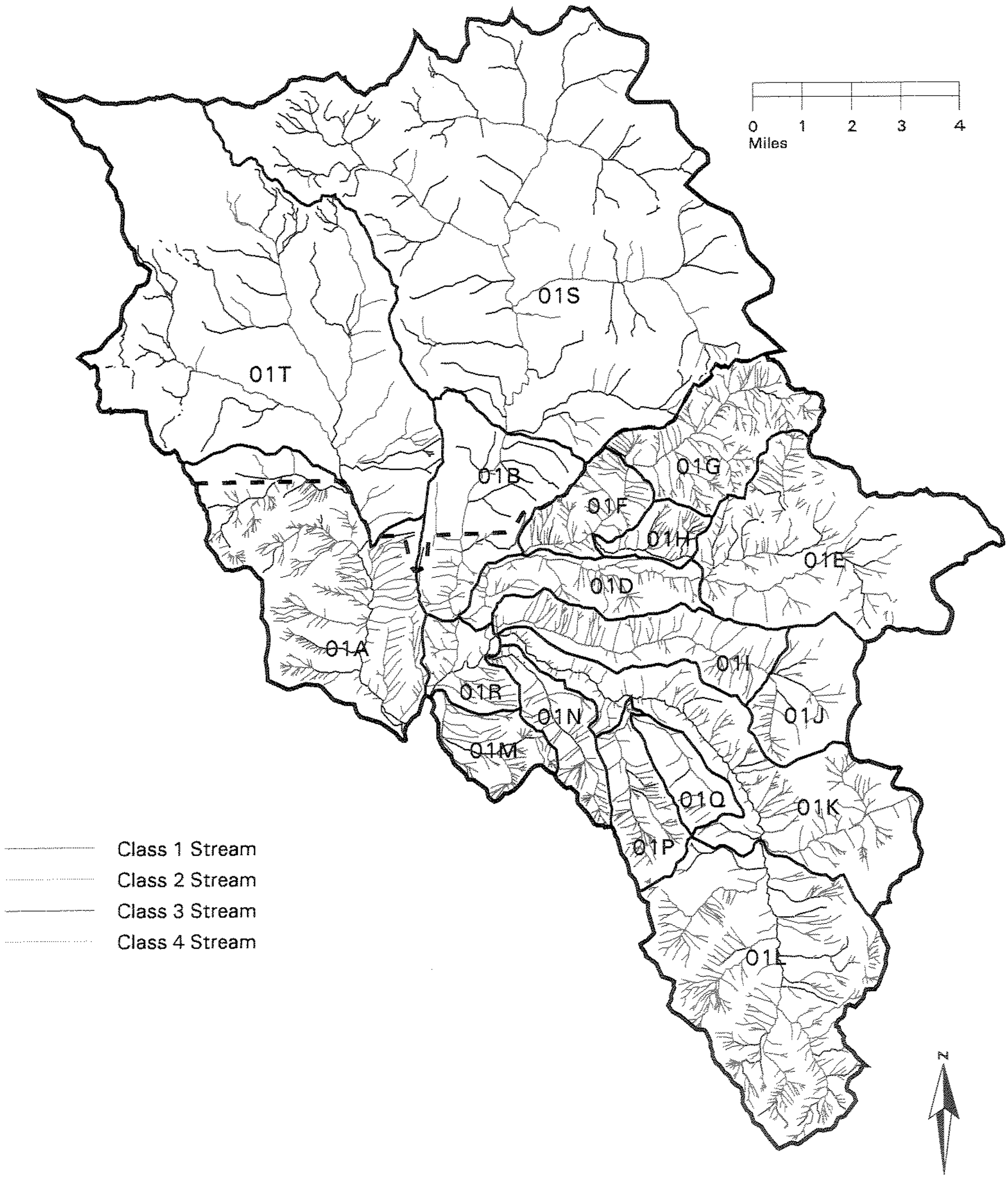
Land uses, especially timber harvest-related, result in an alteration of the riparian vegetation conditions (both existing structure and species, as well as densities), resulting in fragmentation of riparian areas. Salvage logging activities have been reported to reduce the number of standing large trees and number of in-stream logs, thereby reducing the large woody debris recruitment potential (Bryant *et al.* 1984, Bisson *et al.* 1987). Woody debris removal has resulted in a reduction in the amount of cover for rearing salmonids (Bilby and Ward 1989). Removal of trees from the stream channel system can also reduce stream-side shade and increase water temperatures, which is detrimental to aquatic organisms. Within the analysis area, there are approximately 39.8 miles of road inside the existing riparian corridors (Map 20, Road Densities within Riparian Reserves). Roads within Riparian Reserves restrict the ability of a stream to interact with the floodplain during periods of high flows, and reduce the amount of wood available to the stream.

The information presented in Table 3-35 is based on a GIS database analysis and review of available stream survey data to display areas of fragmentation concerns. This section discusses the function of riparian areas by specific stream reaches within the sixth-field watersheds (this is a different approach to riparian function than that discussed in Large Woody Debris, below).

Map 18

CLEAR FORK WATERSHED ANALYSIS

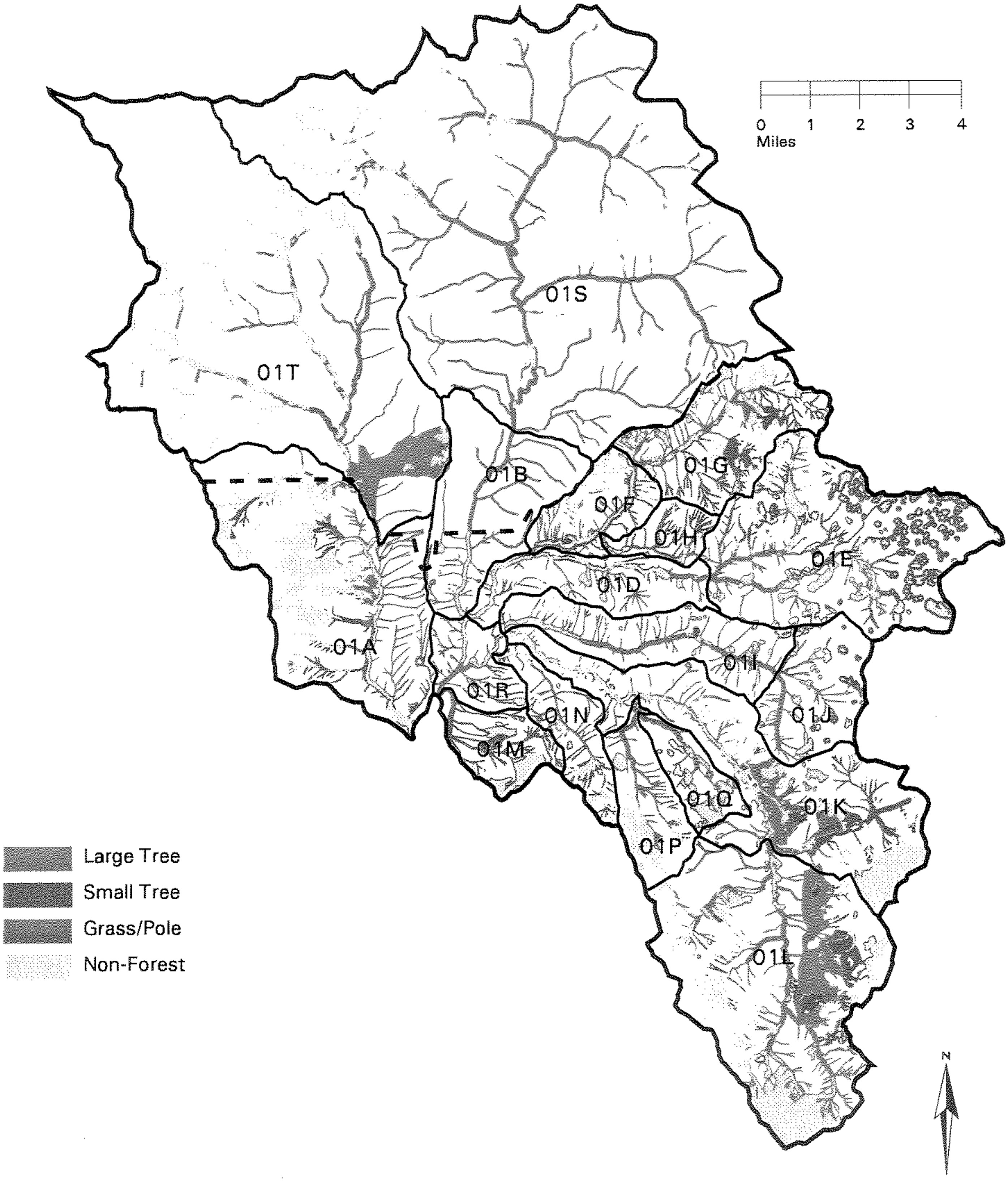
Stream Classes



Map 19

CLEAR FORK WATERSHED ANALYSIS

1998 Vegetation Structure in Riparian Reserves



Map 20

CLEAR FORK WATERSHED ANALYSIS

Road Densities Within Riparian Reserves

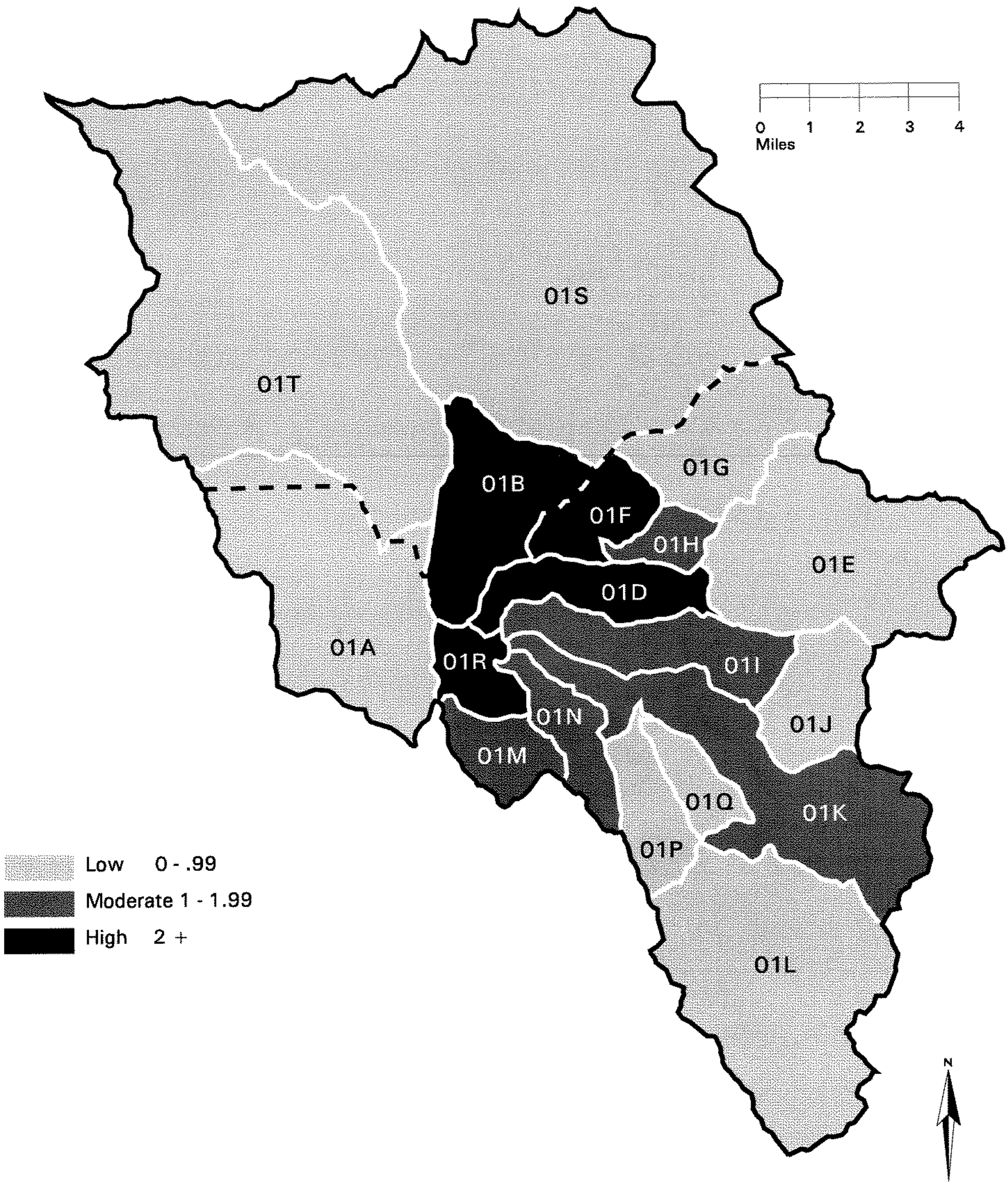


Table 3-35: Current Riparian Stand Age as Determined Using 1993 Aerial Photographs and Silvicultural Data		
Sixth-field Number	**Stream Names**	**Riparian Stand Age (years)**
01A	Lower Muddy Fork Cowlitz River	140+ (mid-late seral)
01T	Upper Muddy Fork Cowlitz River, Nickel, Stevens, TaosCreek, and Twin Falls Creek	140+ (mid-late seral)
01B	Lower Ohanapecosh River	300+ (late seral west banks) and 250+ (late seral east banks)
01S	Upper Ohanapecosh River, Laughingwater, Panther, Chinook, Deer, Needle, and Olallie Creeks	300+ (late seral)
01D	Lower Summit Creek	150+ (mid seral north banks) and >300+ late seral (south banks)
01E	Upper Summit, Allred, Pony, and Buesch Creeks	300+ (late seral); headwaters are mid seral; 200+ (late seral) alpine areas
01F	Lower Carlton Creek	250+ (late seral) north banks 150+ (mid seral) south banks
01G	Upper Carlton Creek	250+ (late Seral)
01H	Cyrenus Creek	lower 65% 150+ (mid seral) upper 35% 300+ (late seral)
01I	Lower Cortright Creek	300+ (late seral)
01J	Upper Cortright Creek	300+ (late seral)
01K	Lower Clear Fork Cowlitz River	250-300+ (late seral)
01L	Upper Clear Fork Cowlitz River, Chimney and Coyote Creeks	250-300+ (late seral)
01M	Purcell Creek	300+ (late seral)
01N	Dam Creek	200-300+ (late seral)
01P	Lava Creek	300+ (late seral)
01Q	Little Lava Creek	300+ (late seral)
01R	La Wis Wis	300+ (late seral)

Reference and Current Conditions - Stream Shading

Pre-1880 Conditions

While no specific information is available on stream shading for 1880, reconstruction of vegetation structural stages shows that the vegetative stands located south and south-east of the Clear Fork Cowlitz River consisted mainly of large tree stands, while a large portion of the Lower and Upper Muddy Fork Cowlitz River, and Nickel Creek consisted primarily of grass/pole stands due to the 1860's fires. It is assumed that the only disturbances in the riparian forests were windthrow, fire, disease and flooding. Therefore, the streams were generally well-shaded in areas where flood plain configuration allowed.

It is assumed that riparian corridors in the Clear Fork watershed had the following forest structural stages by forest zone prior to 1880. This assumption was based mostly on professional judgement, relying on fire history and existing data.

Forest Zone	Large Tree	Small Tree	Grass/Pole
Western Hemlock	80%	10%	10%
Silver Fir	60%	20%	20%

Table 3-36 shows a comparison between sixth-field watersheds of forest structural stages historically existing in Riparian Reserves.

Table 3-36: Historic (1880) Percent of Each Structural Stage in Riparian Reserves *

Sixth-field Watershed	Miles of Stream	Acres of Riparian Reserve	Grass / Pole	Small Tree	Large Tree	Non-Forest
L. Muddy Fork Cowlitz River	93.1	3,573	37%	3%	0%	60%
U. Muddy Fork Cowlitz River	73.3	3,657	40%	7%	8%	45%
L. Ohanapecosh	24.8	901	3%	83%	5%	9%
U. Ohanapecosh	117.0	4,604	0%	16%	58%	26%
L. Summit Creek	24.0	903	0%	49%	20%	31%
U. Summit Creek	54.7	3,999	1%	62%	12%	25%
L. Carlton Creek	25.4	809	0%	37%	29%	34%
U. Carlton Creek	54.7	1,944	<1%	50%	19%	31%
Cyrenus Creek	13.5	399	0%	61%	29%	10%
L. Cortright Creek	32.4	1,163	0%	78%	0%	22%

Table 3-36: Historic (1880) Percent of Each Structural Stage in Riparian Reserves *						
Sixth-field Watershed	**Miles of Stream**	**Acres of Riparian Reserve**	**Grass / Pole**	**Small Tree**	**Large Tree**	**Non-Forest**
U. Cortright Creek	15.9	901	25%	56%	0%	19%
L. Clear Fork Cowlitz River	63.2	3,594	1%	49%	5%	45%
U. Clear Fork Cowlitz River	114.0	5,634	5%	16%	39%	40%
Purcell Creek	22.1	924	0%	62%	5%	33%
Dam Creek	22.7	639	10%	48%	12%	30%
Lava Creek	23.2	877	1%	22%	25%	52%
Little Lava Creek	5.9	663	0%	35%	23%	42%
La Wis	16.5	520	4%	60%	21%	15%

Current Conditions

Riparian forest structural stage is based on a number of factors including, forest health, valley form, disturbance patterns, tree species, windthrow, and channel migration among others. Table 3-37 shows a comparison between sixth-field watersheds of forest structural stages currently existing in Riparian Reserves. Riparian condition for each sixth-field watershed was evaluated and summarized below. The four structural stages are grass/pole, small tree, large tree, and non-forest. Since the last large stand replacement fire was in the 1860's, grass/pole forest occurring in sixth-field watersheds is a result or combination of both management activities in the lower subbasin areas, associated road construction, as well as natural disturbances such as avalanche and mass wasting. See Map 10 - Current (1998) Vegetation Structure; Map 8 - Forest Zones; Map 19 - 1998 Vegetation Structure in Riparian Reserves; and Map 16 - Mass Wasting Inventory.

Table 3-37: Current Percent of Each Structural Stage in Riparian Reserves						
Sixth-field Watershed	**Miles of Stream**	**Acres of Riparian Reserve**	**Grass / Pole**	**Small Tree**	**Large Tree**	**Non-Forest***
L. Muddy Fork Cowlitz River	93.1	3,573	8%	6%	26%	60%
U. Muddy Fork Cowlitz River	73.3	3,657	1%	1%	53%	45%

Table 3-37: Current Percent of Each Structural Stage in Riparian Reserves						
Sixth-field Watershed	**Miles of Stream**	**Acres of Riparian Reserve**	**Grass / Pole**	**Small Tree**	**Large Tree**	**Non-Forest***
L. Ohanapecosh	24.8	901	4%	1%	86%	9%
U. Ohanapecosh	117.0	4,604	1%	1%	72%	26%
L. Summit Creek	24.0	903	18%	12%	39%	31%
U. Summit Creek	54.7	3,999	2%	49%	24%	25%
L. Carlton Creek	25.4	809	24%	19%	23%	34%
U. Carlton Creek	54.7	1,944	2%	36%	31%	31%
Cyrenus Creek	13.5	399	28%	51%	11%	10%
L. Cortright Creek	32.4	1,163	18%	3%	57%	22%
U. Cortright Creek	15.9	901	11%	27%	43%	19%
L. Clear Fork Cowlitz River	63.2	3,594	5%	16%	34%	45%
U. Clear Fork Cowlitz River	114.0	5,634	0%	13%	47%	40%
Purcell Creek	22.1	924	17%	46%	4%	33%
Dam Creek	22.7	639	23%	35%	12%	30%
Lava Creek	23.2	877	3%	4%	41%	52%
Little Lava Creek	5.9	663	2%	16%	40%	42%
La Wis Wis	16.5	520	16%	16%	53%	15%

*Note that the large percentage of non-forest Riparian Reserve is due to the large acreage of non-forest land in the National Park.

Based on riparian area aerial photograph surveys using 1973 1:17,000, 1979 1:12,000, and 1993 1:16,000 photographs; historical stream survey data; and information from the National Park, the riparian reserve vegetative structural stages appear to be about 95 percent accurate. This structural stage approach can be used to evaluate stream shade potential. The large tree structural class is assumed to represent areas meeting potential shading, and therefore meeting the minimum shade criteria.

In the Clear Fork watershed, all but the Upper Ohanapecosh River (01S) and Upper Clear Fork Cowlitz River (01L) sixth-field watersheds have more than 35% of the riparian area in a large tree structural stage (Map 19, 1998 Vegetation Structure in Riparian Reserves). These two sixth-fields do not have more than 35% large tree forest because of the high amount of small tree or non-forest types located in higher elevation, open alpine meadow areas. Such areas are characteristic of steeper (>65%) volcanic-based mountain areas.

Analysis maps reveal that substantial wetlands exist in the Upper Summit Creek (01E) sixth-field, and to a lesser degree in the Lower and Upper Muddy Fork Cowlitz River (01A and 01T), Upper Cortright Creek (01J), and Little Lava Creek (01Q) sixth-field watersheds. Wetland conditions in the Upper Muddy Fork Cowlitz River (01T), Upper Summit Creek (01E), and Upper Cortright Creek (01J), are expected to be similar to reference conditions due to little or no past management activity in these areas. In these areas, the only expected change would be associated with the 1860's fires that occurred in the Lower and Upper Muddy Fork Cowlitz River (01A and 01T) sixth-field watersheds. It is expected that the wetland areas within the lower portion of the Lower Muddy Fork Cowlitz River (01A) and Little Lava Creek (01Q) may have been affected by past management activities.

In summary, the strongest effect to reduced shade is on the tributary streams as a result of past timber harvest, associated roads, and to a lesser extent, recreational project construction along the main tributary stream channels in areas external to the National Park. Table 3-38 indicates stream sections within each sixth-field watershed where management activities would be expected to substantially increase stream channel light exposure.

Table 3-38: Sixth-field Watersheds With A High Amount Of Riparian Habitat Fragmentation and Poor Stream Channel Connectivity (based on 1993 1:16,000 aerial photo interpretation)

Sixth-field	Sixth-field Name	Problem Areas
01A	Lower Muddy Fork Cowlitz	RM 0.0-0.5
01T	Upper Muddy Fork Cowlitz	Not present
01B	Lower Ohanapecosh	RM 0.9-1.1
01S	Upper Ohanapecosh	Not present
01D	Lower Summit	RM 0.5-1.4
01E	Upper Summit	Not present
01F	Lower Carlton	RM 0.0-0.7; RM 0.8-0.9; and RM 1.0-1.4
01G	Upper Carlton	RM 1.4-1.8
01H	Cyrenus	RM 0.1-0.2 and RM 0.4-0.6
01I	Lower Cortright	RM 0.0-0.1; RM 0.4-1.4; RM 1.5-1.6
01J	Upper Cortright	Not present
01K	Lower Clear Fork Cowlitz	Not present
01L	Upper Clear Fork Cowlitz	Not present
01M	Purcell	RM 0.1-0.4
01N	Dam	RM 0.1-1.4

Table 3-38: Sixth-field Watersheds With A High Amount Of Riparian Habitat Fragmentation and Poor Stream Channel Connectivity (based on 1993 1:16,000 aerial photo interpretation)		
Sixth-field	**Sixth-field Name**	**Problem Areas**
01P	Lava	Not present
01Q	Little Lava	Not present
01R	La Wis Wis	RM 0.0-0.4 and RM 0.6-0.8

Disturbance Impacts to Stream Channels

Road Placement

Data Sources/Data Gaps

- Both historic and current, are very limited in scope. The information contained in this document has been compiled from GIS databases on the existing and past road systems which have been developed both on National Forest and National Park lands.

Assumptions

- It is assumed that the GIS database used to determine where the existing road systems are located is not 100% perfect. A notable error within the road system database is the infrequency with which the GIS database is updated, as well as the additional miles of roads which are often constructed while completing projects such as timber harvest, but may not be added to the database.

Pre-1880 Conditions

Prior to the late 1940's and early 1950's the only road system that existed within the Clear Fork watershed was an old wagon trail which was located in the Ohanapecosh River subbasin and used as a way to approach Mt. Rainier from the south.

Current Conditions

Roads have been identified as an important factor in the decline of fish populations. Culverts that do not pass fish, and/or road crossings that alter the flow of large woody debris (LWD) and sediment through the stream channel network fragment the aquatic system. Roads and culverts can not only block upstream migration of resident fish, they can alter the flow pattern of LWD through the system, and increase sediment input (Furniss *et al.* 1991, and presentation at the 1998 Flood Conference). Map 21, Stream Crossings by the Road Network, displays a map of the road network and class I-IV streams. The number of stream crossings within each sixth-field watershed ranges from zero to 79. There are a total of 404 stream crossings within the Clear Fork watershed (Table 3-39).

Road densities within the sixth-fields that exceed 3.0 miles per square mile of area are viewed as "red flags" and indicate where road-related problems are most likely to occur. Within this analysis area road density greater than 3.0 is present in the Lower Summit Creek (01D) and La Wis Wis (01R) subbasins. This value is based on several years of observations by the Gifford Pinchot National Forest hydrologists and fisheries biologists (USDA Forest Service 1997b). Currently, mean road density in the Clear Fork watershed is 1.36 miles per square mile. Individual sixth-field road densities range from zero to 3.9 miles per square mile (Table 3-39). Map 22, Road Densities within Sixth-field Watersheds, highlights those sub-watersheds that exceed 3.0 miles per square mile.

Existing road density concerns at the sixth-field watershed level can also be evaluated by determining road densities within Riparian Reserves and assessing the associated potential impacts to Riparian Reserves. It is the professional judgement of the project hydrologist that road densities exceeding 2.0 miles of road per square mile of Riparian Reserve should be viewed as "red flags" and should be used as a trigger for further field reconnaissance at the project level. Within the Clear Fork watershed, the Lower Ohanapecosh River (01B), Lower Summit Creek (01D), Lower Carlton Creek (01F), and La Wis Wis (01R) sixth-field watersheds were found to have high Riparian Reserve road densities with values of 3.4, 2.5, 2.6, and 4.0 miles of road per square mile of Riparian Reserves, respectively. The Cyrenus Creek (01H), Lower Cortright Creek (01I), Lower Clear Fork Cowlitz River (01K), Purcell Creek (01M), and Dam Creek (01N) sixth-field watersheds were found to have moderate road densities within Riparian Reserves with values of 1.6, 1.6, 1.5, 1.7, and 1.3 miles of road per square mile of Riparian Reserves, respectively.

The Riparian Reserve aquatic habitat fragmentation index is used as an indicator of the impact that increased road construction has had on the aquatic system. It is based upon the number of stream crossings by roads, normalized by stream length in each subwatershed. The Clear Fork watershed aquatic habitat fragmentation values were divided into thirds (low, medium, and high) to evaluate the fragmentation across the entire watershed. Medium (greater than 0.5 road/stream crossings per stream mile) and high (greater than 1.0 road/stream crossings per stream mile) aquatic fragmentation values are displayed on Map 23, Sixth-fields that are Highly Fragmented. In comparison with the rest of the Cowlitz River Valley drainage (USDA Forest Service 1997c, 1997d), the Clear Fork watershed has lower aquatic fragmentation values. Forty-seven percent of the Clear Fork watershed aquatic habitat fragmentation values occur in the lower one-third of the total Cowlitz River watershed aquatic habitat values, while 24 percent occur in the middle one-third, and only 29 percent of the Clear Fork watershed aquatic habitat fragmentation values occur in the highest one-third of the fragmentation values for the Cowlitz River watershed.

The La Wis Wis (01R) sixth-field is a highly fragmented watershed, with a sixth-field fragmentation index value of 2.3. The lower portion of the Clear Fork watershed also had high sixth-field fragmentation in the Lower Ohanapecosh River (01B), Lower Summit Creek (01D), Purcell Creek (01M) and Lower Cortright Creek (01I) sixth-field watersheds with values of 1.73, 1.29, 1.18, and 1.60 stream road crossings/mile of stream, respectively. Sixth-fields within the highest one-third of the Clear Fork watershed (i.e., greater than 1.0 stream road-crossings/mile of stream) are displayed on Map 23, Sixth-fields that are Highly Fragmented. These sixth-field watersheds have received the most intense degree of habitat fragmentation caused by roads (when compared with other sixth-fields in the Clear Fork fifth-field watershed).

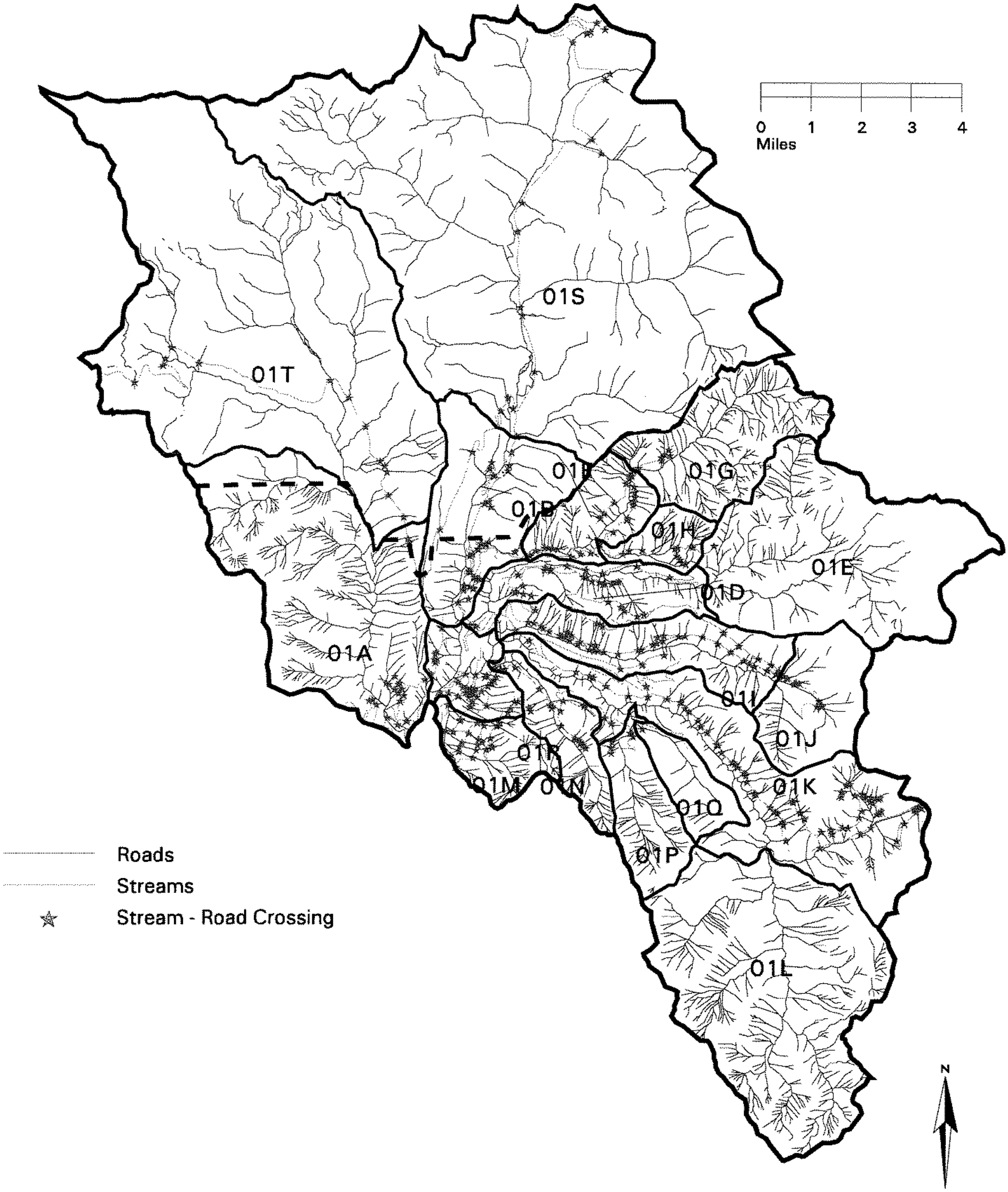
Table 3-39: Clear Fork Watershed Road Densities, Stream Crossings, Aquatic Habitat Fragmentation Indices (Road Crossings / Stream Mile), and Road Density in Riparian Reserves by Sixth-field

Sixth-field Number	Miles of Road	Road Density	Number of Stream Crossings	Miles of Stream	Road Crossings per Stream Mile	Road Density in Riparian Reserves
01A	8.1	0.5 (L)	21	93.1	0.23	0.3 (L)
01T	11	0.3 (L)	13	73.3	0.18	0.2 (L)
01B	19.4	2.3 (M)	43	24.8	1.73	3.4 (H)
01S	16.2	0.3 (L)	18	117.0	0.10	0.5 (L)
01D	16.1	3.4 (H)	31	24.0	1.29	2.5 (H)
01E	0.3	0.1 (L)	1	54.7	0.02	0.0 (L)
01F	5.7	1.6 (L)	25	25.4	0.98	2.6 (H)
01G	1.5	0.2 (L)	7	54.7	0.13	0.3 (L)
01H	2.7	1.5 (L)	13	13.5	0.96	1.6 (M)
01I	17.8	2.8 (M)	52	32.4	1.60	1.6 (M)
01J	2.2	0.5 (L)	9	15.9	0.57	0.6 (L)
01K	24.9	1.7 (L)	79	63.2	1.25	1.5 (M)
01L	0	0.0 (L)	0	114.0	0.0	0.0 (L)
01M	5.8	1.9 (L)	26	22.1	1.18	1.7 (M)

Map 21

CLEAR FORK WATERSHED ANALYSIS

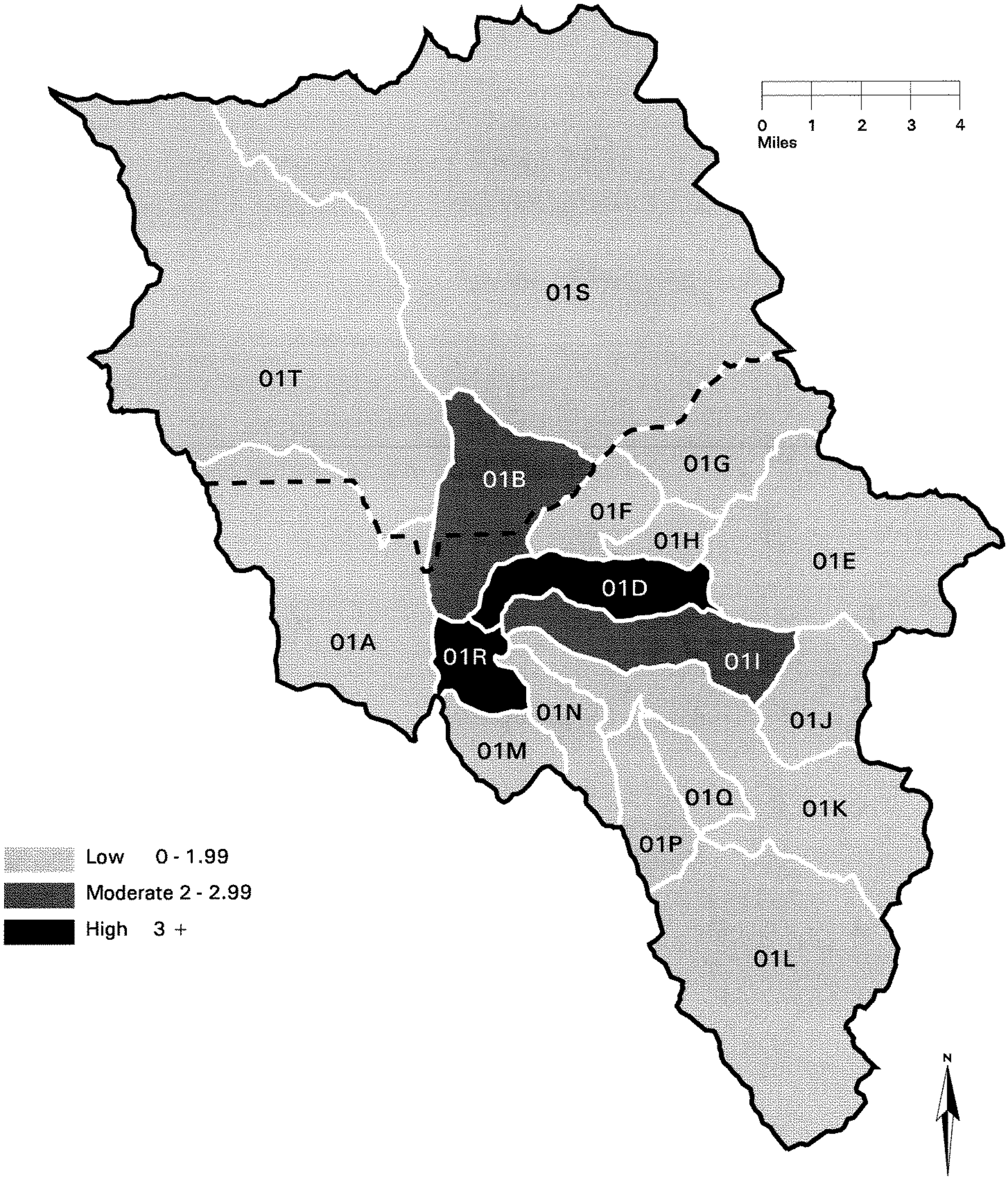
Stream Crossings by the Road Network



Map 22

CLEAR FORK WATERSHED ANALYSIS

Road Densities within Sixth-field Watersheds



Map 23

CLEAR FORK WATERSHED ANALYSIS

Sixth-fields that are Highly Fragmented

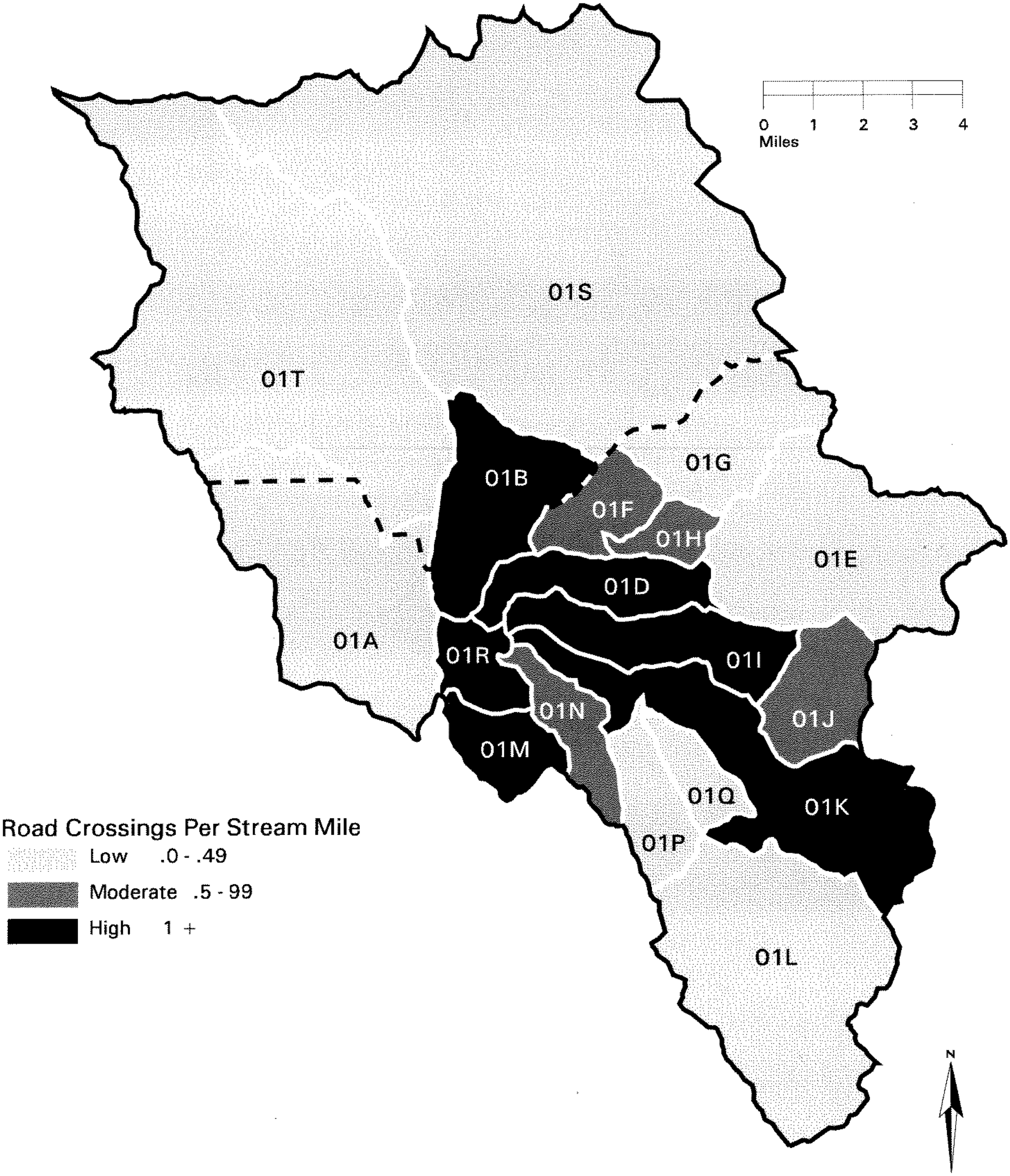


Table 3-39: Clear Fork Watershed Road Densities, Stream Crossings, Aquatic Habitat Fragmentation Indices (Road Crossings / Stream Mile), and Road Density in Riparian Reserves by Sixth-field

Sixth-field Number	Miles of Road	Road Density	Number of Stream Crossings	Miles of Stream	Road Crossings per Stream Mile	Road Density in Riparian Reserves
01N	5.8	1.7 (L)	21	22.7	0.93	1.3 (M)
01P	1.6	0.4 (L)	6	23.2	0.26	0.4 (L)
01Q	1.2	0.5 (L)	1	5.9	0.17	0.2 (L)
01R	10.6	3.8 (H)	38	16.5	2.30	4.0 (H)

Flood Plain

Pre-1880 Conditions

Historically, valley floors were frequently subjected to flooding. Floods can both disturb the existing riparian corridors, as well as create new landforms as a result of fluvial sediment deposits. During floods which were at or above bankfull discharge, new channels and floodplain configurations were developed (Brinson 1990). New landforms developed in response to stand development, and understory succession was subject to controls such as light exposure, physical topography, and further disturbance (Menges and Waller 1983, Hupp 1988). Some of the sixth-field watersheds which were affected by historic flood events include the Lower Muddy Fork Cowlitz River (01A), Lower Ohanapecosh River (01B), and Lower Clear Fork Cowlitz River (01K). Such areas have been naturally conducive to floodplain activities due to a lack of channel confinement when compared to tributary streams such as the lower Summit, lower Carlton, Cyrenus, lower Cortright, Purcell, Dam, Lava, and Little Lava Creeks.

Current Conditions

The aquatic system's ability to respond and cope with natural disturbance regimes probably changed when the effects of man's activities (timber harvest, road and trail construction, recreational activities) in the Clear Fork watershed began to exacerbate the damage done by historical high-flow events. Review of the 1993 (1:16,000), 1979 (1:12,000), and 1973 (1:16,000) basin-wide aerial photographs and stream survey data was used as a method to compare the pre-human disturbance characteristics to what is present today. For the purpose of determining pre-1880 equivalent flood plain parameters, 1973 aerial photographs were used as an interpretation point because older photographs which covered the Clear Fork watershed were not available. Secondly, not all of the analysis area was covered by these photographs due to the large portion of National Park lands for which no aerial photographs were available. It is estimated that the influence of stream channel bank and bed stability, when compared to the present day conditions, are partially due to management activities in areas outside of the National Park. During the 70+ year time period (1880 to approximately early 1950's), the lack of upslope vegetative disturbance (outside National Park lands) resulted in an extensive expanse of large tree stands which were more resilient to the highly disturbing peak flows which have recently occurred within the area. Floodplains within the National Park are in similar ecological conditions to the 1880 time period, except in isolated areas such as campgrounds and trail systems.

A comparative review of the 1993 (1:16,000) aerial photographs with the 1979 (1:12,000) and 1973 (1:16,000) aerial photographs indicates that the riparian zones have been impacted by previous flood events, as well as timber management in the lower reaches of some streams. The channels most strongly affected were the lower Muddy Fork Cowlitz River, lower Ohanapecosh River, lower Summit Creek, lower Cortright Creek, lower Dam Creek, and lower Clear Fork Cowlitz River stream sections. These areas display evidence of significant channel widening. These changes in channel width are partially attributed to past timber management and road construction projects on the surrounding side slopes over a relatively short time period. Timber removal can be associated with accelerated increases in peak flow releases during heavy precipitation events and spring melt off (USDA Forest Service 1995b). Review of the main Clear Fork Cowlitz River, Muddy Fork Cowlitz River, and Ohanapecosh River basins displays an active flood plain and high sediment inputs from the surrounding high peak areas located in Mt. Rainier National Park, and Wilderness areas such as the Tatoosh, Goat Rocks, and William O. Douglas. For this watershed analysis process, it was not possible to do a comparative review of the 1993 aerial photographs with the 1996 "post-flood" aerial photographs (which were used to review the 1996 flood damage) because the 1996 aerial photographs were not available for this area. See Table 3-44 for information regarding areas of channel widening associated with sediment deposition.

Large Woody Debris

Large woody debris is important in many streams of the western Cascade mountains for maintaining the physical integrity and function of stream channels. Large wood dissipates stream energy and promotes scour and turbulence that provide habitat for aquatic organisms, especially fish. The wood itself provides nutrients and a food source for many aquatic organisms.

The dominant source of large woody material is old trees growing near a channel, that die and fall into the channel or are windthrown, or trees growing on the streambanks that are eroded away during major peak flows and associated high runoff events. In small streams, large logs fall and remain in place, too large to be moved by the stream. The exception is in debris avalanche channels where large wood is carried downslope during catastrophic events. In large streams, wood may be transported long distances downstream during storms.

Pre-1880 Conditions

No detailed study of large woody debris (LWD) has been conducted in the Clear Fork watershed. However, based on past stream surveys and the processes evident in the watershed, streambank erosion appears to be the dominant source of LWD recruitment, followed by riparian area trees falling into the channel. As with the shade discussed previously, historical riparian vegetation conditions and 1959 aerial photographs indicate that LWD recruitment potential would have been good throughout the analysis area. This assessment is based on the presence of small tree and large tree forest and the assumption that there were some very old forest stands distributed around the area that were actively contributing large dying trees, and the assumption that natural disturbance by disease, fire and windthrow contributed LWD at intervals of time and space.

Current Conditions

The Riparian Reserves vegetation structural stage information (see Map 19, 1998 Vegetation Structure in Riparian Reserves) is valuable in evaluating the potential for LWD recruitment in the analysis area. The large tree structural stage is considered to represent old, large trees that are desirable as woody debris in streams to control hydraulic energy and create quality aquatic habitat. These areas may be actively providing LWD through dying trees or have the potential to supply large wood through catastrophic events (windthrow, fire, debris slides). The small tree structural stage stands are those that could supply large woody material in the next 10 to 70 years, depending on vegetation zones and the current diameter of the stands. Grass/pole stands will not provide large wood for a very long time.
Forest structural stage was used to evaluate Large Woody Debris (LWD) recruitment potential, based on the GPVEG database. Delineation of riparian forests is quite rough in this database; most of the time, the riparian area was not broken out from adjacent upland forests.

Recruitment potential is based on the following:

Structure	Size	Recruitment Potential
Non-forest	Wetlands, Rock, Talus, Lakes	No foreseeable contribution
Grass/Pole	< 9" diameter	No contribution for many decades
Small Tree	9" to 20.9" diameter	Near term, 1 to 7 decades
Large Tree	> 21" diameter	Can currently contribute

A study of the LWD ratings from stream surveys completed in the last 15 years is the basis for Map 24, Aquatics Concerns - Large Woody Debris. LWD is divided into three classes: small, medium, and large. Small LWD is larger than 12 inches in diameter at a distance of 25 feet from the large end, medium LWD is larger than 24 inches in diameter at a distance of 50 feet from the large end, and large LWD is larger than 36 inches in diameter at a distance of 50 feet from the large end. Before 1994, the ratings were more subjective, based on the following parameters:

POOR - Less than 25% of the stream channel area in a stream reach contains LWD
FAIR - More than 25% of the stream channel area in a reach contains LWD, providing good cover and forming large pools
GOOD - LWD is very abundant.

Since 1994, LWD ratings have been based on the following numbers:

POOR - Less than 40 pieces per mile
FAIR - 40 to 80 pieces per mile
GOOD - More than 80 pieces per mile.

Inner Gorge

Inner gorge is defined in the *Final Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl, Volume I* (USDA, USDI 1994c) as a "stream reach bounded by steep valley walls that terminate up slope into a more gentle topography - common in areas of rapid stream down cutting or uplift". This definition differs slightly from the definition that the Gifford Pinchot National Forest has adopted, in which the inner gorge is delineated as the area consisting of narrow steep valleys located along the riparian corridor which is smaller than the canyon and more steep-sided than a ravine. Slopes along the restricted steep-walled part of the canyon are greater than 65 percent. The inner gorge is an area that is extremely sensitive to management activities. Due to the close proximity of the inner gorge to the creek, soil displacement in the inner gorge will be delivered directly to the channel.

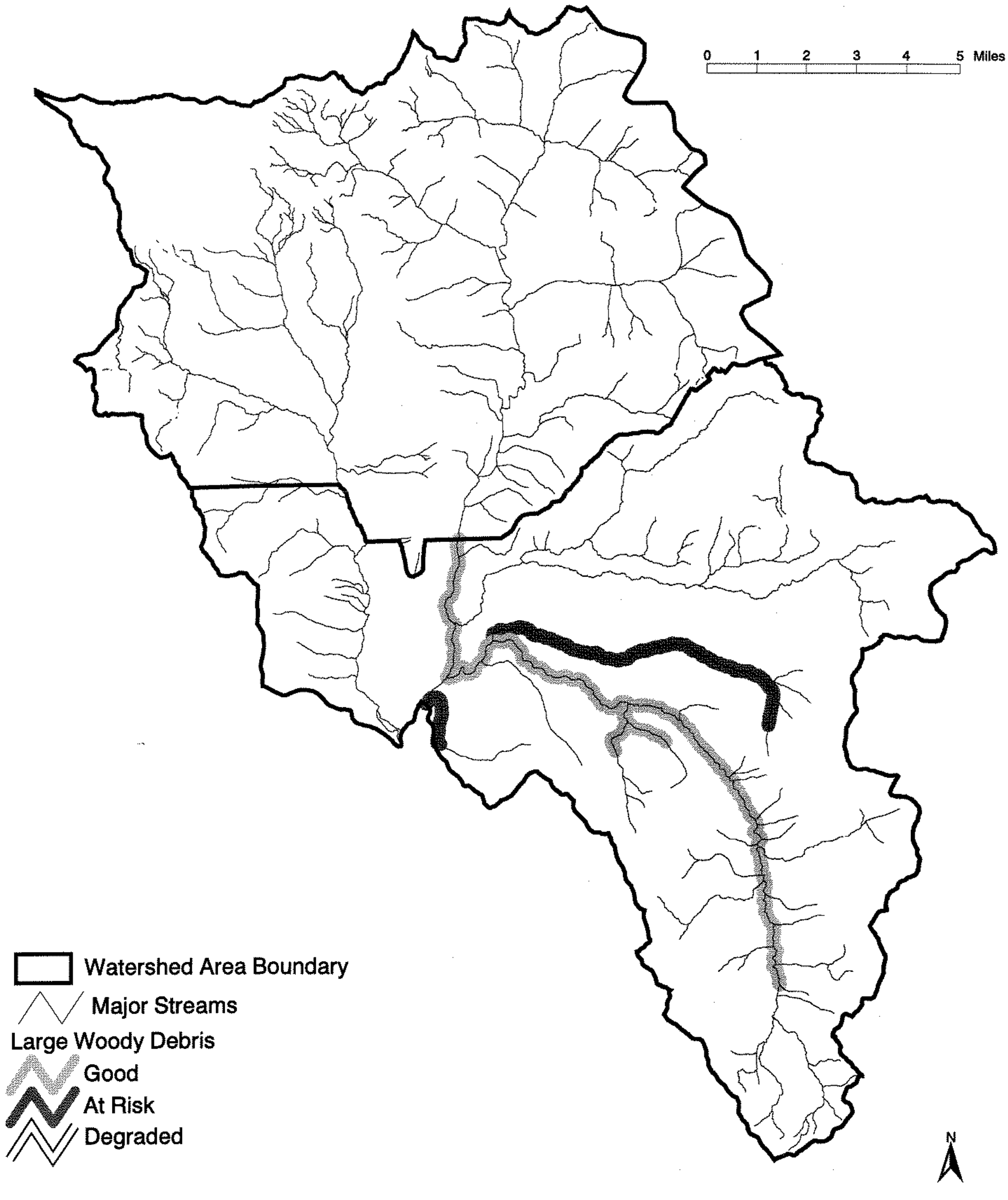
Data Sources/Gaps and Assumptions

Due to time constraints, the watershed analysis team was unable to use aerial photographs to define the inner gorge locations at the watershed analysis scale. The areas consisting of past inner gorge concerns will be determined by reviewing data collected during stream surveys as well as pre-timber harvest and road construction data. Areas taken into consideration were unstable side slopes, side channels on steep slopes, and channels exhibiting frequent stream

Map 24

CLEAR FORK WATERSHED ANALYSIS

Aquatic Concerns - Large Woody Debris



channel shifts identified within the study area. Data was lacking from the Mt. Rainier National Park lands due to few or no aerial photographs being available. For the National Park, delineation of inner gorge concern areas was determined by including avalanche tracks such as those located in the upper stream channel areas of the class IV channels.

Current Conditions

Review of stream survey data and 1993 aerial photographs indicated that a large percentage of the areas indicating disturbed riparian areas were located in the steeper inner gorge headwater areas. Such areas are expected to be associated with steeper A and Aa+ type Rosgen stream channel types (discussed later in the Stream Channel Types section).

Table 3-40: Sixth-field Watersheds Having Rosgen Channel Type "A" Inner Gorge Areas

Sixth-field	Sixth-field Names	Inner Gorge Area Locations
01A	Lower Muddy Fork Cowlitz River	RM 1.3-5.5 (ocular)
01T	Upper Muddy Fork Cowlitz River	Upper Muddy; RM 5.5-15.5+ (ocular) Stevens Canyon Creek; RM 3.6-6.6 (ocular) Nickel Creek; RM 0.0-5.5 (ocular) Williwakas Creek; RM 0.0-3.5 (ocular)
01B	Lower Ohanapecosh River	RM 0.1-1.9 (1992 stream survey) and RM 1.9-7.3 (ocular)
01S	Upper Ohanapecosh River	Upper Ohanapecosh; RM 1.9-7.3; 9.3-10.5; and 12.5-17+ (ocular) Laughingwater Creek; RM 0.2-5.2+ (ocular) Panther Creek; RM 0.2-2.2 and 2.7-6.7+ (ocular) Deer Creek; RM 0.1-2.1+ (ocular) Chinook Creek; RM 0.1-2.1+ (ocular) Needle Creek; RM 0.3-3.5+ (ocular) Olallie Creek; RM 0.1-2.5+ (ocular)
01D	Lower Summit Creek	Approximate RM 0.8-5.0 (1983 stream surveys) and RM 7.5-7.8 (ocular)
01E	Upper Summit Creek	Buesch Creek; RM 0-0.4 (1981 stream survey)
01F	Lower Carlton Creek	No inner gorge identified (1980 stream survey)
01G	Upper Carlton Creek	RM 5.5-7.6 (ocular)
01H	Cyrenus Creek	Inner gorge RM 1.8-2.8 (1979 stream survey)
01I	Lower Cortright Creek	RM 0-2.3; RM 3.3-3.6; RM 4.4-4.9; RM 5.1-5.9 (1989 stream survey)

Table 3-40: Sixth-field Watersheds Having Rosgen Channel Type "A" Inner Gorge Areas		
Sixth-field	**Sixth-field Names**	**Inner Gorge Area Locations**
01J	Upper Cortright Creek	RM 8.2-9.5 (ocular)
01K	Lower Clear Fork Cowlitz River	Lower Clear Fork; RM 0.6-4.2 and RM 4.6-7.0 (1992 stream survey) Millridge Creek; RM 0-2.1+ (1983 stream survey)
01L	Upper Clear Fork Cowlitz River	RM 7.0-9.5 and RM 15.0-16.5 (ocular) Coyote Creek; RM 0.7-2.8 (ocular)
01M	Purcell Creek	RM 1.4-2.0 (1983 stream survey) and RM 2.0-2.1+ (ocular)
01N	Dam Creek	RM 0.0-1.7 and RM 2.3-3.7+ (ocular)
01P	Lava Creek	RM 3.2-4.5 (1984 stream survey data and ocular estimation)
01Q	Little Lava Creek	RM 0-1.5 (1984 stream survey) and RM 1.5-2.2 (ocular)
01R	La Wis Wis	No inner gorge identified

Further work is needed in defining the specific inner gorge confinements for the analysis area. Upon completion of the aerial photograph interpretation a team should complete site-specific field reviews to confirm the inner gorge areas during project analysis to determine the possible extent of both aquatics and wildlife habitat concerns.

Stream Channel Types

Data Sources/Data Gaps

- The source materials for stream channel types is a product of stream channel surveys completed by Gifford Pinchot employees, and GIS stream data collected. It should be noted that some discrepancy is expected, especially since a very large percentage of the analysis area either lies within the Tatoosh, Goat Rocks, or William O. Douglas Wilderness areas or within Mt. Rainier National Park.

Assumptions

- It is assumed that the GIS and stream survey data used to determine the existing stream miles is not 100% perfect. A notable error within data pertaining to stream miles per sixth-field is the infrequency with which the GIS system is updated as well as the large proportion of lands where ground truthing is limited.

Rosgen Classification

Stream reaches for which stream survey data exists have been classified using the Rosgen (1994) stream channel classification methodology which identifies stream channel types based on stream channel entrenchment, width:depth ratios, stream gradient, and sinuosity. Appendix C, Stream Survey Data, displays the analysis area stream channel classification by reach and associated physical parameters where data was available from previous stream surveys. It should be noted that data is lacking for the National Park and significant portions of the Wilderness areas.

When reviewing the stream data collected within the analysis area, noticeable trends of the dominant and subdominant stream channel substrate alterations are apparent: large boulders and cobbles dominate the headwater reaches of the Clear Fork Cowlitz River basin tributaries. Further down toward the confluence of the surrounding streams with the main Clear Fork Cowlitz system, the smaller cobbles intermix with gravels and sands become more dominant. Valley configurations in the steep upper reaches show a strong correlation with either V-shaped or U-shaped landforms displaying a low sinuosity. Such stream channels are indicative of younger geologic basins which are moderately erosive. Steepness of sideslope stream channels within the Clear Fork Cowlitz River basin decreases as one proceeds further west until reaching the lower basin and outlet areas for the individual sixth-fields near the main Clear Fork Cowlitz River.

There is a wide range of sensitivities related to channel characteristics. For example, particles smaller than cobble are more easily mobilized than cobbles or larger. Therefore, a smaller increase in peak flows can be significant in streams with particles smaller than cobble. Refer to Table 3-41 below for sensitivity to streamflows by stream class.

Table 3-41: Sensitivity to Increases in Streamflow

Stream Type	Sensitivity	Reasoning
A1, F1, G1	V. Low	Confined in bedrock
A2	Low	Stable bed and banks
B1, B2	Low	Stable bed and banks, can access floodplain
B3	Low-Mod.	Stable bed, stable-moderately stable banks, can access floodplain
F2	Low-Mod.	Stable bed, stable-moderately stable banks, laterally unstable

Table 3-41: Sensitivity to Increases in Streamflow		
Stream Type	**Sensitivity**	**Reasoning**
C1, C2	Low-High	Stable bed, stable to moderately stable banks, can access floodplain, sensitivity = floodplain terrace and bank stability
B6	Moderate	Cohesive banks, can access floodplain
G2	Moderate	Stable banks, moderately stable banks, confined, high energy
E6	Mod.-High	Cohesive banks, can access floodplain, sensitivity = floodplain (bank vegetation)
A6, G6	Mod.-High	Cohesive banks, confined, high energy (G6 can go up or down one class depending on bank vegetation)
A3	Mod.-High	Stable bed, stable to unstable banks, confined high energy
C3	Mod.-High	Stable streambed, sensitivity = floodplain terrace and bank stability, can access floodplain
F3	Mod.-High	Stable bed, stable to erodible banks, laterally unstable
B4, B5	Mod.-High	Mobile bed, erodible banks, can access floodplain
E3, E4, E5	High	Erodible banks, can go up or down one class depending on bank vegetation
G3	High	Moderately stable bed, erodible banks, confined, high energy, can go up or down depending on vegetation
C4, C5, C6	High-V. High	Unstable bed and banks, can access floodplain, sensitivity = floodplain (terrace and bank stability)
A4, A5	Very High	Confined, high energy, erodible banks, mobile bed (woody debris is critical)
A11(D)	Very High	Unstable braided, erodible banks, laterally unstable, very large wetted perimeter
F4, F5, F6, G4, G5	Very High	Unstable banks, laterally unstable
Floodplain	Very High	Confined, high energy, erosive banks, mobile bed, vertically unstable, (can go up or down one class if banks are well vegetated

This rating method is consistent with the "Standard Methodology for Conducting Watershed Analysis" (Washington Forest Practices Board 1993) because it incorporates shear stress by considering stream channel types or stream bed particles (Washington Forest Practices Board 1993, Rosgen 1994), and it incorporates the "20% rule of thumb discussed under peak flows" related to raising the two-year flow volume to a five-year flow volume (Washington Forest Practices Board 1993). Refer to Appendix C, Stream Survey Data, for a complete listing of the stream channel types and associated risk of potential stream impacts from increased peak flows, where stream surveys have been completed using the Rosgen (1994) methodology.

Stream Channel Density

Data Sources/Data Gaps

- The source materials for stream channel density, both historic and present, consist of the GIS database and stream survey data collected. It should be noted that some discrepancy is expected, especially since a very large percentage of the analysis area either lies within the Tatoosh, Goat Rocks, or William O. Douglas Wilderness areas or within Mt. Rainier National Park.

Assumptions

- It is assumed that the GIS database and stream survey data used to determine the existing stream miles is not 100% perfect. A notable error within the data pertaining to stream miles per sixth-field is the infrequency with which the GIS system is updated as well as the large proportion of lands where ground truthing is limited. Refer to Table 3-42 for the currently known stream channel densities per sixth-field watershed.

- Stream density is important because it gives an indication of potential effects from management activities. For example, activities in areas with high stream channel densities are likely to be close to or cross streams. Therefore, there is a greater probability of impacts to streams from project activities.

Pre-1880 Conditions

It is expected that the number of miles of stream channel types per sixth-field watershed did not change with road construction and management activities along steeper hillsides until the early 1950's. This is based on the lack of management activities within the analysis area prior to that date.

Current Conditions

No detailed study of alterations in the number of class III and IV stream channels has been completed for this basin. Due to the large percentage of Wilderness and National Park land located within the analysis area (approximately 80%) it is expected that the number of channels within this analysis area has only been subjected to changes in the Lower Ohanapecosh River (01B), La Wis Wis (01R), and Lower Summit Creek (01D) sixth-fields.

Table 3-42: Stream Miles by Class and Sixth-field Watershed

Sixth-field Names	Class I Stream Miles	Class II Stream Miles	Class III Stream Miles	Class IV Stream Miles	Total Stream Miles	Stream Density (mi./sq. mi.)
Lower Muddy Fork Cowlitz River	9.7	8.4	6.5	68.5	93.1	5.5
Upper Muddy Fork Cowlitz River	5.5	12.6	41.2	14.0	73.3	1.9
Lower Ohanapecosh	0.2	4.4	10.3	9.9	24.8	3.0
Upper Ohanapecosh	2.2	19.8	79.6	15.4	117	2.0
Lower Summit Creek	0.0	6.5	0.0	17.5	24	5.0
Upper Summit Creek	0.0	7.6	10.0	37.1	54.7	3.5
Lower Carlton Creek	0.0	3.5	0.7	21.2	25.4	3.5
Upper Carlton Creek	0.0	4.2	1.0	49.5	54.7	7.6
Cyrenus Creek	0.0	0.0	4.6	8.9	13.5	7.5
Lower Cortright Creek	0.0	6.4	0.0	26.0	32.4	5.1
Upper Cortright Creek	0.0	1.6	2.4	11.9	24.4	1.7
Lower Clear Fork Cowlitz River	8.5	7.8	3.0	43.9	63.2	3.2
Upper Clear Fork Cowlitz River	3.6	10.9	16.6	82.9	114.0	5.8
Purcell Creek	0.0	1.2	2.1	18.8	22.1	7.1
Dam Creek	0.0	0.0	3.3	19.4	22.7	6.7
Lava Creek	0.0	1.8	2.5	18.9	23.2	6.3
Little Lava Creek	0.0	1.8	0.4	3.7	5.9	2.6
La Wis Wis	2.3	1.2	0.0	13.0	16.5	5.9

Stream Channel Stability and Streambank Stability

Pre-1880 Conditions

Fish species are assumed to have been distributed relative to habitat conditions. Reference conditions are based on the assumption that the region and basin had abundant high quality habitat for fish production as reported by early settlers. Specific number of reference fish populations are not known.

Current Conditions

Refer to Table 3-43 for a listing of the recorded Pfankuch stability ratings of tributaries within the analysis area. These ratings should be viewed with some skepticism based on the inconsistency between the people who completed the surveys as well as the relative abilities of the individuals in the field.

Table 3-43: Percent of Each Surveyed Tributary in the Clear Fork Watershed Within Each Pfankuch Stability Rating

Stream channels which have been inventoried	Good	Fair	Poor	No Data
Clear Fork Cowlitz River	24	53	10	13
Purcell Creek	46	54	0	0
Lava Creek	29	71	0	0
Little Lava Creek	0	100	0	0
Cortright Creek	67	19	14	0
Millridge Creek	0	55	45	0
Ohanapecosh River	76	24	0	0
Summit Creek	100	0	0	0
Buesch Creek	57	34	0	9
Carlton Creek	100	0	0	0
Cyrenus Creek	9	82	0	9

•Excellent = Pfankuch Score between 0 and 38
•Good = Pfankuch Score between 39 and 76
•Fair = Pfankuch Score between 77 and 114
•Poor = Pfankuch Score greater than 114

Millridge Creek is the most sensitive stream to additional disturbances. This is the result of several slides originating from U.S. Highway 12 that have delivered large quantities of sediment.

Additional sediment inputs will likely further affect Millridge Creek. Carlton and Summit Creeks are both in good condition. This rating provides evidence that these streams have the ability to process the current sediment and water inputs. These streams have the greatest resiliency to further impacts.

Sediment Transport and Storage

Pre-1880 Conditions

Since the analysis area is considered to have been relatively undisturbed by human development prior to the late 1940's-early 1950's, it is assumed that sediment generation, transport and storage reflected the natural disturbance regime. Given this assumption, the dominant sediment sources in the Clear Fork watershed would have been deep-seated rotational mass movements which are usually located at the bases of mountain structures or the avalanche and debris chutes from steep ridges, as well as the strong erosion activities associated with the glaciers on Mt. Rainier. Small inner gorge failures and channel erosion would also have been sources of sediment, but to a much lesser extent than the avalanche and debris chutes in the upper portion of the watershed. The dominant sediment sources reaching the mainstem Clear Fork Cowlitz River would have been transported down river and deposited as sediment storage bars throughout the basin in either debris fans where smaller tributaries confluence with the Ohanapecosh, Muddy Fork Cowlitz, and Clear Fork Cowlitz Rivers, or as altering point and sediment bars. In the summer, the waters are relatively opaque with gray, fine-grained volcanic-origin sediments. In the winter the waters are often cloudy, with high concentrations of brown suspended sediment routed from natural hillslope erosion. Erosion events have been aggravated by ground-disturbing activities such as glaciation, deep-seated rotational slides, debris flows, and avalanche chutes. These natural disturbances are having the highest impacts to the stream channel sediment loads in some of the stream channels within the Clear Fork watershed. In general, a scientific weakness exists in the interpretations of past sideslope failures and the impacts to stream channels associated with both management activities and natural conditions, and that often such failures are misinterpreted.

During storms and catastrophic events, it is estimated that sediments were moved through the system in pulses (Benda 1997, Ketcheson 1996 personal communication) as opposed to a continual even flow of sediments transported by the system. The tributaries coming from both the Goat Rocks (Purcell Creek, Dam Creek, Lava Creek, Little Lava Creek, and Clear Fork Cowlitz River), Tatoosh (Lower and Upper Muddy Fork Cowlitz River) and William O. Douglas (Carlton and Cortright Creeks) Wilderness areas, as well as the sixth-fields originating in Mt. Rainier National Park (Muddy Fork Cowlitz River and Ohanapecosh River basins) generally have moderately to very steep headwater and stream channel reaches which could be classified as transport reaches. These reach types are characterized by higher delivery of sediments to lower gradient stream channels (generally 1-3% gradient). It is expected that the transport reaches did not experience the negative impacts of large sediment flushes as compared to response reach channel sections located lower down near the flood plain (lower Muddy Fork Cowlitz River, lower Ohanapecosh River, and lower Clear Fork Cowlitz River, as well as lower Summit Creek) which consist of depositional reaches.

Current Conditions

Review of stream surveys, as well as the 1993, 1979, and 1973 aerial photographs, identified stream channel types which have the hydrologic flow energies necessary to move large amounts of bedload through the system which limits potential fish habitat. In addition to causing channel aggradation and widening, this sediment is filling in pools which are important for juvenile salmon rearing and adult holding habitat. Loss in depth of channel and particularly the pools, increases the heating effects from solar radiation which can lead to increased water temperatures.

Within the analysis area, the sixth-fields identified as having high impacts to stream channels from bedload movement include the Lower Muddy Fork Cowlitz River (01A), Lower Ohanapecosh River (01B), Lower and Upper Carlton Creek (01F and 01G), Lower and Upper Summit Creek (01D and 01E), Lower and Upper Cortright Creek (01I and 01J), Lower and Upper Clear Fork Cowlitz River (01K and 01L), Lava Creek (01P), and Purcell Creek (01M). A very large amount of the sediment moving through the system and being deposited is primarily in response to the sediment associated with the Wilderness areas, Mt. Rainier glacial systems, and to a much lesser degree, past management activities such as road construction and timber harvest. Such heavy sediment movements through the river systems have resulted in enough sediment deposition to cause problems with stream channel migration.

Review of the 1993, 1979, and 1973 aerial photographs along with information gained from previous stream surveys, indicates that the lower Clear Fork Cowlitz River, Ohanapecosh River, Muddy Fork Cowlitz River and the mainstem of the Clear Fork Cowlitz River continue to route sediments through the watershed. It would appear that these high sediment loads are slowly, but steadily transported downstream into the Upper and Middle Cowlitz River fifth-field watersheds and associated floodplains. In this process, any pools that may be existing along the channel are often partially or wholly filled by sediment pulses. Review of aerial photographs displaying channel shape is of interest due to the fact that the existing stream channel shape is predominantly influenced by (1) quantity of water; (2) the type of sediment load, material in suspension, bedload, and/or material moving near the bed; and (3) the type of bank material. Change in any one of these factors will result in alterations of the stream channel's flow regimes and channel configuration based on sediment transport abilities by the system (Heede 1980). Refer to Table 3-44 below where response reaches were identified.

Table 3-44: Stream Channel Response Reaches Interpreted as Having Significant Channel Widening

Sixth-field	Sixth-field Name	1973 Aerial Photographs	1979 Aerial Photographs	1993 Aerial Photographs
01A	Lower Muddy Fork Cowlitz	RM 0-0.5 Upper Cowlitz; RM 0-0.3 Lower Muddy Fk.	RM 0-0.5 Upper Cowlitz; RM 0-0.3 Lower Muddy Fk.	RM 0-0.5 Upper Cowlitz; RM 0-0.3 Lower Muddy Fk.
01T	Upper Muddy Fork Cowlitz	No Data	No Data	No Data
01B	Lower Ohanapecosh	RM 0.5-1.0	RM 0.5-1.5	RM 0.5-1.5
01S	Upper Ohanapecosh	No Data	No Data	No Data
01D	Lower Summit	RM 0-0.5	RM 0.1-0.6; RM 0.7-3.0 & RM 3.1-3.2	RM 0-0.4
01E	Upper Summit	Not Present	Not Present	Not Present
01F	Lower Carlton	RM 0.5-1.3+	RM 0.5-1.4	Not Present
01G	Upper Carlton	Not Present	RM 1.4-1.8+	Not Present
01H	Cyrenus	Not Present	Not Present	Not Present
01I	Lower Cortright	Not Present	RM 1.4-1.9; RM 2.2-2.8; & RM 2.9-3.9+	Not Present
01J	Upper Cortright	Not Present	Not Present	Not Present
01K	Lower Clear Fork Cowlitz	Not Present	RM 2.5-5.5+	RM 0.6-1.2
01L	Upper Clear Fork Cowlitz	Not Present	Not Present	No Data
01M	Purcell	Not Present	Not Present	RM 0-0.3
01N	Dam	Not Present	RM 0-1.9	Not Present
01P	Lava Creek	Not Present	RM 0-0.1	RM 0-0.3
01Q	Little Lava	Not Present	RM 0-0.8	Not Present
01R	La Wis Wis	RM 0-0.5, Lower Ohanapecosh and RM 0-0.4, Lower Clear Fork Cowlitz	RM 0-0.9, Lower Ohanapecosh and RM 0-0.3, Lower Clear Fork Cowlitz	RM 0-1.2, Lower Ohanapecosh and RM 0-0.5, Lower Clear Fork Cowlitz

The sediment regime at the watershed scale reflects near-natural conditions as most of the sediment delivered to the stream system is generated from natural sources (e.g. glacial systems, natural mass wasting, etc.). On a small scale, some streams are sediment impaired (e.g. Millrigde Creek).

Aquatic Organisms and Stream Habitat

Data Sources

Data sources for aquatic organism distribution include, Packwood Ranger District files, Region 6 stream surveys, Washington Department of Fish and Game anadromous/resident fish surveys, National Park Service records, and stocking records.

Data Gaps and Limitations

- Historical fishery and habitat information is scarce for the area.
- Existing surveys only consistently reported salmon and trout species, therefore, the distribution of other species is considered a data gap.
- Forest Service records do not distinguish between the native rainbow and stocked rainbow trout, or coastal cutthroat and stocked strains of cutthroat trout.
- No field data collection or validation was done for this analysis.
- Unknown populations and a large amount of potential habitat and may exist in the watershed.
- The map used for resident species does not clearly show the upper limit of distribution for individual species.
- The maps display approximate locations of upstream migration limits because data used for anadromous species only listed rivermile (RM) rather than mapping it. In addition, it is unclear if the rivermiles were measured channel lengths or estimates made from mapped distances.
- The records for species distribution do not include the extent of fish use for unnamed tributaries to occupied habitats.

Assumptions for Aquatic Organism Distribution

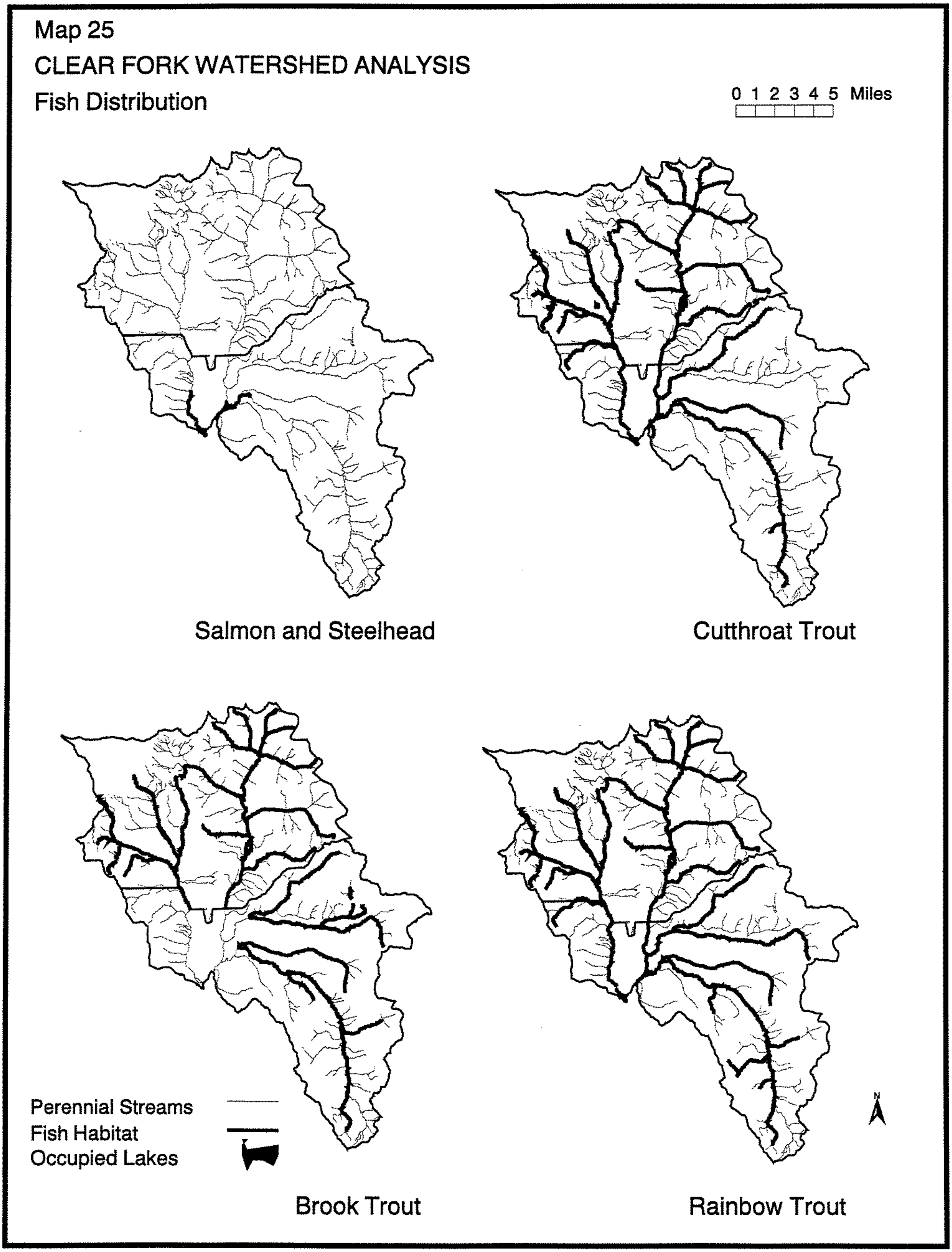
- Spring chinook (*Oncorhychus tshawytscha),* coho (O.*kisutch*), and winter steelhead *(O. mykiss)* are being reintroduced into the Cowlitz River and larger tributaries above Cowlitz Falls Reservoir as mitigation for the Cowlitz Falls Dam. Because no man-made barriers block access to the known historical habitat, it is assumed that salmon and steelhead will reoccupy this habitat.

Fish Species Distribution

Both the fish distribution information by stream, and the fish distribution map display the approximate known distribution of salmon and trout in the watershed (Map 25, Fish Distribution).

Migration Barriers

Several factors combine to limit anadromous and non-anadromous fish in the Clear Fork watershed. Natural and human-caused barriers such as bedrock falls, high stream channel gradients, logjams, and road crossings prevent migration of adult spawners and rearing juveniles. The Tacoma Public Utilities projects on the Cowlitz River currently block volitional passage of anadromous species into the Clear Fork watershed. Currently salmon and steelhead are trapped and hauled around the hydroelectric facilities in the lower Cowlitz River. Natural barriers occur at approximately rivermile 0.5 on the Ohanapecosh River, rivermile 1.5 on the Clear Fork Cowlitz River, rivermile 3.0 on the Muddy Fork Cowlitz River, and rivermile 0.2 on Purcell Creek. Steep waterfalls near the mouths of Cortright Creek, Lava Creek, and Little Lava Creek act as barriers to resident and anadromous fish migration from downstream locations. The steep gradients of Millridge Creek and Summit Creek are also migration barriers to downstream populations. Any fish in Millridge Creek are probably migrants from fish stocking in Knuppenberg Lake. The upper limit of fish in Cortright Creek was noted at about rivermile 5.3. Migration barriers within resident fish habitats are mentioned in stream surveys, however, resident fish were found above "migration barriers". If these populations are not native species (ie., brook trout) they were stocked. It is not clear if the populations of native fish species (i.e., cutthroat or rainbow trout) above these barriers are stocked populations, populations that existed before the barriers developed, or if the barriers were misidentified. The fish distribution table and map indicate the approximate locations of complete migration barriers. The culverts where Forest Road 46 crosses Lava Creek and Little Lava Creek are migration barriers. These culverts are not high priority problems to treat because there are natural barriers near by.


Map 25
CLEAR FORK WATERSHED ANALYSIS
Fish Distribution
0 1 2 3 4 5 Miles
Salmon and Steelhead
Cutthroat Trout
Brook Trout
Rainbow Trout
Perennial Streams
Fish Habitat
Occupied Lakes
N

Aquatic Population Viability

Threatened, Endangered, and Sensitive Fish Species

The Lower Columbia River steelhead *(Oncorhynchus mykiss)* is listed as "Threatened" under the Endangered Species Act. The Cowlitz River watershed above the Mayfield dam is inside the Lower Columbia River Evolutionary Significant Unit (ESU). These fish or hatchery progeny of these fish are known to exist in the Clear Fork watershed, and are being used for reintroduction purposes.

Lower Columbia River chinook and chum are proposed for listing as "Threatened" under the Endangered Species Act. As of this writing, the Cowlitz River watershed above Mayfield dam is outside of the Lower Columbia River ESU for chinook salmon. The ESU for chum salmon includes the upper part of the Cowlitz watershed. However, the Tacoma PUD dams block passage of the chum salmon. There are no efforts to reintroduce chum to the upper watershed, and the dams act as a buffer to any effects (e.g. increased sediment) from projects occurring in the Clear Fork watershed.

Bull trout in the Cowlitz River is listed as "Threatened" under the Endangered Species Act. The Columbia River Distinct Population Segment (DSP) includes the upper Cowlitz River. It is unlikely that bull trout are in the Clear Fork watershed, or will reoccupy the area because the last anecdotal record of bull trout was for Dolly Varden trout in 1934. Furthermore, there is no volitional passage around the Tacoma Public Utility dams, and there are no plans to reintroduce bull trout.

Extinct Species

There are historical accounts of Dolly Varden trout (*Salvelinus malma*) and Arctic grayling (*Thymallus articus*) in the watershed. There are no recent records of these species in the watershed, and they are considered extinct. The Dolly Varden may have been what are now know as bull trout (*Salvelinus confluentus*). Bull trout have only been recently recognized as a separate species.

Introduced Species

Several different species and strains of fish have been planted in isolated sections of streams and lakes to promote sport fisheries. All of the lakes in Mt. Rainier National Park were barren of fish prior to stocking (personal communication Barbara Samora, Mt. Rainier National Park Aquatic

Program Manager). Stocking of fish in these lakes began in the 1920s. The practice of stocking fish in Mt. Rainier National Park ended in the 1970s. Fish are still stocked in lakes on National Forest lands. Appendix D, Partial Fish Stocking Records, shows partial stocking records for introduced species in the watershed analysis area.

Fish stocking introduced several exotic species and subspecies of fish. Eastern Brook trout (*Salvelinus fontinalis*) were introduced from the eastern United States. Brown trout (*Salmo trutta*) were introduced from Europe. The Montana black spotted trout (*Oncorhynchus* sp.) and Twin Lakes cutthroat (*Oncorhynchus* sp.) are non-native strains of cutthroat trout. Although rainbow and coastal cutthroat trout are native to the area, they have been stocked in lakes and streams where they did not originally occur. Hatchery stocks of salmon and steelhead from other rivers have been introduced to the Cowlitz River and its tributaries in an effort to supplement stocks, and more recently, to reintroduce these species to the watershed.

Aquatic Habitat

Effects of Natural Processes on Habitat and Aquatic Organisms

Salmonid habitats are products of the existing geology and soils, topography, vegetation, climate, and hydrology of a watershed. Any changes in these conditions can bring about changes in the existing habitat that may greatly affect the fish habitat (Meehan 1991). Salmonids are adapted to a dynamic landscape. Stocks of salmon and trout that have evolved in stream systems with fluctuations in flow, turbidity, and temperature have often developed behaviors that enable survival despite the occurrence of temporarily unfavorable conditions (Bjornn and Reiser 1991). This flexibility is limited and has evolved for the existing environment under each stock. Natural or human-caused changes (such as the dams located in the lower portions of the Cowlitz River system) can be large enough to prevent fish from completing their maturation or migration.

Floods

Large and small floods have had a major influence on the existing aquatic ecosystem within the Clear Fork Cowlitz River basin. Flood events (such as the 1996 incident) that have the potential to cause adverse impacts to stream channels and fish habitat are those occurring during the late fall to early spring, from November to early March. Flood impacts to watershed areas affected by late fall to early spring floods are further compounded by rain-on-snow effects as described previously in this chapter. Floods are and have been part of the natural disturbance history in the Clear Fork Cowlitz River basin. Periodic major floods (e.g., 1996 flood) along with fire, have altered and changed stream channel and fish habitat conditions through time. The amount of time (years to decades) between such major events, and the relatively intact refuge watersheds, allowed fish populations to respond and adjust to altered channel and habitat conditions. These populations remained intact, viable, and self-sustaining. The ability to respond and cope with this natural disturbance regime was probably changed when the effects of man's activities (road construction, timber harvest, and riparian stand or streambank alterations) in the Clear Fork Cowlitz River basin began to exacerbate the damage done by naturally-occurring floods. Refer to the following section for further description of effects of human influences on habitat and aquatic organisms.

Land slides

Periodic erosion, mass wasting and flood events deliver large woody debris and fresh sediments (usually cobble-sized with relatively large percentages of finer sands and silts) to streams and rivers. A certain amount of natural erosion or disturbance to both upslope and instream channel conditions is beneficial to the aquatic habitat within the area. This process of sediment delivery provides substrate for fish spawning purposes. Periodic flushing of sediments cleans out gravel areas that are negatively impacted by accumulation of fine, silt-rich sediments, and scours out sediments, or maintains pools for fish rearing and other life history requirements. Fish populations have evolved over time in stream channels that are relatively balanced with bedload transportation and deposition and a stable channel condition. Increases in sediment influx during a flush event (such as a heavy storm) will negatively affect fish habitat as the sediment settles in depositional or low gradient areas and pools. Channels shift and residual pool depth is lost, changing fish habitat. In depositional areas, the effects of increased sediment supply are expected to correspond with accumulation of sediments. The development of salmonid eggs and alevin (fry) typically occurs in gravelly substrate in freshwater streams and rivers (Schuttes-Hames *et al.* 1993). Eggs and fry require a stable streambed, and an adequate supply of clean water to prevent dehydration and loss of oxygen and to continue standard metabolic waste removal while they develop (McNeil 1969). Therefore, excessive sediment deposition can adversely affect salmonid eggs and fry.

Fine sediments that lodge in the spaces between gravel particles reduce permeability and slow the flow rate through the gravel substrate (Johnson 1980). Numerous other studies associated higher fine sediment loads with elevated rates of mortality and reduced fitness of the surrounding fish (Chapman 1988; Everest *et al.* 1987; Koski 1975). Washington Department of Fish and Wildlife (and participating agencies) in the Wild Salmonid Policy (first draft, 1995) consider spawning gravels impaired if fine sediments exceed 11 percent (based upon Peterson *et al.* 1992).

Stream channel scouring events resulted in both positive and negative impacts to the existing anadromous and non-anadromous fish habitat in the analysis area. Upslope scouring provides a source for spawning-sized gravels and cobbles, which when concentrated in areas of moderate flow, are excellent sites for redd placement. It should be noted that sediment diameter and flow velocity preference vary among salmonid species. In areas with high volumes of sediment inputs, such as those during higher peak flow events, redds get covered, and temperatures and oxygen flow are affected. Such events have been found to frequently occur within the analysis area.

Effects of Human Influences on Habitat and Aquatic Organisms

Several aspects of impacts to stream habitat and aquatic organisms are addressed below. Refer also to Habitat Condition - Connectivity and Fragmentation above.

Timber Management

Timber harvesting and associated road construction has affected stream habitats within the Clear Fork watershed over the past 40-45 years. Fine sediments are typically more abundant where land-use activities such as road building or vegetative disturbance expose soil to higher erosion potential and increased mass wasting potential (Swanson *et al.* 1987; Chamberlin *et al.* 1991).

Timber harvesting can modify hydrologic processes and stream morphology (Chamberlin *et al.* 1991). Increases in peak flows from rain-on-snow events can increase scouring and accelerate bank erosion. Increases in sediment from bank erosion causes aggradation in pools, and degrades spawning gravels (both quality and quantity). Stream habitat diversity declines due to removal of instream structure-forming agents such as woody material (Hicks *et al.* 1991; Chamberlin *et al.* 1991). The size, number, and density of timber harvest clearcut units and roads constructed in a relatively short time period (1950s-1990s) is suspected to have had a major influence on channel and aquatic habitat conditions. Road-related flood damage is associated with the following aquatic concerns:

- severe stream channel aggradation associated with upslope failures.
- mass failure of fillslopes and/or cutbanks into stream channels.
- fluvial erosion of fillslopes, cutbanks, or road surface.
- road crossing failure at stream crossings.
- diversion of streams at stream crossings.
- blockage of fish passage at stream crossings.

Stocking of Exotic Fish Species

When fish are stocked, resident fish populations must compete for space and food. Interbreeding opportunities are also introduced. Stocking of brook trout has been linked to the decline of bull trout.

Recreational Fishing

Current information on recreational fishing use is limited. Starting in 1969, Forest Service management re-introduced steelhead runs above the Cowlitz River dam barriers that exist west of the analysis area. Since that time, the population has improved to a minor degree, but fishing availability is still very limited. The main fishing interests at this time are resident cutthroat, rainbow, and brook trout that are found in the larger tributary stream channel systems as well as a number of the larger and deeper lake systems. Shallow lakes are unable to maintain natural fish populations on a yearly basis due to extreme cold winter conditions and potential full water freezings.

Other Recreational Impacts

Habitat degradation has occurred along riverbanks and lake shores. Dispersed camping compacts soils in riparian areas, campers often cut down trees which provide both shade and future LWD needs, and trash is frequently deposited in both stream and lake areas. Lack of nearby toilet facilities leads to water quality concerns. Instream impacts occur from small impoundments (e.g. swimming pools) constructed with cobbles, and when people swim and play in the stream.

Poaching

Poaching concerns are very limited and are expected to be scattered about the analysis area. Such events are thought to be most predominant within the main fishing areas.

Key Habitats

Spawning and Rearing Habitats

The fish distribution maps (Map 25, Fish Distribution) show the rearing habitats for each stream. The spawning habitat maps identify the best potential for spawning habitats based on stream gradient, substrate sizes and known migration barriers. The key spawning reaches (Map 26, Key Spawning Habitats) are identified in the stream survey data appendix.

Refugia

Anadromous Species

Although the Clear Fork Cowlitz River, Muddy Fork Cowlitz River and Ohanapecosh River are relatively intact watersheds, they provide only 5 miles of habitat. This limited amount of habitat is not enough habitat to be considered refugia. The natural migration barriers limit the amount of available anadromous fish habitat to 5 miles of stream.

Resident Species

The Clear Fork Cowlitz River upstream to Millridge Creek, the Muddy Fork Cowlitz River, and the Ohanapecosh River in Mt. Rainier National Park are relatively intact watersheds and large enough to function as refugia. All three of these areas are needed to insure that a single large disturbance does not destroy the entire refugia.

Limiting Factors Analysis

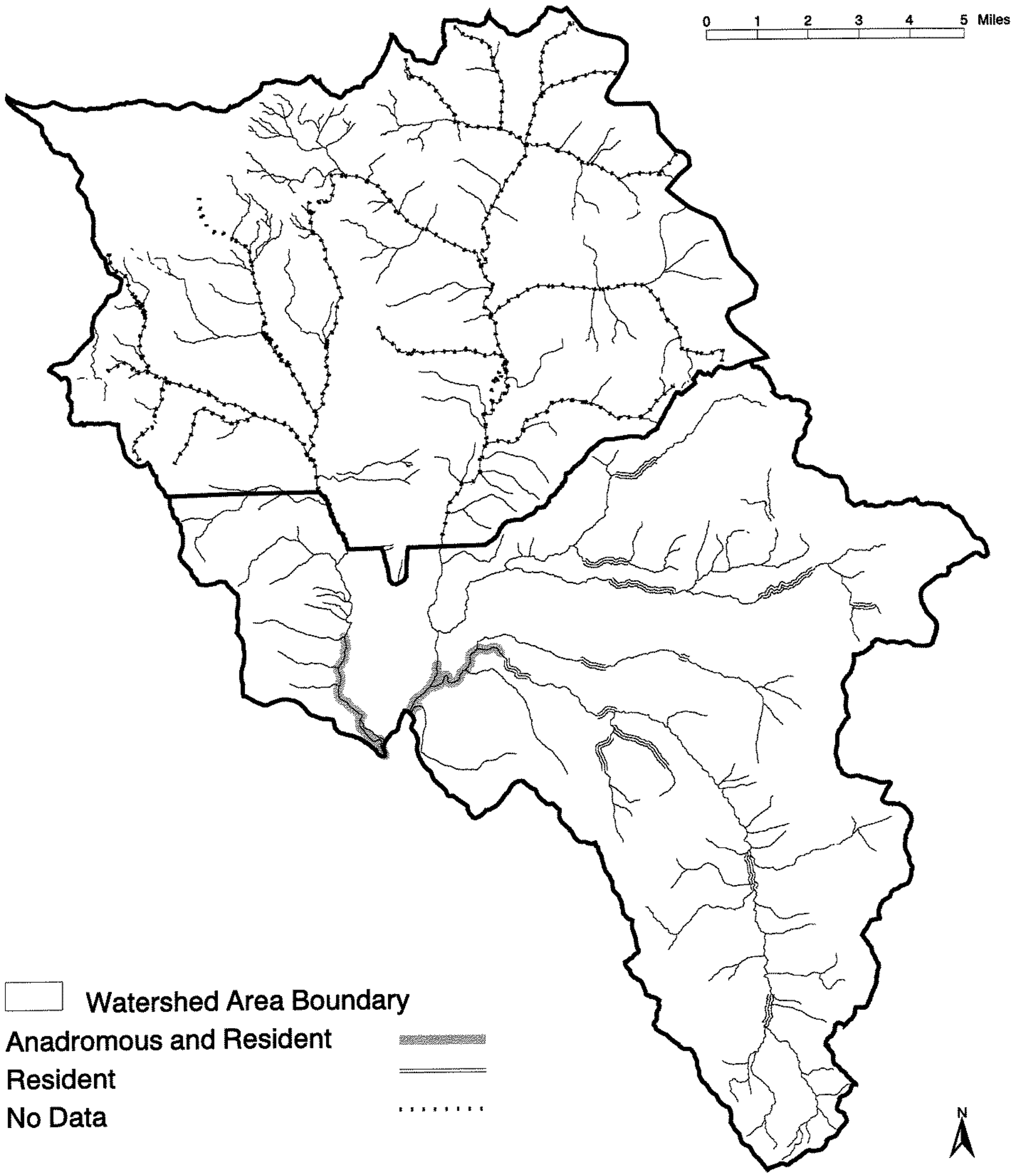
Analysis Procedures

This procedure is a rating of a stream's fish habitat condition and does not factor in the potential of the stream. This limiting factor analysis rates four fish habitat elements as good, fair or poor by stream survey reach. A habitat element was considered limiting if most of the stream length that is available to fish rates as fair or poor. The degree of limitation increases as the percentage of the stream length rated as fair or poor increases. Streams in ideal condition have no limiting factors, while streams in poor condition are limited by all four habitat variables. The limiting factors table (Table 3-49) identifies the limiting factors for surveyed stream sections.

Map 26

CLEAR FORK WATERSHED ANALYSIS

Key Spawning Habitats



The data and rating for individual stream reaches are found in the Stream Survey Data Appendix, Appendix C.

Four elements were chosen to evaluate the habitat requirements of salmon and trout. All four of the elements were chosen, because if they are in less than good condition they can limit population size or create a bottleneck for fish populations. Pool frequency was chosen as one of the variables because it is a measure of the amount of suitable rearing habitat (deep slow water) (Bjornn and Reiser, 1991). Woody debris was chosen because of its importance in forming pools, trapping sediments, providing hiding cover, and providing nutrients (Hicks *et al.* 1991). In addition, woody debris has been correlated with fish population size (Burnett and Reeves, 1998). Spawning gravel gives an estimate of the amount of gravel that is suitable for spawning, thus it is a measure of a stream's suitability for reproduction. Fine sediment gives a measure of the quality of the spawning gravel and a measure of the spaces between rocks that are available for hiding cover and aquatic invertebrate production. Effects of fine sediment become noticeable when fine sediments make up approximately 11% of the substrate. Egg to fry survival begins to dramatically decline when fine sediments make up 20% or more of the substrate (Bjornn and Reiser, 1991). Stream temperature was not chosen as a limiting factor because existing information does not indicate that stream temperatures are limiting to aquatic organisms. Other habitat variables (such as pool quality and hiding cover) were not chosen because they were rarely gathered, not gathered in a consistent manner, or it was not possible to extract the data needed in the time frame of the analysis.

Data Sources/Gaps and Analysis Limitations

- The data used in this analysis was collected in stream surveys from 1979 to 1997. Protocol for these stream surveys changed over the years. Appendix C , Stream Survey Data, identifies the year of the stream survey along the with values used in the analysis.
- All of the data, except for the 1997 Summit Creek survey, was collected before the 1995/1996 floods which altered channel conditions in many areas, so it is not considered up to date.
- Data collected prior to 1989 is difficult to interpret because protocols could not be determined.
- Measures of spawning gravel and sediment are highly subjective and may differ between surveyors.
- Many stream surveys did not gather information for all four variables.
- There is no data available from relatively unmanaged streams to serve as reference data for these stream systems to determine if management effects exist.
- The criteria for good fish habitat used in the National Marine Fisheries Matrix of Pathways and Indicators was used, which may not be indicators of stream potential.

- Historical data for which the protocols used to collect it are not known is useless for comparison, therefore this data is not reported. In addition, because surveyors and protocols changed between years it is impossible to distinguish between differences in habitat condition and artifacts created by different surveys and surveyors. The one exception is the data for the Clear Fork Cowlitz River which was part of a larger study which was able to compare similar data sets.

Habitat Element Rating Criteria/Reference Conditions

Pool Frequency

This analysis used the criteria described in the National Marine Fisheries Service (NMFS) Matrix of Pathways and Indicators for the definition of good pool frequency. Under the NMFS protocol, ratings are dependent on stream width. The table below displays the pool frequency required for a stream to receive a rating of good. We expanded this rating system to include ratings for fair and poor. The pool frequency rating criteria for the ratings used in the limiting factors analysis are shown in Table 3-45.

Table 3-45: Pool Frequency Rating Criteria (NMFS protocol)

Wetted Channel Width in feet	5	10	15	20	25	50	75	100
# of Pools/ Mile required for a rating of Good	184	96	70	56	47	26	23	18
# of Pools/ Mile required for a rating of Fair	92	48	35	28	24	23	11	9
# of Pools/ Mile required for a rating of Poor	<92	<48	<35	<28	<24	<23	<11	<9

When the survey did not directly count pools (e.g., Carlton Creek) we used the percent of the stream area that was classified as pool habitat (Table 3-46).

Table 3-46: Rating Criteria for Percent Pool Habitat

Rating	Criteria for rating % pool habitat.
Good	> 40% of the stream is pool habitat
Fair	>25% of the stream is pool habitat
Poor	< 25% of the stream is pool habitat

The 1983 and 1984 stream surveys on Purcell Creek , Lava Creek, Little Lava Creek and Buesch Creek do not provide enough information to rate pool frequency.

Large Woody Debris

The discussion of large woody debris describes how the ratings for large woody debris were arrived at.

Spawning Gravel

Table 3-47 displays the rating criteria for spawning gravel.

Table 3-47: Rating Criteria for Spawning Gravels

Rating	Criteria
Good	less than 25% of the channel has spawning areas that cover most of the streambed.
Fair	25% or more of the channel has spawning gravel, but that gravel is limited to isolated pockets.
Poor	Spawning gravel is not present.

Fine Sediment

Table 3-48 displays the criteria for rating fine sediment.

Table 3-48: Rating Criteria for Fine Sediments

Rating	Criteria
Good	Fine sediments make up less than 11% of the substrate, or cobble embeddedness is less than 20%
Fair	Fine sediments make up between 11% and 20% of the substrate, or cobble embeddedness is between 20% and 35%
Poor	Fine sediments make up more than 20% of the substrate, or cobble embeddedness is 35% or greater.

Limiting Factors

Table 3-49 displays the overall rating for the habitat elements of a stream. Habitat is considered a limiting factor on fish populations when most of a stream rates as fair or poor. The limitation is less if the stream rates as fair, than if a stream rates as poor. The overall condition of the stream is a combination of all of the ratings for that stream.

Table 3-49: Summary of the Limiting Factors Analysis for Fish Habitat

Stream	Pool Frequency	Woody Debris	Spawning Gravel	Fine Sediment
Clear Fork Cowlitz River	Limiting Fair	Good	Data Gap	Good
Cortright Creek	Limiting Fair	Limiting Fair	Limiting Fair	Limiting Poor
Purcell Creek	Data Gap	Limiting Fair	Data Gap	Good
Lava Creek	Data Gap	Good	Limiting Poor	Limiting Poor
Little Lava Creek	Data Gap	Good	Limiting Poor	Limiting Poor
Ohanapecosh River	Limiting Fair	Good	Data Gap	Good
Summit Creek	Limiting Poor	Data Gap	Data Gap	Good
Buesch Creek	Limiting Fair	Data Gap	Data Gap	Good
Carlton Creek	Limiting Fair	Data Gap	Limiting Poor	Limiting Poor
Cyrenus Creek	Limiting Fair	Data Gap	Limiting Fair	Limiting Fair

A discussion of limiting factors for each stream follows below. It briefly describes which factors are considered limiting and why they are considered limiting. The years listed with the stream name are the years in which stream surveys were conducted for the stream.

Clear Fork Cowlitz River - 1992 and 1987

Two different crews surveyed different parts of the Clear Fork Cowlitz River. The 1987 crew surveyed approximately 3 miles starting at the Clear/Lost trail #76 crossing. The 1992 survey started at the mouth of the Clear Fork Cowlitz River and ended near the Clear/Lost trail crossing. In general, habitat conditions were worse in the 1987 survey, but it is impossible to determine if the differences in conditions between 1987 and 1992 are real or just an artifact of different survey methods. Combining the two surveys increases the coverage of the river, and does not change the conclusions from the 1992 data alone. Table 3-50 displays the ratings for the habitat elements in the combined survey.

Table 3-50: Clear Fork Cowlitz River Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	0	78	18	4
Woody Debris	58	27	11	4
Spawning Gravel	16	9	2	73
Fine Sediment	68	12	0	20

Pool Frequency

Pool frequency is considered a limiting factor in the Clear Fork Cowlitz River because:

- Nearly all of the surveyed stream length lacks pool type habitat and rates as fair for pool frequency.
- A comparison of large pools between 1935 and 1991 show a loss of 6.7 pools per mile (-36%). A similar comparison for deep pools showed a loss of 10.3 pools per mile (-89%). This data was from a much larger study that showed smaller negative changes or improvements for relatively unmanaged streams. Therefore, the differences in the number of pools between years is not an artifact of comparing different surveys.

Because most of the stream falls into the fair category, this is considered a fair condition for pool frequency.

Large Woody Debris

Large woody debris is not considered a limiting factor in the Clear Fork Cowlitz River because this habitat element is abundant and rates as good for most of surveyed section of stream for this habitat element.

Spawning Gravel

Spawning gravel is a data gap because the 1992 survey did not collect spawning gravel information. Prior to the construction of the Tacoma Public Utility dams, the lower 1.5 miles of the Clear Fork Cowlitz River was used as spawning habitat by steelhead, chinook, and coho (HARZA 1998), therefore some spawning gravel was available. Spawning gravel was characterized as abundant in the 1989 survey data and rates as good for just over half of the surveyed length. However, this survey only collected data for about one-quarter of the surveyed section, so there is a large data gap.

Fine Sediment

Fine sediment is not considered a limiting factor in the Clear Fork Cowlitz River because it was rare and rates as good for nearly all of the stream.

Cortright Creek - 1989

Table 3-51 displays the ratings for the Cortright Creek habitat elements.

Table 3-51: Cortright Creek Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	25	44	31	0
Woody Debris	24	22	22	32
Spawning Gravel	10	59	31	0
Fine Sediment	36	13	50	1

Pool Frequency

Pool frequency is considered a limiting factor in Cortright Creek because:

- Most of the stream length lacks pools.
- Although this stream has some reaches that rate as good, these reaches are extremely steep (17% to 10% gradient). Sections of stream that are this steep generally act as migration barriers, so fish may have limited access to these habitats.

Because most of the stream falls into the fair and good categories, this is considered a fair condition for pool frequency.

Large Woody Debris

Large woody debris is considered a limiting factor in Cortright Creek because much of the stream length lacks wood. However, there is a substantial portion of the stream in the good category, therefore, this stream rates as fair condition for large woody debris. There is a data gap for this habitat element in the upper third of the stream.

Spawning Gravel

Spawning gravel is considered a limiting factor in Cortright Creek because spawning is limited to small patches of gravel rather than spawning beds. Because most of the stream falls into the fair category, this is considered a fair condition for spawning gravel.

Fine Sediment

Fine sediment is considered to be a limiting factor in Cortright Creek because:

- fine sediment is considered to be elevated above the background level and rates as fair or poor for more that half of the stream.
- some of the steep sections of the stream, which are usually relatively free of fine sediment, are high in fine sediment and rate as poor.

Purcell Creek - 1983

Table 3-52 displays the ratings for the Purcell Creek habitat elements.

Table 3-52: Purcell Creek Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	0	0	0	100
Woody Debris	59	21	20	0
Spawning Gravel	0	0	0	100
Fine Sediment	69	31	0	0

Pool Frequency

Pool frequency information is not available for Purcell Creek because it is not possible to determine pool abundance from the information gathered by the stream survey.

Large Woody Debris

Large woody debris is considered a limiting factor in Purcell Creek, although large woody debris is abundant and rates as good for most of the stream. Large woody debris is considered a limiting factor because it is lacking in the fish-bearing reaches near the mouth of Purcell Creek.

Spawning Gravel

Spawning gravel information was not collected in the stream survey for Purcell Creek.

Fine Sediment

Fine sediment is not considered a limiting factor in Purcell Creek because the substrate is relatively free of sand and silts.

Lava Creek - 1984

Table 3-53 displays the ratings for the Lava Creek habitat elements.

Table 3-53: Lava Creek Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	0	0	0	100
Woody Debris	100	0	0	0
Spawning Gravel	0	0	100	0
Fine Sediment	0	0	100	0

Pool Frequency

Pool frequency is considered a data gap for Lava Creek because it is not possible to determine pool abundance from the information gathered by the stream survey.

Large Woody Debris

Large woody debris is not considered a limiting factor in Lava Creek because it is abundant.

Spawning Gravel

Spawning gravel is considered a limiting factor in Lava Creek because this stream lacks gravel areas that are suitable for spawning.

Fine Sediment

Fine sediment is considered a limiting factor in Lava Creek because this stream has a relatively large amount of fine sediment in the substrate.

Little Lava Creek - 1984

Table 3-54 displays the ratings for the Little Lava Creek habitat elements.

Table 3-54: Little Lava Creek Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	0	0	0	100
Woody Debris	100	0	0	0
Spawning Gravel	0	0	100	0
Fine Sediment	0	0	100	0

Pool Frequency

Pool frequency is considered a data gap for Little Lava Creek because it is not possible to determine pool abundance from the information gathered by the stream survey.

Large Woody Debris

Large woody debris is not considered a limiting factor in Little Lava Creek because it is abundant.

Spawning Gravel

Spawning gravel is considered a limiting factor in Little Lava Creek because this stream lacks gravel areas that are of suitable size for spawning.

Fine Sediment

Fine sediment is considered a limiting factor in Little Lava Creek because this stream has a relatively large amount of fine sediment in the substrate.

Ohanapecosh River - 1992

There is no habitat information available for the portion of the Ohanapecosh River that is inside Mount Rainier National Park. The 1992 stream survey only covered 13% of the fish-bearing portion of the Ohanapecosh River. There is a data gap for resident fish habitat within the National Park boundary. Table 3-55 displays the ratings for the Ohanapecosh River habitat elements.

Table 3-55: Ohanapecosh River Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	35	56	9	0
Woody Debris	84	0	16	0
Spawning Gravel	0	0	16	84
Fine Sediment	94	0	6	0

Pool Frequency

Pool frequency is considered a limiting factor in the Ohanapecosh River because most of the surveyed stream length lacks pools. Because most of the stream falls into the fair category, this is considered a fair condition for pool frequency.

Large Woody Debris

Large woody debris is not considered a limiting factor in the Ohanapecosh River because it is abundant in almost all of the surveyed section.

Spawning Gravel

Spawning gravel information was collected for only 16% of the surveyed portion of the Ohanapecosh River, therefore, spawning gravel is considered a data gap. Prior to constructing the Tacoma Public Utility dams, the lower 0.5 miles of the Ohanapecosh River was used as spawning area by steelhead, chinook, and coho (Federal Energy Regulation Committee studies), therefore, some spawning gravel was and probably is available.

Fine Sediment

Fine sediment is not considered a limiting factor in the Ohanapecosh River because the substrate is relatively free of fine sediment.

Summit Creek - 1979, 1983, 1997

The three Summit Creek surveys are not comparable because different crews covered different areas using different methodology. Because the surveys overlap in the area covered, they can not be combined like those for the Clear Fork Cowlitz River or Buesch Creek. The longest section of stream survey covered 44% of the fish bearing portion of Summit Creek. Table 3-56 displays the ratings for the Summit Creek habitat elements.

Table 3-56: Summit Creek Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
1979				
Pool Frequency	0	40	60	0
Woody Debris	0	0	0	100
Spawning Gravel	67	0	0	33
Fine Sediment	100	0	0	0
1983				
Pool Frequency	0	0	0	100
Woody Debris	0	0	100	0
Spawning Gravel	0	0	0	100
Fine Sediment	100	0	0	0
1997				
Pool Frequency	0	0	16	84
Woody Debris	0	0	16	84
Spawning Gravel	0	0	0	100
Fine Sediment	0	0	0	100

Pool Frequency

Pool frequency is considered a limiting factor because Summit Creek lacks pools.

Large Woody Debris

Insufficient large woody debris information was collected for Summit Creek.

Spawning Gravel

Spawning gravel information was not collected for Summit Creek.

Fine Sediment

Fine sediment is not considered a limiting factor in Summit Creek because the substrate is relatively free of sand and silt.

Buesch Creek - 1981, 1983

Buesch Creek is located within the Upper Summit Creek (01E) sixth-field watershed. The 1981 survey covered the lower 17% of the fish-bearing portion of Buesch Creek, and the 1983 survey covered the remainder of the fish-bearing portion of Buesch Creek. Table 3-57 displays the ratings for the Buesch Creek habitat elements.

Table 3-57: Buesch Creek Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	0	17	0	83
Woody Debris	0	0	0	100
Spawning Gravel	0	7	49	44
Fine Sediment	74	2	15	9

Pool Frequency

Pool frequency information is not available for Buesch Creek because it was not possible to determine pool abundance from the information gathered by the 1983 stream survey.

Large Woody Debris

Large woody debris information was not collected for Buesch Creek.

Spawning Gravel

Spawning gravel is considered a limiting factor in Buesch Creek because it is limited to small pockets. Spawning gravel is also considered a data gap because this information is missing for 43% of the surveyed sections of the stream.

Fine Sediment

Fine sediment is not considered a limiting factor in Buesch Creek because most of the stream is relatively free of sand and silt.

Carlton Creek - 1980

Table 3-58 displays the ratings for the Carlton Creek habitat elements.

Table 3-58: Carlton Creek Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	0	100	0	0
Woody Debris	0	0	0	100
Spawning Gravel	0	23	77	0
Fine Sediment	77	0	23	0

Pool Frequency

Pool frequency is considered a limiting factor in Carlton Creek because the stream lacks pool type habitat. Although small pools are abundant in some areas, they make up less than 30% of the stream. Because most of the stream falls into the fair category, this is considered a fair condition for pool frequency.

Large Woody Debris

Large woody debris information was not collected for Carlton Creek.

Spawning Gravel

Spawning gravel is considered a limiting factor in Carlton Creek because spawning gravel is limited to small pockets.

Fine Sediment

Fine sediment is considered a limiting factor in Carlton Creek because the section of stream with the most spawning potential rates as poor.

Cyrenus Creek - 1979

Table 3-59 displays the ratings for the Cyrenus Creek habitat elements.

Table 3-59: Cyrenus Creek Habitat Element Rating - Percentage of stream length in Good, Fair, and Poor condition and percentage of the surveyed length with data gaps.

Habitat Element	Good	Fair	Poor	Data Gap
Pool Frequency	3	0	97	0
Woody Debris	0	0	0	100
Spawning Gravel	0	100	0	0
Fine Sediment	9	82	0	9

Pool Frequency

Pool frequency is considered a limiting factor in Cyrenus Creek because the stream lacks pools.

Large Woody Debris

Large woody debris information was not collected for Cyrenus Creek.

Spawning Gravel

Spawning gravel is considered a limiting factor in Cyrenus Creek because it is limited to small pockets.

Fine Sediment

Fine sediment is considered a limiting factor in Cyrenus Creek because sand and silt are moderately abundant in the substrate.

Forest Service Fisheries Habitat Improvement and Watershed Restoration

Large woody debris was removed from streams primarily in conjunction with timber sales. The purpose was twofold: as a flood control/prevention measure (reduce the potential a log jam has to damage/destroy a downstream bridge or road segment), and to remove the suspected fish blockages these jams were interpreted as being. With new studies and research available indicating the beneficial nature of large woody debris, the Forest Service has attempted to adopt the information available and restrict any human activities within the riparian area that are suspected to alter aquatics habitat conditions. One of the exceptions to this condition is where woody debris or large bedrock/boulders that are present within stream channels may pose a threat to existing bridges or road systems.

No restoration has been planned for this watershed because funding has been directed at higher priority streams. This area has been placed lower on the priority list because a high proportion of the area lies within Wilderness and National Park boundaries.

Monitoring

Monitoring in the Clear Fork watershed analysis area has been limited to the stations on Carlton and Cortright Creeks. The monitoring includes stream cross sections, stream flows, Wollman pebble counts and temperature monitoring with continuous recording thermographs.

Chapter 4 - Interpretations/Areas of Concern

Introduction

This chapter focuses on the interpretation of data presented in Chapter 3 as it pertains to current and proposed management within the watershed. It is through understanding of the function of the various ecosystem elements that the context for future management is set. As in Chapter 3, the information is presented for the major terrestrial, aquatic, and social elements known from the Clear Fork watershed.

Human Ecology

Information pertaining to past human use of the watershed was examined from the perspective of ecosystem management. Maintenance of a ``properly functioning, self-sustaining ecosystem" is described as a necessity of management, identified previously in this document as Issue 4, Ecosystem Function (see Chapter 2). The principal questions addressed by this analysis relate to the retention of native plant and animal species within the watershed including adequate distributions of suitable habitat and populations.

Past human use of the Clear Fork watershed analysis area by indigenous people included hunting, fishing, and gathering of a variety of native plants and animals. These resources were important components of the naturally functioning ecosystem prior to 1883, when non-native people began settlement of the Cowlitz River valley, west of the analysis area. Historic shifts in local land use practices and the resource demands of an increasing *regional* population resulted in impacts to the natural distribution of some species, especially in the past fifty years.

Populations of six species of fish were sufficient to have contributed to the subsistence base of the indigenous culture. Historic data suggest the salmonids (*Onchorhynchus sp.*) were the most abundant. Identifications have been based largely on Sahaptin fish taxonomy (Hunn 1990) which uses the noun *sinux* for coho, or silverside salmon, *tk^{w}inat* for Chinook, *shushaynsh* for steelhead, or the generic *núsux* for all salmonids. Construction of hydroelectric dams on the Cowlitz River has eliminated the native runs of all three species. Hatchery coho and steelhead have been reintroduced, but numbers and distribution do not approximate historic conditions. Dolly Varden are now extinct. This situation suggests a significant imbalance within the structure of the aquatic ecosystem.

The distribution of culturally significant plant communities, particularly fire-created seral communities with *Vaccinium membranaceum* as a dominant shrub component, has diminished throughout the analysis area. The collection and processing of huckleberries was an important focus of historic use by indigenous people. To assure continued supply of this resource, vegetation was manipulated by setting fires. Huckleberry coverage expanded within several years. The effects of fire, whether natural or human-caused, were a natural part of the historic ecosystem.

The prevention of fire has been an important aspect of federal land management policy since the 1890s. As a result, historic berry patches have disappeared with the natural reforestation of former burns. Packwood District Ranger William Sethe observed this trend in the Cowlitz Pass area between 1933 and 1942. Tree encroachment contributed not only to the closure of sheep grazing in the area, but led also to the end of Yakama traditional use. This same pattern is well-documented within the National Park. Yakama elders interviewed by Allan Smith in 1963 reported that traditional family berry patches were now ``all grown up" and largely unrecognizable (Smith 1964).

At present, no analyses have been done to determine the estimated acreage loss of historic *Vaccinium* stands within the study area. As Minore (1972) points out, clearcut logging has produced new, transitory huckleberry fields in some areas, but occurrence and productivity is erratic. The total acreage of these newer patches is likely only a fraction of the acreage lost through encroachment, given the significant portion of the study area that lies within Wildernesses or National Park lands.

Representatives of the Yakama Indian Nation have expressed concern about the maintenance of huckleberry fields in and adjacent to the Clear Fork analysis area, particularly in the vicinity of White Pass (Glass 1989). They have encouraged the Forest Service to develop a management plan that would consider treatments to check tree encroachment.

Recreational Uses

Comprehensive recreational use data is generally lacking for the non-Wilderness areas in this watershed. With projected demand for semi-primitive and primitive recreation opportunities expected to exceed the supply on public forest lands (Swanson and Loomis 1996), the collection of information on recreational use trends in non-Wilderness areas should be considered very important. Information on use levels, type of use, numbers of dispersed recreation sites, conditions of sites, etc. would be useful for future decision making.

All developed sites within the watershed are heavily utilized. The campgrounds are typically full on mid-summer weekends. Water system upgrades are needed at La Wis Wis Campground in order to meet potable water needs during the summer. Both Summit and Soda Springs Campgrounds are in need of significant upgrades and/or reconstruction. The sites in both of these campgrounds are poorly defined and trailhead parking within Soda Springs Campground is inadequate. The heaviest dispersed recreation use occurs at Jody's Bridge (sixth-field 01A - Lower Muddy Fork Cowlitz River). This area is often used as an informal overflow camping area when the developed campgrounds are full. User group conflicts are frequent and sanitation and litter problems are an ongoing concern. Coordination with local volunteer groups have alleviated some of the problems.

In general, recreational use in Wilderness and backcountry areas is expected to continue to rise and, unless managed appropriately, there will be increased crowding and physical degradation in most areas. Several areas within Wilderness are considered to be particularly vulnerable to the impacts of increased recreational pressure. This includes areas such as Coyote Lake (sixth-field 01L) and Lily Lake (sixth-field 01Q) in the Goat Rocks Wilderness. Also of concern is the Upper Summit Creek (01E) sixth-field watershed in the William O. Douglas Wilderness. This area has literally hundreds of lakes and ponds along with relatively flat terrain which makes cross-country travel easy. The popular Pacific Crest National Scenic Trail further attracts people to this area. A primary concern in these areas is the increasing use trends and the tendency for people to want to recreate near water. An increase in the number of campsites, along with shoreline impacts, would be expected if use trends continue as they have in recent years. Most documented campsites are within 300' of water sources. In the Upper Summit Creek sixth-field watershed (01E), 96% of the 83 sites are within 300 feet of water sources. Many sites are well within 50 feet of water sources in both the Goat Rocks and William O. Douglas Wildernesses.

Several trails have been identified as having erosion or tread stability problems. Tatoosh Trail #161 and Tatoosh Lakes Trail #161B (sixth-field 01A) have steep, rugged sections that have rutted from use and water damage. Four trails in the William O. Douglas are a concern. These include Cowlitz Trail #44 (sixth-field 01E), Jug Lake Trail #43 (sixth-field 01E), Kincaid Trail #42 (sixth-fields 01E, 01G, 01H) and Judkin Trail #47 (sixth-field 01E). All of these areas are listed as needing reconstruction work to correct problems. Unstable soils account for much of the problem. Heavy stock use has been a factor in contributing to the trail erosion problems in the William O. Douglas Wilderness. The Carlton Trail #22 (sixth-field 01G) has been virtually impassable to stock for many years due to severe rutting and erosion. Maintenance problems have contributed to the situation. This trail is scheduled for major reconstruction work in 1998 and 1999. Two trails of concern in the Goat Rocks Wilderness are the Clear Fork #61 (sixth-fields 01K, 01L, 01Q) and Clear Lost #76 (sixth-fields 01K, 01L, 01P) Trails. A major land slide obliterated a portion of the Clear Fork Trail in 1996. Reconstruction of this trail will be completed in 1998. The Clear Lost Trail has extensive drainage problems and reconstruction work has been proposed to alleviate the problem.

Three roads in this watershed have been identified as being concerns in terms of recreational access. Forest Road 1284 (sixth-field 01K - Lower Clear Fork Cowlitz River) provides access to the Sand Lake Trail and has experienced some minor washouts which inhibits access to a certain extent. Forest Road 46 (sixth-field 01Q - Little Lava Creek) provides access to the Clear Fork Trailhead and experiences chronic washouts in the last mile. Trailhead relocation options are being investigated to bypass and/or decommission the last mile of this road. Forest Road 44 (sixth-fields 01D, 01F) accesses the Carlton Creek Trail. Heavy snowloads damaged two road bridges which has prevented vehicle access over the last 4 miles of that road system. It is unlikely that these bridges will be replaced in the near future. One mile of trail is being reconstructed to provide trail access below the last bridge, and planning is underway to provide alternate access over the remaining road section and/or develop an alternate route that would bypass the first bridge.

Other concerns associated with Wilderness management include: 1) The historic suppression of wildfire within Wilderness. Management objectives for Wilderness include allowing lightning-caused fires to play, as nearly as possible, their natural ecological role. This is in keeping with the intent of the Wilderness Act of 1964. Over time, suppression of fire significantly alters vegetative mosaics across the landscape. This, in turn, affects wildlife and plant species that are dependent on fire for the perpetuation of habitat conditions. The reintroduction of fire into Wilderness is considered critical to meet management objectives and the intent of the Wilderness Act. To date, the Goat Rocks Wilderness is the only Wilderness within this watershed with an approved plan for managing lightning-ignited fires. Without an approved plan, all fires are considered to be wildfires and appropriate suppression actions must be taken. The intent is for all Wildernesses to have approved fire management plans which would allow lightning-ignited fires to play their natural ecological role to the extent feasible within management constraints; 2) The potential introduction of noxious weeds, which could significantly alter natural plant communities. Ongoing monitoring to detect where noxious weeds are being introduced will assist in managing their spread; and 3) The illegal harvest of special forest products such as beargrass and salal. This has occurred primarily in the Tatoosh Wilderness along Road 5290. Some of the problem stems from confusion about the location of the Wilderness boundary, but there also appear to be instances where people knowingly harvest within Wilderness.

Special Forest Products

Special forest products have been actively managed for the past decade. Permits are now issued to build a database of information about the demand for products and to better administer the harvest. Research into how forest products are reacting to harvest is just beginning. There is also interest in the local community to expand the gathering, storage, and processing of forest products to provide additional local employment. It appears that the demand for traditional and non-traditional forest products will increase.

The Forestwide Late-Successional Reserve Assessment (USDA Forest Service 1997e) provides several opportunities for additional special forest product harvest. There are concerns about over-harvest of these mushrooms in particular stands. One possible solution is to rotate harvest among several areas to allow mushroom populations to rebuild. The sale of green poles and transplants could be also be expanded within these areas.

An overall decline in beargrass productivity is suggested by a significant drop in the demand for permits. Efforts to increase monitoring are underway in some areas.

Moss harvesting may be limited due to concerns about the disruption of sensitive species. Harvesting in Wilderness and other areas designated as "no harvest" is still occurring, but seems to be tapering off due to education efforts.

Road access is not essential for harvest of these forest products. However, it is desirable to be able to use an All Terrain Vehicle (ATV) to assist with the hauling of the products. Where feasible, road closures to designated harvest areas should allow ATV access.

Lands, Minerals and Special Uses

Mining

While the apparent level of mining activities in this watershed analysis area is minimal, mining is a legitimate activity on National Forest lands, as recognized by 125 years of federal mining laws. Proposed mining activities are not discretionary, that is, the Forest Service cannot choose to defer consideration of a mining proposal as it could an application for a Special Use Permit. As they occur, mining proposals are matters that the Forest Service must deal with. The Forest Service's function is to evaluate a mining proposal pursuant to all pertinent federal laws and regulations, and to help shape resulting on-the-ground operations pursuant to same.

A long-abandoned mine is located within the William O. Douglas Wilderness. In 1994, this mine was visited by the Forest Service's Area Mining Engineer as part of the first phase of a national program to create an inventory of such sites. The purpose of the inventory was to create a list of sites which would receive treatment and funding for problems such as mining-generated acid drainage. While the site mentioned above generates a small amount of acid drainage, it is minor compared to other sites. It would be prudent to institute a simple program to monitor drainage from this mine, the results of which could be used to develop mitigation measures that might be necessary.

Special Uses

Utility Lines

It should be recognized that the underground utility lines in the Lower and Upper Ohanapecosh River (01B and 01S), and La Wis Wis (01R) sixth-field watersheds may need to be replaced periodically. Ground disturbance generated will vary with the terrain to be crossed.

Private Use of National Forest Roads

There are two small blocks of privately-owned land located within the National Forest portion of the watershed. The Forest Service, by law, must allow access across National Forest lands for the benefit of adjacent private lands, when such access across the National Forest is reasonable.

U.S. Highway 12 and State Highway 123

Improvement, maintenance and repair activities will be on-going for a variety of reasons, the most important being public safety.

The flood control and repair activities such as road repair and building/rebuilding Lewis County's Cowlitz River flood control revetments (described in Chapter 3 - Miscellaneous Other Special Roads and Minerals Uses For Flood Control Repair and Activities) could be on-going.

There will probably be continued inquiries from the communications industry about the study of and/or use of high elevation peaks for communication sites.

Terrestrial Elements

Disturbance Regimes

The Role of Fire

The watershed is currently outside the natural condition for fire "effects". Past harvest activity in the area outside of the Wilderness and National Park have been extensive, resulting in the loss of certain structural elements, such as snags and large down coarse woody debris. Because of effective fire suppression, only 2% of the analysis area has experienced a stand-replacing fire event in the 98 years since 1900. This is far below the average for the previous 200 years. Fire is a natural part of the ecosystem and creates and maintains meadows. Some high elevation meadows have been lost due to encroachment from adjacent timber stands.

Insects and Disease

Our limited knowledge indicates that current insect and disease occurrences in this watershed appear to be within the range of natural variability. However, we don't know the precise limits of that range. In general, the insects and diseases residing in western Washington forests (and in this watershed) seem to have a relatively narrow range of natural variability. There are no records or data that indicate any past insect or disease disturbance in this watershed that was of such magnitude as to adversely affect the ecosystem.

The generally moderate environment of western Washington forests leads to less drought and other tree stresses that are often related to insect outbreaks (and sometimes to disease occurrence). Consequently, insect outbreaks will tend to be infrequent, small in size (usually less than 5 acres), and very low to moderate in severity. We can expect most insect and disease occurrences to be widely and irregularly distributed across the parts of the watershed occupied by their respective hosts, with attacks often being associated with host trees under environmental stress.

Insects

Balsam woolley adelgid occurrences/outbreaks have the potential to be rather large. Although we have no record of large outbreaks of this insect in the watershed, a large outbreak did occur on the Gifford Pinchot National Forest in 1954 near Mt. St. Helens (Johnson *et al.* 1963). Being a recently introduced insect into this forested ecosystem, it is unclear how it will react over the long-term. It is probably the one insect present in the watershed that could cause a large, widespread outbreak across a large number of acres in stands in which Pacific silver fir is either a dominant or important secondary tree species.

We can expect the balsam woolley adelgid to continue (mostly in scattered, small patches) affecting the growth and vigor of Pacific silver fir (as well as causing mortality) in this watershed. As an introduced species, this insect has no natural enemies to help control it. Large, significant outbreaks of this insect are possible in portions of the watershed where Pacific silver fir is dominant, but that is most likely to happen only in those areas of high site productivity where this species is most susceptible.

We can expect the Douglas-fir beetle (mostly in small, scattered patches) to continue killing Douglas-fir in this watershed, especially in connection with areas of unsalvaged windthrow and/or root disease. Large, significant outbreaks of this insect are possible in portions of the watershed where Douglas-fir is dominant, but that would be most likely to happen in conjunction with a large windthrow event or wildfire, especially if there was no significant salvage of the dead/down material.

Disease

Disease infections generally move slowly through the forest. In this watershed, root disease centers are generally small in size (<1 acre to 15+ acres), and the number of infection centers in the Western Hemlock Zone portion of the watershed (while generally small in size) can be relatively high. The damage severity of disease occurrences in the watershed ranges from very low to severe, but for most diseases it is most often in the very low to moderate range; although for laminated root rot, damage severity can often be in the high to severe range.

Laminated root rot is expected to continue causing mortality as the infections move through the stands where they are currently located. In some managed stands reforested with highly susceptible Douglas-fir during the 1950's, 1960's, and 1970's, where laminated root rot was located prior to harvesting, the level of disease inoculum and the virulence of the disease has increased. The disease has been provided a new generation of highly susceptible host trees. Young stands of this type are not likely to reach maturity before they are effectively destroyed by the disease, if they were moderately to heavily infected before regeneration harvest.

It is unknown how many stands like this exist, but this type of situation is one which has the potential to increase the amount of laminated root rot in the watershed, as well as prolong the time it takes for the disease to naturally subside in these stands. On a site specific basis, the significant presence of laminated root rot in some portions of this watershed may have a detrimental effect on the future production of deer and elk winter range optimal cover and the hydrologic recovery of some young stands. These problems will most likely increase in the central southwest portion of the watershed in the general vicinity of the upper end of the Cowlitz River valley (lower Purcell Creek, lower Dam Creek, lower Clear Fork Cowlitz River, lower and middle Cortright Creek, lower and middle Summit Creek, lower and middle Carlton Creek, lower Ohanapecosh River, and lower Muddy Fork Cowlitz River).

In the recent past (1980's and 1990's), efforts have been made to reduce the level and spread of laminated root rot through regeneration harvest of infection centers, followed by planting intermediately susceptible, tolerant, resistant, or immune tree species to grow for a rotation. Managing regenerated infection centers with a mix of tree species less susceptible to the disease will slow or limit damage and spread of the disease.

Windthrow

Available evidence indicates that timber harvest activities (mainly regeneration harvest by clearcut) have increased the amount of windthrow and the number of windthrow events in this watershed. Prior to the start of timber harvest activities in the mid-1950's it appears (from looking at the aerial photographs) that very little windthrow of significance took place in the watershed. Future windthrow events are likely to occur along the margins of existing clearcuts and future regeneration harvest units. Under the right conditions (high wind and water-saturated soils) these events could impact significant acres, but not necessarily in large patches, more likely in a large number of smaller patches.

Forest Vegetation

Vegetation Structural Stages

Chapter 3 described what is known about the forest vegetation structural stages at two discrete points-in-time (1880 and 1998). Natural variability is a complex temporal and spatial property of all ecosystems. There is insufficient vegetation data over a long span of time in this watershed to accurately or meaningfully describe the range of natural variability for forest vegetation in this watershed. It would be erroneous to conclude that the differences described between forest vegetation in 1880 and 1998 constitute the range of natural variability. Therefore, we will simply compare the historic or reference forest vegetation structural stage data to the current forest vegetation structural stage data to determine trends and possible areas of concern within the watershed.

The current structural stages existing in this watershed are significantly different than those found in 1880 (Table 4-1). From 1880 to 1998, the dominance of forest vegetation has shifted from small tree and large tree forest to large tree forest. During this period, the following factors have influenced forest vegetation structure: a small amount of regeneration timber harvest in the watershed (5,533 acres in the last 45 years) because of the large amount of National Park and Wilderness, the vigorous suppression of wildfires, and forest growth (natural succession).

The amount of large tree forest has increased in this watershed by 31,537 acres (105%) since 1880. This is a result of a large amount of the small tree forest (and some of the grass/pole forest) that existed in 1880 having grown into the large tree forest condition over the last 118 years.

Table 4-1: Comparison of Historic and Current Vegetation by Structural Stage

Structural Stage	Year 1880		Year 1998	
	Acres	**%**	**Acres**	**%**
Grass/Pole	13,271	10	7,398	5
Small Tree	45,370	33	19,394	14

Table 4-1: Comparison of Historic and Current Vegetation by Structural Stage				
Structural Stage	**Year 1880**		**Year 1998**	
	Acres	**%**	**Acres**	**%**
Large Tree	30,131	22	61,668	45
Non-Forest	*49,133	35	*49,445	36

* Note: The difference in these two non-forest acreage figures is due to the fact that some areas of the watershed that were forested before the Euro-American settlers arrived have been converted to permanent non-forest acres (e.g., recreation sites, highways, etc.).

For a more detailed comparison of the amount and distribution of historic (1880) and current (1998) vegetation structure by sixth-field subbasin see Appendix B: A Comparison of Historic and Current Vegetation by Structural Stage and Sixth-field Subbasin.

With the advent of fire suppression activities in the 1930's, the number of acres lost to wildfire has dropped substantially. This means that the grass/pole forest component of 1880 moved undisturbed into the small tree condition of today. The amount of grass/pole forest in 1998 is primarily attributed to regeneration harvest activity. Regeneration harvest acted as a surrogate for wildfires.

A major difference exists in the location, size, structure, shape, and timing of initiation of the grass/pole forest patches created by timber harvest from the grass/pole forest patches that are created by wildfire events. The grass/pole patches resulting from clearcut harvest and broadcast burning contain very few snags; large, live remnant trees; or large down woody material (as a general rule). Until recently, the nature of timber harvest activities (both regeneration harvest and commercial thinning) across the watershed has meant the simplification of forest structure. Harvest activities tended to eliminate snags, live remnant trees, less vigorous/diseased/damaged trees, large down wood, and multi-layered canopies. Often patches were created with hard, distinct, straight edges, single-layered canopies, a less diverse species composition, and generally healthy undamaged trees with few deformities (i.e., a much simpler and less diverse structure -- both vertically and horizontally).

As these simplified grass/pole patches grow into small tree forest, (and eventually large tree forest patches) they will carry forward the more simplified structural characteristics of their clearcut harvest origins. Future management activities (e.g., precommercial thinning, commercial thinning) should attempt to create more diversity in the current grass/pole stands over time.

The large tree forest, with one notable exception, currently forms the largest, and most connected forest patches in the watershed. The size of large, intact patches of large tree forest has been greatly expanded over what existed in 1880. The one notable exception mentioned above is the area of significant fragmentation of large tree forest by small clearcut-created patches of grass/pole forest in the Purcell Creek (01M), lower Dam Creek (01N), lower Clear Fork Cowlitz River (01K), lower Cortright Creek (01I), lower Summit Creek (01D), and Carlton Creek (01F and 01G) drainages.

Between the mid-1950's and today much of the large tree forest in the east-west corridor, (comprised of the drainages mentioned above) has been highly fragmented, disconnected, and isolated by a high concentration of clearcut harvest. The nature of many of these currently narrow, gangly, (and sometimes isolated) large tree forest patches has been dramatically altered. The interior characteristics and nature of the sunlight, shade, canopy closure, vegetation species composition, large standing and down wood, and moisture regimes in those narrow patches are much different than those found in the large tree patches prior to the start of timber harvest activities. This can have dramatic impacts to a variety of forest resources. The nature of these narrow, gangly patches may also make them more unstable -- more susceptible to windthrow and the quickening of their natural aging/deterioration process. One concern for the future will be how to restore larger, more connected patches of large tree forest in this area of heavy fragmentation that will have the structural and spatial characteristics needed to meet this area's management direction (which is currently LSR).

The *Northwest Forest Plan*'s emphasis on leaving snags, live remnant trees in various states of health and condition in patches and as scattered individuals; pieces of large down wood; more varied tree species composition; unthinned patches and canopy gaps in thinnings; variety in tree sizes and spacings, etc.; will slowly return some of the structural complexity lost over the past few decades through clearcut timber harvest.

Under today's emphasis of an ecosystem approach to management, the rate, type, and nature of timber harvest has changed dramatically, altering the successional trends in the watershed as well as the locations and configurations of current and future vegetation structural stage patches. The watershed is dominated by management allocations/direction that limits the amount of future timber harvest. Wilderness designation (both Forest Service and National Park Service) drives the management on approximately 80% of the watershed. These are areas that allow no timber harvest at all, and areas that are largely covered by large tree forest at present. Another 17% is managed as Late-Successional Reserves (LSR). In the LSR, only treatments that will hasten the development of late-successional forest (such as precommercial thinning and commercial thinning in stands up to 80 years of age) are permitted. Most of the current grass/pole forest (past clearcuts) resides in the LSR. Over the next few decades, much of the grass/pole forest in the LSR (the vast majority of it being in portions of sixth-fields 01I, 01D, 01N, 01K, 01F, 01M, and 01R) will become small tree forest. Much of the current small tree forest will succeed to large tree forest. This means that over the next 80-90 years it is possible that nearly all of the forested landbase in the watershed will be large tree (late-successional) forest, assuming continued absence of large wildfires.

In the Matrix allocation (approximately 1% of the watershed) where timber harvest is allowed in most areas, the initiation of grass/pole forest (and succession from grass/pole to small tree to large tree) will continue to occur over time in a somewhat regulated manner. Regeneration harvest will not occur in the Riparian Reserves within the Matrix, thus succession of current structural stages in those reserves will continue toward a large tree forest condition (if they are not already in that condition). Although the overall amount of timber harvest in the watershed has declined in the 1990's (and will in all likelihood remain very low in the future), the amount of probable harvest has been shifted to a much smaller land base of allocations that allow harvest, thus the rate of harvest on that reduced land base may be somewhat similar to what it was prior to the advent of the *Northwest Forest Plan.*

One of the tools used to control the stocking of managed grass/pole stands to meet a variety of resource objectives is precommercial thinning. Since 1991, the budgets and acres treated for timber stand improvement have dropped precipitously, while the acres of grass/pole stands needing stocking control (those acres initiated by clearcut harvest in the late 1970's and early 1980's) continue to come on line each year (an estimated 100 acres per year in this watershed). There is an immediate concern that the stocking levels of many of those grass/pole stands will not be managed, foregoing the opportunity to accelerate the early and important development of various desired conditions, depending on the management allocations in which they reside (thus affecting future wildlife habitat, hydrologic recovery, production of large woody debris and large snags, timber production, etc.). There are currently about 400 acres of known/documented precommercial thinning needs in this watershed. There are an estimated 2,000 acres that will be in need of stocking control in the next few years (based on past regeneration harvest rates in the late 1970's/early 1980's). These have not yet been documented due to insufficient funding for stand exams necessary to track the development of the grass/pole stands.

Botanical Species of Concern

TES Plant Species

Population dynamics of known sites of TES plant species have not been monitored. Without information on population trends it is difficult to assess how these species are responding to changes within the watershed.

Surveys for TES species within the analysis area have been specific to individual project boundaries (usually timber sales) and thus do not accurately portray the distribution of these species across the landscape. This is particularly true for the Clear Fork watershed since most of the lands fall into management allocations (Wilderness, National Park, LSR) where timber harvest is either not permitted, or is severely restricted. Additionally, no information on TES species is included for National Park lands.

Of the five known sites of TES plants within the analysis area, four are partially protected by virtue of the land allocation (LSR) within which they are located. Since no regeneration harvest will occur within this allocation, potential threats to these species from land management activities are reduced. These sites still need to be considered during other projects that may occur within the LSR. The remaining one site is located within the Matrix allocation and is currently vulnerable to management activities that might occur within that area. All known sites of TES plants must be considered during the planning phase of management activities. Table 4-2 provides a summary of the vulnerability of known TES plant sites to management activities within the analysis area based upon land management allocations.

Table 4-2: Vulnerability of Known Populations of TES Plant Species to Management Activities (based on land allocation)

Species	Sixth-field	Land Allocation	Status
Orobanche pinorum	01D	Late Successional Reserve	Partially Protected
Orobanche pinorum	01I	Late Successional Reserve	Partially Protected
Orobanche pinorum	01K	Late Successional Reserve	Partially Protected
Orobanche pinorum	01K	Late Successional Reserve	Partially Protected
Epipactis gigantea	01K	Matrix	Vulnerable

It is possible that one or more of the above listed known sites also falls within the confines of a riparian reserve. This would add to the protected status of the site, however, since Riparian Reserves are subject to be changed during the planning phase of management activities, this information is not pertinent here.

Survey and Manage Botanical Species

No specific surveys for survey and manage species have been conducted within the analysis area. Known sites are not based upon thorough surveys and, therefore, do not accurately portray the distribution of these species across the landscape.

Population dynamics of known sites of survey and manage species have not been monitored. Without information on population trends it is difficult to assess how these species are responding to changes within the watershed. The historic condition of vegetation within the analysis area was described within Chapter 3 of this report. In 1880 (the time period chosen to represent historic vegetation), approximately 22% of the analysis area was in a large-tree or late-successional stage (Table 3-12). Currently (1998), approximately 45% of the analysis area supports late-successional habitats (Table 3-23). While this increase in habitat acres would appear to benefit late-successional dependent species, other important factors such as pattern and distribution of habitat must also be considered. In 1880, a large area of grass/pole forest occurred along the Muddy Fork Cowlitz River drainage as a result of a large fire. The remainder of the forested lands within the watershed were split between mid- and late-seral stands. Currently, the majority of forested areas within the watershed are in a late-seral condition and the only grass/pole areas are found scattered on either side of the U.S. Highway 12 corridor in the form of previous harvest units. Neither of these conditions (historic and current) appear to have a significant amount of isolated or fragmented blocks, thus, the overall condition for late-successional dependent species appears to be quite good within the watershed. This is a rather unique situation in the southwest Washington Province, as most other areas have seen dramatic land use change over time. Refer to Chapter 3, "Forest Vegetation" for a thorough comparison of historic and current conditions of vegetative landscape pattern.

Table 4-3 provides a summary of the vulnerability of known botanical survey and manage sites to management activities within the analysis area based upon land management allocations.

Table 4-3: Vulnerability of Known Populations of Survey and Manage Plant Species to Management Activities (based on land allocation)

Species	6th	Land Allocation	Status
Allotropa virgata	01K	Late Successional Reserve	Partially Protected
Allotropa virgata	01K	Matrix	Vulnerable
Glomus radiatum	01K	Administratively Withdrawn	Protected
Otidea onotica	01R	Late Successional Reserve	Partially Protected
Ulota megalospora	01L	Congressionally Withdrawn	Protected

All known sites of survey and manage species that are part of component 1 (manage known sites) require consideration during the planning phase of management activities.

Noxious Weeds

There are currently no control measures in place for these species within the analysis area and new introductions and future spread into previously uninfested areas is highly probable given the many sources, variety of dispersal methods, and corridors that are available. Current Forest Service policy on the management of noxious weeds is defined in Forest Service Manual 2080. Where funds and resources are not available to permit the timely undertaking of all desirable control measures, priorities have been outlined as follows:

1) Prevent the introduction of new species.
2) Conduct early treatment on new infestations.
3) Contain and control established infestations.

In order to minimize the chances of new species of noxious weeds becoming established within the analysis area (and the establishment of new populations of species already present within the analysis area) it is recommended that a provision that requires heavy equipment to be "weed free" be included in contracts for all management activities within the analysis area that involve large amounts of ground disturbance.

No specific surveys for these species have been conducted within the analysis area, thus it is not possible to identify and prioritize specific weed populations for treatment. Instead, some priority areas have been identified where an effort should be made to prevent weed populations from becoming established. The following is a preliminary list of such sites:

1) The segment of State Highway 123 from its junction with U.S. Highway 12 to the Mount Rainier National Park boundary.

2) All trailheads leading into Wilderness areas or Mount Rainier National Park, especially those that are used by pack stock.

3) The U.S. Highway 12 corridor from La Wis Wis Campground to White Pass.

These (and similar) sites are high priority areas for future surveys to determine potential threats from noxious weeds. If populations of noxious weeds are found at these areas, it is recommended that control measures be implemented as soon as possible to protect unique resources.

Wildlife

Big Game Habitat

Deer and Elk

As mentioned in Chapter 3, very little biological winter range acreage (6,790 acres) is present within the Clear Fork watershed, with the remaining acreage classified as big game summer range. The acreage of winter and summer range that is within the Packwood Late-Successional Reserve (LSR) will eventually mature into stands defined as optimal cover. The ability to create open foraging habitat through timber harvest will be greatly reduced, and primarily restricted to the several hundred acres of Matrix land on the winter range. Commercial thinning prescriptions to silviculturally treat the younger-aged stands may temporarily increase the forage base, but increased tree growth and crown width would eventually reduce this forage base increase.

In the short-term, little change to big game populations would be expected. This determination is based on the availability of current forage openings to provide a food resource for summering and wintering animals for another decade or so. However, these timber harvest openings with their planted conifer seedlings will eventually shade out browse species, and limit foraging to natural openings (meadows, brushfields) and late-successional stands with a forb and shrub layer. The long-term result may be fewer animals produced on the National Forest lands outside of Wilderness. Since the majority of the watershed is either congressionally-designated Wilderness or National Park (which prohibits timber harvest), no appreciable changes in habitat conditions are expected, at least in the short-term in these areas. However, this assessment also realizes that natural disturbance events such as a major wildfire have occurred in the past and are still capable of modifying vast expanses of land in this watershed.

Mountain Goats

One of the data gaps mentioned in Chapter 3 is the lack of knowledge about where most mountain goats winter in this watershed. While several dozen goats are known to winter along the cliffs above the lower Ohanapecosh River, other wintering areas have not been identified. The inherent difficulty in accessing these high elevations via snowmobile, cross-country skis, or snowshoes (plus finding funding sources), really limits our ability to collect data on this aspect of goat ecology. Mountain goat migration routes between summer and winter ranges are also not known and represent another major data gap for this species.

One concern has been expressed to the district wildlife staff concerning mountain goats in the Tatoosh Wilderness. The majority of the mountain goat activity in this area is confined to the rocky cliffs near the Tatoosh Lakes. During mid- to late-summer, people recreating near the lakes may be disturbing the animals enough that animals are migrating into the adjacent Mt. Rainier National Park where less disturbance is present. At this time, no studies have been conducted to confirm or deny this concern.

No major changes to mountain goat populations or their distribution within the watershed are expected in the short-term. Hunting is strictly regulated as previously mentioned, and any appreciable drop in population numbers would result in an appropriate reduction of goat permits in those areas where harvest is allowed.

Survey and Manage Wildlife Species

The species listed in Table 3-27 represent known or suspected survey and manage wildlife with the potential for occurrence in the watershed. The Larch Mountain salamander and Van Dyke's salamander are the only species documented to occur at this time. The abundance of rock outcrops, talus slopes, and forested boulder fields would suggest there may be other populations of Larch Mountain salamanders in the watershed than those documented at this time. The presence of high gradient streams would suggest there may be populations of Van Dyke's salamander in other locations of the watershed than those documented at this time. Prior to any ground disturbing activities in areas where either salamander may occur, surveys would be conducted to whatever protocol standards are in effect at the time. The discovery of any population would automatically become a known site and appropriate measures taken to protect the population and their habitat consistent with known site management recommendations. Overall, it is difficult to assess how this collective group of species are responding to environmental changes in the watershed. A thorough understanding of their habitat requirements is still lacking, particularly for the mollusk group. Some mollusk species seem to be habitat generalists and others closely associated with riparian habitat or mixed conifer and hardwood stands. Mollusk surveys will be required for project areas with decision notices signed after September 30, 1998 and where ground disturbance may occur.

Threatened and Endangered Species

The species listed in Table 3-25 are listed because of declining populations and/or loss of habitat that is threatening the species viability or causing a concern that warrants further review. Northern spotted owls are the only species from Table 3-25 for which surveys have been conducted over a substantial portion of their suitable habitat in the watershed. For the remaining species, the majority of the sighting data is from random observations of the staff of federal agencies and the public and may not always be totally reliable. Without historical population information on species, it is difficult to assess how species are currently responding to environmental changes. However, within the Clear Fork Cowlitz watershed, with the land allocations present, future habitat projections for these species appear to be very favorable. This assessment is based on the amount of habitat congressionally designated as Wilderness, the presence of Mt. Rainier National Park which is about 97 percent Wilderness (unroaded), and the inclusion of lands identified as LSR by the *Northwest Forest Plan*. Since timber harvest and road construction would be very limited within the LSR allocation, threats to the species in Table 3-25 such as the northern spotted owl, marbled murrelet, northern bald eagle, grizzly bear, and gray wolf would be greatly reduced.

As long as the *Northwest Forest Plan* is in effect, regeneration timber harvest is limited to the small amount of allocated Matrix lands in the watershed. Scheduling regeneration harvest would have to be consistent with the current standards and guidelines in place when the environmental analysis is conducted. Timber harvests may have an impact on suitable owl habitat within the range of one or more spotted owl pairs and incidental take for that pair(s) would be requested from the U.S. Fish and Wildlife Service. However, the vast majority of the watershed acreage is within the boundaries of Mt. Rainier National Park or congressionally designated Wilderness which prohibits road construction and timber harvest. The majority of the spotted owl pairs in the watershed would experience a gradual increase in the amount of suitable habitat available within their respective home ranges as younger-aged forested stands mature into mid- and late-successional habitat.

The maturation of younger-aged stands into late-successional (large tree) habitat would improve and increase the amount of habitat available for other species that utilize large tree stands such as bald eagles, marbled murrelet, wolverine, lynx, fisher, and bat species. If commercial thinning is determined to be appropriate within Riparian Reserve acreage, the thinning prescriptions would be designed to maintain and/or improve the aquatic conditions. The prescriptions would also optimize tree growth where possible, ultimately improving large tree forest connectivity for riparian species including tailed and Cascade frogs.

Based on the land allocations listed above and the projected future vegetative conditions, habitats for threatened and endangered and survey and manage wildlife species are adequately protected under GP Forest Plan and *Northwest Forest Plan* standards and guidelines.

Connectivity (Riparian and Terrestrial)

While some breaks in riparian connectivity were noted and discussed in Chapter 3, the overall terrestrial and riparian connectivity across the entire watershed could be described as being in very good condition for wildlife needs. The projected future condition with the present land allocations in place would result in an increase in large tree acreage. This would eventually connect most of the land base within the watershed, at least in lands capable of growing trees. For large tree habitat-associated species, the projection is very favorable. Habitat for early-successional-dependent species, however, would be reduced, particularly in the Packwood LSR land allocation and would be restricted to natural openings (meadows, brushfields, avalanche chutes) present in the three Wilderness areas and within Mt. Rainier National Park.

Habitat Improvement Projects

As previously mentioned under the big game section, open road densities in deer and elk winter range are higher than standards and guidelines recommend. There may be opportunities to seasonally close some National Forest roads in future project areas within biological winter range to bring the road density closer to the desired condition. A non-habitat project, but still valuable nonetheless, would be the placement of a wildlife habitat interpretive display in La Wis Wis

Campground. A photographic display with written discussion of wildlife species and habitat requirements could be placed on interpretive signboards located across from the guard station.

Aquatic Elements

Disturbance Regimes - Geological Processes

Seismic Conditions and Volcanic Eruption

Earthquakes and volcanic eruptions are natural processes that will take place regardless of consequences to human populations. The most we can do is be aware of the potential for occurrence, and where possible, try to describe possible consequences and plan to evacuate in time. Mount St. Helens has erupted, on average, once per century over the last 500 years, and at least two of these eruptions have deposited ash and tephra across the Clear Fork watershed. The deposits have contributed to increased fine sediment delivery to streams for a period of years to decades after each eruption.

Mt. Rainier has also inundated the floodplain of the Cowlitz River with mudflows since the retreat of the last glaciation, and will do so again, with or without an actual volcanic eruption (Scott and Vallance 1995). Given the short travel times expected for mudflows traveling from Mt. Rainier to the towns of Packwood and Randle (about ½ to 2 hours), warning for the Cowlitz River Valley inhabitants during such an event will be minimal, and the potential consequences quite severe. Fortunately, the Cowlitz River valley is influenced by a relatively smaller proportion of the Mt. Rainier volcano, and available evidence suggests that mudflows have been smaller and travelled down the Cowlitz River drainage less often than other major drainages such as the White, Puyallup, and Nisqually Rivers (Banks *et al.* 1998, Scott and Vallance 1995).

Seismic activity in the area will also continue, usually in the form of smaller earthquakes felt by residents at night (Magnitude 0.5 to 3.0 on the Richter scale) but with occasional larger earthquakes greater than Magnitude 3.0. Larger earthquakes can pose the additional hazard of causing landslides that either directly affect human habitations, or block stream drainages that then form dam break floods along stream channels. Most of the major stream valleys in the Clear Fork watershed are unpopulated, with the notable exception of the Ohanapecosh (sixth-field 01B), which has a large campground that is busy during summers, and some residents that live there year-round. Communities downstream in and near the towns of Packwood and Randle, particularly those located near the confluence of streams with the Cowlitz River, would be vulnerable to such an event.

Mass Wasting

Mass wasting in the form of large landslides has been occurring in the Clear Fork Cowlitz drainage for thousands of years. Portions of these features are stable or marginally stable and not overly sensitive to disturbance by management activities, whereas some other areas are more sensitive. Site-specific investigation is required to further refine areas of these slides that are active/dormant/past active.

Increased levels of mass wasting related to roads and timber harvest have occurred throughout the Lower Summit Creek (01D), Lower Carlton Creek (01F), and Purcell Creek (01M) sixth-field watersheds. In particular, segments of the road systems within these drainages are in need of reconstruction and/or decommissioning efforts to reduce sedimentation. See Road Conditions, below, and Chapter 6, Management Recommendations.

Hillslope Erosion

Hillslope erosion is generally not a concern in this watershed except in local situations where mass wasting has exposed tracts of soil, and revegetation has not yet successfully occurred.

Road Conditions

A number of roads within the watershed have been identified as contributors of elevated sediment levels to streams. In particular, segments of roads in the Lower Summit Creek (01D), Lower Carlton Creek (01F), and Purcell Creek (01M) sixth-field watersheds have been identified as concerns. It is important to note, however, that roads in the Clear Fork watershed have historically had far fewer failures, and had relatively less impact on streams, than roads elsewhere in the Cispus River and Cowlitz River watersheds. Table 4-4 lists roads in each sixth-field that are in need of some type of restoration work. This listing is not all inclusive, but it does identify the majority of road restoration projects proposed within the Clear Fork watershed.

Table 4-4: Forest Roads in Each Sixth-field That Need Restoration Work

Sixth-field	**Forest Roads in Need of Restoration Work**
01 A	1270
01B	State Hwy 123 & Steven's Canyon turnoff (condition unknown).
01D	45, 4500106, 4510, 4510026, 4510029, 4510410
01E	None known
01F	44, 4400026, 4400064 (Note: two bridges need replacement)
01G	44, 4400071

Table 4-4: Forest Roads in Each Sixth-field That Need Restoration Work	
Sixth-field	**Forest Roads in Need of Restoration Work**
01H	4400049
01I	1276, 1276027, 45, 4500032, 4500045, 4500053
01J	4500077
01K	U.S. Hwy. 12 (improvements ongoing), 1276, 1276042, 1276046
01L	none known
01M	4610018, 4612
01N	46, 4600061, 4600062, 4600420
01P	46, 4600079
01Q	46
01R	46, 4600035, 1270
01S	None known
01T	Stevens Canyon turnoff

Synthesis Summary

Within the Clear Fork watershed analysis area, the rate of delivery of fine and coarse sediment to streams via mass wasting and erosion has fluctuated substantially across the watershed and through time as a result of both natural and human-caused disturbances. The more or less continuous erosion of exposed soils and streambanks has been augmented episodically by increased erosion and mass wasting associated with earthquakes, wildfires, and flood events. Eruptions of Mt. St. Helens and Mt. Rainier over the last several thousand years have also added large volumes of fine ash/pumice to the system, in addition to occasional smaller mudflows along the Muddy Fork Cowlitz. In portions of the watershed that have experienced greater human disturbance, four main mechanisms have contributed to these increases of sediment delivery. Road construction and timber harvest have sometimes occurred on hillsides with active landslides, or where the hillsides are particularly susceptible to mass wasting processes (e.g., steep inner gorges of incised streams). Clearcut timber harvest, and subsequent broadcast burning of the logging debris, have often removed much of the organic duff layer, exposing soils to increased surface erosion. Roads have been constructed across numerous perennial or intermittent streams (Class I-IV), and for some distance on either side of the crossing, the water collected in the ditch relief system is routed into the stream, which expedites the delivery of water and sediment into the stream. Also, some road segments have become susceptible to storm damage during which culverts are washed out and road fills fail to form landslides and debris flows. As noted above, however, roads in the Clear Fork Cowlitz watershed have historically had far fewer failures, and less of an impact on streams, than roads elsewhere in the Cispus and Cowlitz watersheds. A qualitative review shows that these management-related events have introduced sediment to streams that is somewhat additional to the background rate during the same time period, but are well within the range of sediment delivery rates that have varied over the last several thousand years in response to natural disturbance events.

Hydrology

Rain-on-snow/Peak Flows and Flooding

Peak flow events associated with heavy, warm rain-on-snow events will continue to occur on an estimated 30 to 50 year interval at the fifth-field watershed scale. However, site specific occurrence in the sixth-fields which contain relatively high rain-on-snow (>30%) area may experience more frequent peak flow occurrences associated with precipitation events. Sixth-field watersheds that may experience these more frequent peak flow occurrences are Lower Muddy Fork Cowlitz River (01A), Lower Ohanapecosh River (01B), and La Wis Wis (01R). Lower Summit Creek (01D) and Purcell Creek (01M) sixth-field watersheds are very close to 30% rain-on-snow. Two- to five-year peak flow magnitude is expected to decrease in areas of the National Forest or private land which were extensively clearcut, as the vegetation recovers and road systems are either stabilized, naturally revegetated, decommissioned, or storm-proofed. These changes in peak flow occurrence are expected to be more dominant on National Forest lands where past timber management has reduced the existing Aggregate Recovery Percentage (ARP) values to 85% (Dam Creek - 01N, and Lower Summit Creek - 01D). Peak flow alterations within the main tributary streams from Mt. Rainier National Park, and the Goat Rocks, William O. Douglas, and Tatoosh Wilderness areas are not expected to change over time except in areas where past human disturbance may have be affected the area. In areas outside of the National Park and National Forest, peak flow augmentation may persist due to continued timber harvest. Future potential peak flow concerns may be present in the following sixth-field watersheds (see also Map 27, Aquatics Concerns - Flow Conditions):

- Lower Summit Creek (01D)
- Purcell Creek (01M)
- Dam Creek (01N)
- La Wis Wis (01R)

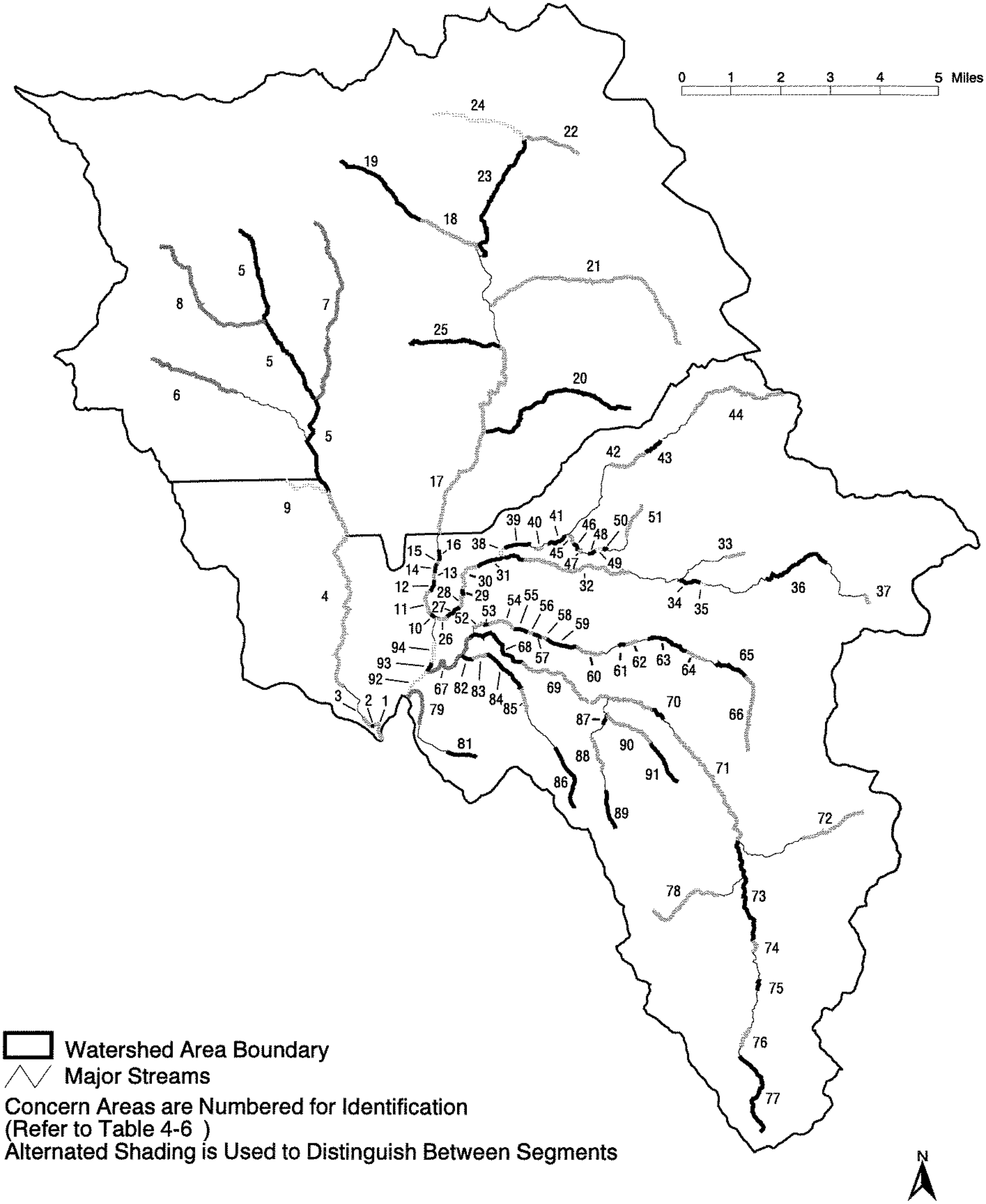
Water Temperatures

Temperature concerns are not expected within the Clear Fork watershed because the originating source for most of the streams is either Mt. Rainier glaciers or Wilderness area snow-fields. Currently, all streams are maintaining Washington state temperature standards for Class AA waters. Water quality in areas dominated by National Forest sixth-field watersheds or smaller stream channels, which have been subject to past riparian timber harvest, is expected to generally increase

Map 27

CLEAR FORK WATERSHED ANALYSIS

Aquatic Concerns - Flow Conditions



Watershed Area Boundary

Major Streams

Concern Areas are Numbered for Identification
(Refer to Table 4-6)
Alternated Shading is Used to Distinguish Between Segments

over time due to vegetative recovery, watershed restoration efforts, fish habitat improvements, and a reduction in the amount of openings in the canopy of the riparian corridor. Water temperatures within the analysis area, particularly on National Forest lands, will continue to be considerably better than conditions located downstream of the analysis area (Upper and Middle Cowlitz River watersheds).

Lakes, Ponds, and Wetlands

Increased recreational use of lakes throughout the analysis area will result in increased impacts to riparian habitat and riparian/aquatic organisms, as well as associated wetland areas and water quality. The need for information on lakes, ponds, and wetlands is of increasing importance.

Riparian Conditions

There are a total of 35,704 acres in the riparian corridor within the entire analysis area, of which approximately 10% consists of the grass/pole seral stage. Riparian area structural stage is expected to improve most on National Forest lands in the Lower Summit Creek (01D), Lower Carlton Creek (01F), Lower Clear Fork Cowlitz River (01K) sixth-field watersheds. It will improve to a much lesser degree in the Lava Creek (01P), and Little Lava Creek (01Q) sixth-field watersheds where the non-forest riparian structural stage makes up greater than 30% of the sixth-field area. Areas that consist of a high percentage of non-forest within either National Park or Wilderness lands were not considered to be concern areas. The lower amounts of large tree structural stage within the above mentioned areas are expected to improve with time, based on altered timber harvest approaches.

Recovery of riparian vegetation on National Forest lands will be particularly evident in the areas where a large portion of direct riparian disturbance has occurred in the past, due to either natural fire, disturbance, or land management activities. Areas where the most improvements are expected, and the reasons why current problems exist are as follows:

- Lower Muddy Fork of the Cowlitz River (RM 0-0.5, management; and a large amount of the basin area affected by 1860's fire).
- Upper Muddy Fork of the Cowlitz River, Nickel, Stevens, Taos, and Twin Falls Creeks (1860's fire).
- Lower Ohanapecosh (RM 0.9-1.1, management).
- Lower Summit Creek (RM 0.5-1.4, management, and mid-seral stand age on northern stream banks).
- Lower Carlton Creek (RM 0-0.7, RM 0.8-0.9, RM 1-1.4, management).
- Upper Carlton Creek (RM 1.4-1.8, management).

- Cyrenus Creek (RM 0.1-0.2, RM 0.4-0.6, management; lower 65% of basin currently mid-seral due to fires).
- Lower Cortright Creek (RM 0-0.1, RM 0.4-1.4, RM 1.5-1.6, management).
- Purcell Creek (RM 0.1-0.4, management).
- Dam Creek (RM 0.1-1.4, management).
- La Wis Wis (RM 0-0.4, 0.6-0.8, management).

Riparian vegetation conditions within the Goat Rocks, William O. Douglas, and Tatoosh Wilderness areas or Mt. Rainier National Park are only expected to alter in response to natural fire occurrence. Current stands will maintain their existing conditions for an unknown time into the future. These areas include the following sixth-field watersheds:

- Upper and Lower Muddy Fork of the Cowlitz River - 01A and 01T
- Ohanapecosh River - 01B and 01S
- Upper Carlton Creek - 01G
- Upper Cortright Creek - 01J
- Lava Creek - 01P
- Little Lava Creek - 01Q
- Upper Clear Fork of the Cowlitz River - 01L
- Dam Creek - 01N
- Purcell Creek - 01M

Alpine areas of steep mountains characteristically have approximately 15%-20% of the riparian area in debris chutes, where the existing vegetation is less likely to grow to the large tree structural stage. Within the Goat Rocks, William O. Douglas, and Tatoosh Wilderness areas or Mt. Rainier National Park, such areas are present in the following drainages:

- Lower Muddy Fork Cowlitz River sixth-field watershed - 01A
- Nickel, Stevens, Taos, and Twin Falls Creeks of the Upper Muddy Fork Cowlitz River sixth-field watershed - 01T
- Lower Ohanapecosh River sixth-field watershed - 01B
- Laughingwater, Panther, Chinook, Deer, Needle, and Olallie Creeks of the Upper Ohanapecosh River sixth-field watershed - 01S
- Allred, Pony, and Buesch Creeks of the Upper Summit Creek sixth-field watershed - 01E
- Upper Carlton Creek sixth-field watershed - 01G
- Upper Cortright Creek sixth-field watershed - 01J
- Lower Clear Fork Cowlitz River sixth-field watershed - 01K

- Upper Clear Fork Cowlitz River sixth-field watershed - 01L
- Lava Creek sixth-field watershed - 01P
- Dam Creek sixth-field watershed - 01N

Riparian area conditions along privately-owned lands are expected to improve at a much slower rate due to expected future vegetative disturbance, including timber management and road construction. Such activities are affecting the existing riparian vegetation, both in stand age and species present. Basin areas which may experience the most future timber management, or recreational impacts include the following sixth-field watersheds:

- Lower Muddy Fork of the Cowlitz River - 01A
- Lower Clear Fork Cowlitz River -01K
- Lower Summit Creek - 01D
- Cyrenus Creek - 01H

Note: With only 109 acres of private land within the entire fifth-field watershed, any private management is not likely to have a large impact on riparian conditions.

Road Placement

Within the National Forest portion of the Clear Fork watershed, road density is not expected to change substantially unless additional funds become available to decommission or remove roads from the existing system. It is expected that in sixth-field watersheds where road densities are either moderate (2-3 miles of road/.sq. mi.), or high (>3 miles of road/sq. mi.), the increased stream flows and associated fish habitat or stream channel degradations may be of concern. Such areas include the following sixth-field watersheds:

- Lower Ohanapecosh River - 01B (moderate concern; 2.3 miles of road/sq. mi.)
- Lower Summit Creek - 01D (high concern, 3.4 miles of road/sq. mi.)
- Lower Cortright Creek - 01I (moderate concern, 2.8 miles of road/sq. mi.)
- La Wis Wis - 01R (high concern, 3.8 miles of road/sq. mi.)

Within National Forest, National Park, and non-federal lands, the concentrations of stream crossings by road systems (based on the number of crossings per stream mile) is expected to remain a concern in some of the sixth-field watersheds where past management activities have placed higher concentrations of Forest Service roads within the drainage basins. Similar to the road density concerns, the moderate (0.5 - 1.0 road crossings/stream mi.) or high (>1 road crossing/stream mi.)

road densities may increase stream flows during heavy precipitation or snow-melt-off events. Areas of concern include the following sixth-field watersheds:

- Lower Ohanapecosh - 01B (high concern, 1.73 rd. crossings/stream mi.)
- Lower Summit Creek - 01D (high concern, 1.29 rd. crossings/stream mi.)
- Lower Carlton Creek - 01F (moderate concern, 0.98 rd. crossings/stream mi.)
- Cyrenus Creek - 01H (moderate concern, 0.96 rd. crossings/stream mi.)
- Lower Cortright Creek - 01I (high concern, 1.60 rd. crossings/stream mi.)
- Upper Cortright Creek 01J (moderate concern, 0.57 rd. crossings/stream mi.)
- Lower Clear Fork Cowlitz River - 01K (high concern, 1.25 rd. crossings/stream mi.)
- Purcell Creek - 01M (high concern, 1.18 rd. crossings/stream mi.)
- Dam Creek - 01N (moderate concern, 0.93 rd. crossings/stream mi.)
- La Wis Wis - 01R (high concern, 2.30 rd. crossings/stream mi.)

The number of road crossings per stream mile will improve in the future due to reduced road density. Diminished impacts from stream flow increases, and improvements to road/stream crossing densities are expected in the following sixth-field watersheds:

- Lower Summit Creek - 01D (high concern, 1.29 rd. crossings/stream mi.)
- Lower Carlton Creek - 01F (moderate concern, 0.98 rd. crossings/stream mi.)
- Cyrenus Creek - 01H (moderate concern, 0.96 rd. crossings/stream mi.)
- Lower Cortright - 01I (high concern, 1.60 rd. crossings/stream mi.)
- Upper Cortright - 01J (moderate concern, 0.57 rd. crossings/stream mi.)
- Lower Clear Fork Cowlitz River - 01K (high concern, 1.25 rd. crossings/stream mi.)
- Purcell Creek - 01M (high concern, 1.18 rd. crossings/stream mi.)
- Dam Creek - 01N (moderate concern, 0.93 rd. crossings/stream mi.)

Note: Reductions in road density are not a certainty at this time and will be largely based on outyear funding.

Flood Plain

Flooding events associated with rain-on-snow occurrence or scattered high peak flows are expected to continue to impact the existing floodplain conditions into the future, especially in areas impacted by existing and future riparian stand age alterations. Sixth-field watersheds that may be affected by flooding events include:

- Lower Muddy Fork Cowlitz River - 01A (RM 0-0.5)
- Lower Ohanapecosh River - 01B (RM 0.5-1.5)
- Lower Summit Creek - 01D (RM 0-0.4)
- Lower Clear Fork Cowlitz River - 01K (RM 0.6-1.2)
- Purcell Creek - 01M (RM 0-0.3)
- Lava Creek - 01P (RM 0-0.3)
- La Wis Wis - 01R (RM 0-1.2 Lower Ohanapecosh; RM 0-0.5 Lower Clear Fork Cowlitz)

Floodplain areas on National Forest lands which are expected to maintain their existing conditions into the future include the following sixth-field watersheds:

- Lower Muddy Fork Cowlitz River - 01A (RM 0-0.5)
- Lower Ohanapecosh River - 01B (RM 0.5-1.5)
- Lower Clear Fork Cowlitz River - 01K (RM 0.6-1.2)
- Lava Creek - 01P (RM 0-0.3)

The frequency in flooding is expected to remain relatively constant throughout the Clear Fork watershed because 80% of the fifth-field consists of either National Park or Wilderness. It is expected that peak flow increases associated with past or future management activities will be associated with sixth-fields that were affected by past management activities.

Large Woody Debris and Connectivity-Fragmentation

Large Woody Debris

Large woody debris (LWD) recruitment potential in the Clear Fork watershed is expected to remain constant and resemble pre-1880 conditions within Mt. Rainier National Park, and within the Tatoosh, Goat Rocks, and William O. Douglas Wilderness areas. Woody material, unless caught in log jams, will be transported out of the main Clear Fork watershed analysis area and delivered to the Upper Cowlitz River fifth-field watershed primarily through catastrophic delivery (e.g., debris torrents). Such areas include the following sixth-field watersheds:

- Lower Muddy Fork Cowlitz River - 01A
- Upper Muddy Fork Cowlitz River, Stevens Canyon, Nickel, and Williwakas Creeks - 01T
- Lower Ohanapecosh River - 01B
- Upper Ohanapecosh River, and Laughingwater, Panther, Deer, Chinook, Needle, and Olallie Creeks - 01S

- Lower Clear Fork Cowlitz River - 01K
- Upper Clear Fork Cowlitz River - 01L
- Purcell Creek - 01M
- Dam Creek - 01N
- Lava Creek - 01P
- Little Lava Creek - 01Q

Woody material from National Forest land tributary stream channels to the main Clear Fork Cowlitz River system will continue to be shorter in length and smaller in diameter in areas where past timber harvest has strongly impacted the riparian corridor. In-stream wood in the mainstems will continue to occur in jams at stream bends, with individual pieces transported annually. Human removal of in-channel large woody material in the mainstems occurred during timber management, making existing wood increasingly more important. This situation is present in the following sixth-fields:

- Lower Cortright Creek - 01I (RM 0.3-1.3)
- Lower Purcell Creek - 01M (RM 0-0.5)
- Dam Creek - 01N (RM 0.2-1.4)
- La Wis Wis - 01R (RM 0-0.5)
- Lower Summit Creek - 01D (RM 0.2-0.4 and RM 0.7-2.5)
- Lower Carlton Creek - 01F (RM 0.1-0.9)
- Cyrenus Creek - 01H (RM 0-0.1, RM 0.2-0.3, and RM 0.5-0.7)

LWD recruitment is expected to improve in the future due to reduced stand management and riparian disturbance (improved connectivity) within Riparian Reserves, and on LSR lands. The goal of managing the LSR is to assist in the development of late-successional forest. Riparian woody debris recruitment is expected to improve in the same sixth-fields listed above.

Inner Gorge

Sideslope failure is expected to continue into the future, especially within the upper headwall portions of secondary stream channels. However, Riparian Reserves will minimize effects to these areas ensuring that sideslope failures will occur at near-natural levels. Areas within the Clear Fork analysis area where inner gorge failures are expected to play a continuous role in high sediment delivery volumes are:

- Lower and Upper Muddy Fork Cowlitz River, and Stevens, Nickel, and Williwakas Creeks - 01A and 01T

- Upper Ohanapecosh River, and Laughingwater, Panther, Deer, Chinook, Needle, and Olallie Creeks - 01S
- Lower Carlton Creek sixth-field watershed - 01F
- Upper Carlton Creek sixth-field watershed - 01G
- Lower Cortright Creek sixth-field watershed - 01I
- Upper Cortright Creek sixth-field watershed - 01J
- Lower Clear Fork Cowlitz River sixth-field watershed - 01K
- Upper Clear Fork Cowlitz River sixth-field watershed - 01L
- Lava Creek sixth-field watershed - 01P
- Little Lava Creek sixth-field watershed - 01Q
- Dam Creek sixth-field watershed - 01N

Stream Channel Types

Alteration of stream channel types is most likely to occur in areas with high percentages of vegetation disturbance in riparian zones, areas subject to more frequent peak flow occurrence, and areas with stream channels that are sediment-rich and are receiving more sediments into the stream channels from upslope sources than the stream is able to actively move through the system. Such areas are often typified by stream channels which are located in glacial-rich terrain. Note that stream channel types have been broken down based on sensitivity ratings (Table 4-5).

Table 4-5: Stream Channel Sensitivity based on Rosgen Channel Types

Very Low	Low	Low-Mod.	Low-High	Mod.	Mod.-High	High	Very High
A1 F1 G1	A2 B1 B2	B3 F2	C1 C2	B6 G2	E6 A6 G6 A3 C3 F3 B4 B5	E3 E4 E5 G3	C4 C5 C6 A4 A5 A11(D) F4 F5 F6 G4 G5 FP*

*FP = Floodplain

Below is a listing of streams in the analysis area that have been identified as having moderate to very high sensitivity ratings. Data used to define potentially unstable "response reaches" consist of stream surveys, field reconnaissance, and aerial photographs. The streams identified include the following:

- Lower Muddy Fork Cowlitz River (RM 0-0.2, D3-D5; RM 0.2-0.3, G3; and RM 0.3-0.5, A3)*
- Lower Ohanapecosh River (RM 0-0.1, G3; RM 0.1-0.7, A3)
- Summit Creek (RM 0-2.45, A3)
- Carlton Creek (RM 3.3-4.3, C3)
- Buesch Creek (RM 0.4-0.5, A3; RM 1.9-2.7, B3; RM 2.7-3.4, A4; and RM 4.5-5.3, C5b)
- Cortright Creek (RM 1.0-1.3, A3; RM 1.5-1.7, A3; RM 2.3-2.5, A3; RM 2.5-2.8, C3; RM 3.1-3.3, G2; RM 3.6-3.9, B3; RM 3.9-4.2, C3; and RM 4.2-4.4, A3)
- Lower Clear Fork Cowlitz River (RM 0-0.6, G3; RM 2.0-2.6, C3; RM 2.6-4.4, A3; RM 4.6-7.0, A3; and RM 7.0-9.5, B3)
- Millridge Creek (RM 1.8-2.1, B3a)
- Upper Clear Fork Cowlitz River (RM 9.5-9.7, B3; RM 10.5-10.7, C3; and RM 11.7-12.1, C3)
- Lava Creek (RM 0.4-1.3)
- Little Lava Creek (RM 0-1.5, B4)

*Stream section where ocular review of 1993 aerial photographs was used to determine channel stability.

Stream channel alterations are expected to be dominated by changes in the width/depth ratio and substrate present. Confined reaches are expected to be rated as stable and less prone to alterations of stream channel sedimentation and associated change in the width/depth ratio in the future. Unconfined reaches will continue to displaying greater reach fluctuations with time regardless of management alterations. Stream channel reaches on National Forest lands where future width/depth ratios are expected to improve are:

- Lower Summit Creek (RM 0-2.45, A3)
- Lower Cortright Creek (RM 1.0-1.3, A3; RM 1.5-1.7, A3; RM 2.3-2.5, A3; RM 2.5-2.8, C3; RM 3.1-3.3, G2; RM 3.6-3.9, B3; RM 3.9-4.2, C3; and RM 4.2-4.4, A3)
- Lava Creek (RM 0.4-1.3, B4)
- Little Lava Creek (RM 0-1.5, B4)

* It should be noted that stream channel width/depth ratios, and associated improvements or degradation of aquatic habitat, are not expected to change in the main stream channels within Mt. Rainier National Park, or the Tatoosh, Goat Rocks, or William O. Douglas Wilderness areas. These main stream channels are receiving such heavy loads of natural sediments that they will always display signs of instability (e.g., lower Muddy Fork Cowlitz River).

Stream Channel Density

Stream channel density is calculated by dividing the total number of stream miles within a sixth-field watershed by the area of that particular sixth-field. Within the Clear Fork analysis area, land management such as road construction and timber harvest did not occur until the early 1950's and remained isolated in the easier accessed drainages such as the Summit Creek, Cortright Creek, Carlton Creek, and Purcell Creek drainages. Areas located within Wilderness and National Park lands have experienced little to no road construction. As a result of current management allocations, stream channel density is not expected to change much in the future and is expected to remain consistent with the values presented in Chapter 3 (Refer to Table 3-42).

Sediment Transport and Storage

Where natural sediment delivery to stream channels not associated with human disturbance (National Park and Wilderness) will remain constant, the stream channels will largely retain the existing width/depth ratios. Avalanche chutes on steep hillsides, alpine areas, and naturally unstable soils will continue to add natural sediment to stream channels at a uniform rate into the future. Such areas include:

- Lower Muddy Fork Cowlitz River (RM 0-0.3) - 01A
- Upper Muddy Fork Cowlitz River, and Stevens Canyon, Nickel, and Williwakas Creeks - 01T
- Lower Ohanapecosh River (RM 0-1.2) - 01B
- Upper Ohanapecosh River, and Laughingwater, Panther, Deer, Chinook, Needle, and Olallie Creeks - 01S
- Buesch Creek (RM 0.4-0.5; RM 1.9-2.7; RM 2.7-3.4; and RM 4.5-5.3) - 01E
- Lower Clear Fork Cowlitz River (RM 0-0.6; RM 2.0-2.6; RM 2.6-4.4; RM 4.6-7.0; and RM 7.0-9.5) - 01K
- Millridge Creek (RM 1.8-2.1) - 01K
- Upper Clear Fork Cowlitz River (RM 9.5-9.7; RM 10.5-10.7; and RM 11.7-12.1) - 01L
- Upper Dam Creek in the Goat Rocks Wilderness (RM 1.4+) - 01N
- Upper Lava Creek in the Goat Rocks Wilderness (RM 1.3+) - 01P
- Upper Little Lava Creek in the Goat Rocks Wilderness (RM 1.5+) - 01Q

Stream channels are expected to become more stable as upslope vegetative recovery proceeds. In the interim, most stream channels will continue to experience degradation/aggradation events before reaching equilibrium. Such changes will be associated with riparian stand structure improvements and reduction of sediment routing to stream channels in areas where roads of concern have either been treated or decommissioned within the analysis area. Depositional reaches are expected to store existing sediments for 20-50 years into the future (L. Benda 1997 - personal communication), with the changes primarily occurring during less frequent high flow events in response to rain-on-snow precipitation. Changes in this estimated time-frame will largely be based on future upslope vegetative conditions (estimates based on L. Benda personal communications 1997). The changes are most likely to occur in the following stream reaches which are located predominantly on National Forest lands:

- Lower Carlton Creek (RM 0.1-0.9) - 01F
- Lower Summit Creek (RM 0-2.45) - 01D*
- Cortright Creek (RM 0.3-1.3; RM 1.5-1.7; RM 2.3-2.5; RM 2.5-2.8; RM 3.1-3.3; RM 3.6-3.9; RM 3.9-4.2; and RM 4.2-4.4) - 01I and 01J
- Cyrenus Creek (RM 0-0.1, RM 0.2-0.3, and RM 0.5-0.7) - 01H*
- Lava Creek (RM 0.4-1.3) - 01P
- Little Lava Creek (RM 0-1.5) - 01Q
- Dam Creek (RM 0.2-1.4) - 01N
- Lower Purcell Creek (RM 0-0.5) - 01M

*Sixth-field watersheds where private land management may continue to influence the stream channel reaches within that area as well as further downstream from the location.

Synthesis Summary

The synthesis process used in this watershed analysis resulted in the identification of several areas of concern for aquatic resources where management efforts would be needed to help achieve the management objectives for the areas as described in the *Northwest Forest Plan* and the GP Forest Plan. Summaries for these areas of concern are displayed in Table 4-6. Management objectives in these areas would focus on the achievement of the aquatic conservation strategy in the *Northwest Forest Plan.*

Aquatic Organisms and Stream Habitat

Migration Barriers

Efforts are being made to provide passage for coho, chinook and steelhead around the Tacoma Public Utility dams in the Cowlitz River. Natural barriers to fish migration (e.g., from gradient) will

Table 4-6: Watershed Concern Areas by Sixth-field Watershed

Stream Segment	**Stream Name**	6^{th} Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
1	Lower Muddy Fk.(RM 0-0.2)	01A		X	X			X			X	X
2	Lower Muddy Fk. (RM 0.2-0.3)	01A		X				X			X	X
3	Lower Muddy Fk. (RM 0.3-0.5)	01A		X				X			X	
4	Lower Muddy Fk. (RM 1.3-5.5)	01A								X		
5	U. Muddy Fk. (RM 5.5-15.5)	01T								X		
6	Stevens Canyon Ck. (RM 3.6-6.6)	01T								X		X
7	Nickel Creek (RM 0.0-5.5)	01T								X		X
8	Williwakas Creek (RM 0.0-3.5)	01T								X		X
9	Taos Creek	01T								X		
10	L. Ohanapecosh (RM 0.0-0.1)	01B				X	X			X		

Table 4-6: Watershed Concern Areas by Sixth-field Watershed

Stream Segment	Stream Name	6th Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
11	L. Ohanapecosh (RM 0.1-0.5)	01B				X	X			X	X	X
12	L. Ohanapecosh (RM 0.5-0.7)	01B				X	X	X	X	X	X	X
13	L. Ohanapecosh (RM 0.7-0.9)	01B				X	X	X	X	X		X
14	L. Ohanapecosh (RM 0.9-1.1)	01B		X		X	X	X	X	X		X
15	L. Ohanapecosh (RM 1.1-1.2)	01B				X	X	X	X	X		X
16	L. Ohanapecosh (RM 1.2-1.5)	01B				X	X	X		X		
17	L. Ohanapecosh (RM 1.5-7.3)	01B				X	X			X		
18	U. Ohanapecosh (RM 9.3-10.5)	01S								X		
19	U. Ohanapecosh (RM 12.5-17+)	01S								X		X
20	Laughingwater Creek	01S										X
21	Panther Creek	01S										X

Table 4-6: Watershed Concern Areas by Sixth-field Watershed

Stream Segment	Stream Name	6^{th} Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
22	Deer Creek	01S										X
23	Chinook Creek	01S										X
24	Needle Creek	01S										X
25	Olallie Creek	01S										X
26	Lower Summit Crk. (RM 0-0.2)	01D	X		X	X	X	X			X	X
27	L. Summit Crk. (RM 0.2-0.4)	01D	X		X	X	X	X	X		X	X
28	L. Summit Creek (RM 0.5-0.7)	01D	X	X	X	X	X				X	X
39	L. Summit Crk. (RM 0.7-0.8)	01D	X	X	X	X	X		X		X	X
30	L. Summit Crk. (RM 0.8-1.4)	01D	X	X	X	X	X		X	X	X	X
31	L. Summit Crk. (RM 1.4-2.5)	01D	X		X	X	X		X	X	X	X
32	L. Summit Crk. (2.5-5.0)	01D	X		X	X	X			X		

Table 4-6: Watershed Concern Areas by Sixth-field Watershed													
Stream Segment	**Stream Name**	6th Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
33	L. Summit Crk. (RM 7.5-7.8)	01D	X		X	X	X			X		
34	Buesch Crk. (RM 0-0.4)	01E								X		
35	Buesch Crk. (RM 0.4-0.5)	01E									X	X
36	Buesch Crk. (RM 1.9-3.4)	01E									X	X
37	Buesch Crk. (RM 4.5-5.3)	01E									X	X
38	L. Carlton Crk. (RM 0-0.1)	01F	X	X			X					
39	L. Carlton Crk. (RM 0.1-0.7)	01F	X	X			X		X			
40	L. Carlton Crk. (RM 0.8-0.9)	01F		X			X		X			
41	L. Carlton Crk. (RM 1-1.4)	01F		X			X					
42	L. Carlton Crk. (RM 3.3-4.3)	01F					X				X	
43	U. Carlton Crk. (RM 4.3-4.7)	01G		X								

Table 4-6: Watershed Concern Areas by Sixth-field Watershed

Stream Segment	Stream Name	6th Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
44	U. Carlton Crk. (RM 5.5-7.6)	01G								X		
45	Cyrenus Crk. (RM 0-0.1)	01H	X						X			X
46	Cyreuus Crk. (RM 0.1-0.2)	01H	X	X								
47	Cyrenus Crk. (RM 0.2-0.3)	01H	X						X			X
48	Cyrenus Crk. (RM 0.4-0.5)	01H	X	X								
49	Cyrenus Crk. (RM 0.5-0.6)	01H	X	X					X			X
50	Cyrenus Crk. (RM 0.6-0.7)	01H	X						X			X
51	Cyrenus Crk. (RM 1.8-2.8)	01H	X							X		
52	L. Cortright Crk. (RM 0-0.1)	01I	X	X		X				X		
53	L. Cortright Crk. (RM 0.3-0.4)	01I	X			X			X	X		X

Table 4-6: Watershed Concern Areas by Sixth-field Watershed													
Stream Segment	Stream Name	6th Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
54	L. Cortright Crk. (RM 0.4-1.0)	01I	X	X		X			X	X		X
55	L. Cortright Crk. (RM 1.0-1.3)	01I	X	X		X			X	X	X	X
56	L. Cortright Crk. (RM 1.3-1.4)	01I	X	X		X				X		
57	L. Cortright Crk. (RM 1.5-1.6)	01I	X	X		X				X	X	X
58	L. Cortright Crk. (RM 1.6-1.7)	01I	X			X				X	X	X
59	L. Cortright Crk. (RM 1.7-2.3)	01I	X			X				X		
60	L. Cortright (RM 2.3-2.8)	01I	X			X					X	X

Table 4-6: Watershed Concern Areas by Sixth-field Watershed

Stream Segment	Stream Name	6^{th} Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
61	L. Cortright Crk. (RM 3.1-3.3)	01I	X			X				X	X	X
62	L. Cortright Crk. (RM 3.3-3.6)	01I	X			X				X		
63	L. Cortright Crk. (RM 3.6-4.4)	01I	X			X					X	
64	L. Cortright Crk. (RM 4.4-4.9)	01I	X			X				X		
65	L. Cortright Crk. (RM 5.1-5.9)	01I	X			X				X		
66	U. Cortright	01J	X									
67	L. Clr. Fk. Cowlitz (RM 0-0.6)	01K	X		X	X		X			X	X

Table 4-6: Watershed Concern Areas by Sixth-field Watershed

Stream Segment	Stream Name	6th Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
68	L. Clr. Fk. Cowlitz (RM 0.6-1.2)	01K	X			X		X				
69	L. Clr. Fk. Cowlitz (RM 1.2-4.2)	01K	X			X				X	X	X
70	L. Clr. Fk. Cowlitz (RM 4.2-4.4)	01K	X			X					X	X
71	L. Clr. Fk. Cowlitz (RM 4.6-7.0)	01K	X			X				X	X	X
72	Millridge Crk. (RM 1.8-2.1)	01K	X							X		X
73	U. Clr. Fk. Cowlitz (RM 7.0-9.5)	01L								X	X	X
74	U. Clr. Fk. Cowlitz (RM 9.5-9.7)	01L									X	X

Table 4-6: Watershed Concern Areas by Sixth-field Watershed

Stream Segment	Stream Name	6th Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
75	U. Clr. Fk. Cowlitz (RM 10.5-10.7)	01L									X	X
76	U. Clr. Fk. Cowlitz (RM 11.7-12.1)	01L									X	X
77	U. Clr. Fk. Cowlitz (RM 15-16.5)	01L								x		
78	Coyotee Crk. (RM 0.7-2.8)	01L								X		
79	Purcell Crk. (RM 0-0.3)	01M	X	X		X			X			X
80	Purcell Crk. (RM 0.3-0.5)	01M	X	X		X			X			X
81	Purcell Crk. (RM 1.4-2.2)	01M	X	X						X		
82	Dam Crk. (RM 0-0.1)	01N	X							x		
83	Dam Crk. (RM 0.1-0.2)	01N	X	X						X		

Table 4-6: Watershed Concern Areas by Sixth-field Watershed													
Stream Segment	Stream Name	6th Field	Peak Flow	Riparian Connectivity	Road Density	High Riparian Frag. Index	High RR Road Density	Floodplain Concerns	Large Woody Debris	Inner Gorge	Channel Instability (Rosgen)	Channel Widening
84	Dam Crk. (RM 0.2-1.4)	01N	X	X					X	X		X
85	Dam Crk. (RM 1.4-1.7)	01N	X							X		
86	Dam Crk. (RM 2.3-3.7)	01N	X							X		
87	Lava Crk. (RM 0-0.3)	01P						X				
88	Lava Crk. (RM 0.4-1.3)	01P									X	X
89	Lava Crk. (RM 3.2-4.5)	01P								X		
90	L. Lava Crk. (RM 0-1.5)	01Q								X	X	
91	L. Lava Crk. (RM 1.5-2.2)	01Q								X		X
92	La Wis Wis (RM 0-0.4)	01R	X	X	X	X	X		X			
93	La Wis Wis (RM 0.4-0.5)	01R	X		X	X	X		X			
94	La Wis Wis (RM 0.6-0.8)	01R	X	X	X	X	X					

Stream Segments = Portions of the Class 1 and 2 streams in the Clear Fork watershed.
6th Field = Sixth-field watersheds located in the Clear Fork watershed
Peak Flow = Stream channels displaying a moderate-high ARP value.
Riparian Connectivity = Stream channel segments displaying stream-side riparian fragmentation
Road Density = Sub-basins displaying High (>3.0 mi. Rd./sq. Mile) at the sixth-field watershed level
High Riparian Fragmentation Index = Sub-basins displaying High (>1.0) road/stream crossings
High RR Road Density = Sub-basins displaying High (>2.0 mi. Rd./sq. Mi. RR) road density in Riparian Reserves
Large Woody Debris = Areas identified as having <40 pieces of LWD/stream mile
Inner Gorge = Stream channels in areas where riparian sideslopes exceed 65%
Channel Instability = Areas identified as having moderate to very high sensitivity to sediment movements and changes in stream flows.
Channel Widening = Stream channel segments identified as having a high sensitivity to channel widening based on excessive suspended and bedload sediment movements.

continue to exist, but associated barriers (e.g., log jams at nick points associated with gradient) are expected to decline as human-related input of woody material from management activities declines.

Fish Habitat Conditions

Intact upper portions of the Clear Fork Cowlitz River, Ohanapecosh River, and Muddy Fork Cowlitz River systems will become increasingly more important as crucial refuge for resident fish species and stocks, and in providing high-quality water for threatened and proposed anadromous stocks downstream.

If most of the stream is rated as fair for a specific habitat element, then the habitat element is in an "at risk" condition (Table 4-7). When a habitat element is in an "at risk" condition, loss of fish habitat would be detrimental to salmon or trout species. Efforts should be made to recover "at risk" habitat where feasible. If most of the stream falls into the poor category, the stream is considered "degraded". Efforts should be made to recover "degraded" habitat, where feasible. "Potential for Improvement" is defined as follows:

High - Current condition is "Degraded", and management activities are likely to be more protective in the future (i.e. LSR and Riparian Reserves). There is potential for restoration projects.

Moderate - Current condition is "At Risk", and management activities are likely to be more protective in the future (i.e. LSR and Riparian Reserves). There is limited potential for restoration projects.

Low - Current conditions are "Good", the protection provided by management direction is not likely to change, or there is no potential for restoration projects.

Table 4-7: Summary of Areas of Concern and Potential for Improvement.

Stream	Pool Frequency	Woody Debris	Spawning Gravel	Fine Sediment
Clear Fork Cowlitz River	"At Risk"	Good	Data Gap	Good
Potential for Improvement	Moderate	Low	Low	Low
Cortright Creek	"At Risk"	"At Risk"	"At Risk"	Degraded
Potential for Improvement	High	High	High	High
Purcell Creek	Data Gap	"At Risk"	Data Gap	Good

Stream	Pool Frequency	Woody Debris	Spawning Gravel	Fine Sediment
Potential for Improvement	High	High	High	High
Lava Creek	Data Gap	Good	"Degraded"	"Degraded"
Potential for Improvement	Low	Low	Low	Low
Little Lava Creek	Data Gap	Good	"Degraded"	"Degraded"
Potential for Improvement	Low	Low	Low	Low
Ohanapecosh River	"At Risk"	Good	Data Gap	Good
Potential for Improvement	Moderate	Low	Low	Low
Summit Creek	Degraded	Data Gap	Data Gap	Good
Potential for Improvement	High	High	Low	Low
Buesch Creek	Data Gap	Data Gap	Data Gap	Good
Potential for Improvement	Low	Low	Low	Low
Carlton Creek	"At Risk"	Data Gap	"Degraded"	"Degraded"
Potential for Improvement	High	High	High	High
Cyrenus Creek	"At Risk"	Data Gap	"At Risk"	"At Risk"
Potential for Improvement	High	High	High	High

Table 4-7: Summary of Areas of Concern and Potential for Improvement.

Limiting Factors

Pool Frequency

Pool frequency is a function of water, wood and sediment delivery (Rosgen, 1996). Decreases in woody debris generally result in a decrease in the number of pools in a stream. The optimum pool frequency is maintained by a balance of sediment and water. When the balance between sediment and water is upset, pool frequency declines. Map 28, Aquatics Concerns - Pool Frequency, displays areas of concern pertaining to pool frequency within the Clear Fork watershed.

"At Risk" Streams - Pool frequency is considered a limiting factor for all of the streams analyzed. The following streams fall into an "at risk" condition:

- Clear Fork Cowlitz River
- Ohanapecosh River
- Cortright Creek
- Carlton Creek
- Cyrenus Creek

The "at risk" conditions of the Clear Fork Cowlitz River and Ohanapecosh River are due to a mix of naturally unstable conditions, and land management activities.

Natural Causes - The poor conditions of the Clear Fork Cowlitz River are found upstream from Millridge Creek, and can only be attributed to natural causes. The Ohanapecosh River is largely within Mt. Rainier National Park, so land management influences on the streams are relatively small.

The "at risk" conditions of the Clear Fork Cowlitz River and Ohanapecosh River are also related to land management activities. The Clear Fork Cowlitz River stream survey noted at least two landslides that were associated with U.S. Highway 12. Maintenance type activities, such as the removal of woody debris, have directly affected the amount of woody debris and indirectly affected pool frequency near La Wis Wis campground. The roads and campsites have certainly influenced hydrological function of the riparian area. Stream crossings at the highways influence peak flows and processing of sediments. The influences of the highways and campgrounds are not likely to change in the near future.

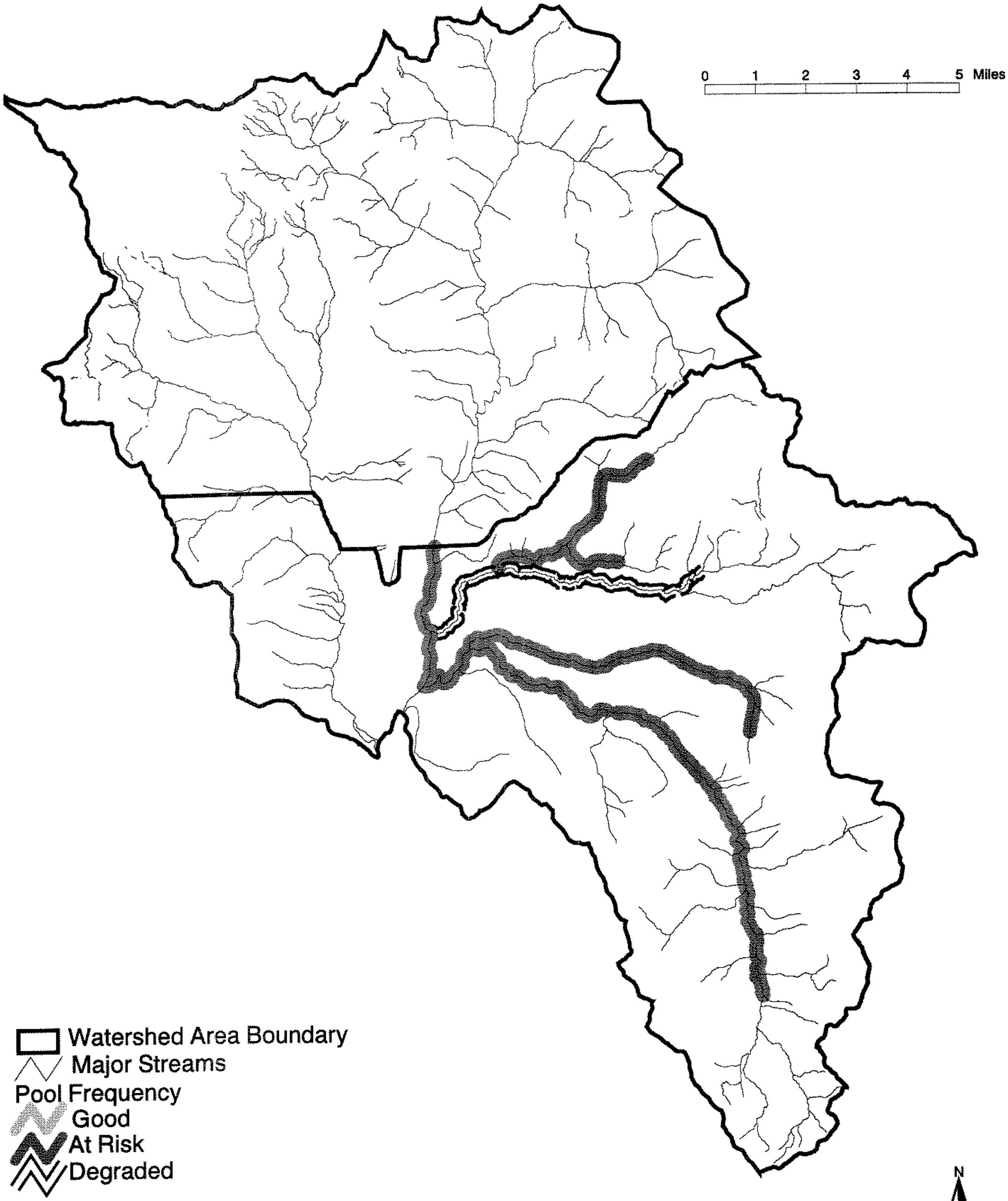
Management activities (timber harvest and road construction) along Purcell Creek, Dam Creek, and Cortright Creek in the Clear Fork Cowlitz River watershed, and Summit and Carlton Creeks in the Ohanapecosh River watershed have altered the way these streams process sediments and water and deliver them to the Clear Fork Cowlitz and Ohanapecosh Rivers. The influence of forest roading and timber management are likely to decrease as trees in harvested areas increase in size and more emphasis is placed the recovery of watershed function.

The "at risk" conditions for Carlton Creek, Cortright Creek, and Cryenus Creek are due to a combination of natural and management influences. All of the streams have had some harvest within their watersheds and roads parallel much of Carlton Creek and Cortright Creek. It is not possible to distinguish between the influence of natural factors and management-related factors for these streams. The influences of forest roading and timber management are likely to decrease as trees in harvested areas increase in size and more emphasis is placed on the recovery of watershed function.

Map 28

CLEAR FORK WATERSHED ANALYSIS

Aquatic Concerns - Pool Frequency



"Degraded" Streams - Pool frequency in Summit Creek is in a degraded condition. Pool frequency in Summit Creek is considered to be in a degraded condition due to the lack of pools, moderate road densities and moderate amount of harvest. Summit Creek lacks large woody debris which contributes to the lack of pools. The influences of forest roading and timber management are likely to decrease as trees in harvested areas increase in size and more emphasis is placed on the recovery of watershed function.

Potential for Recovery - The potential for recovery is high in the following streams:

- Cortright Creek
- Carlton Creek
- Summit Creek

Sedimentation rates and peak flows are expected to normalize as management direction places more emphasis on the recovery of watershed function.

The potential for recovery is moderate in:

- Ohanapecosh River
- Clear Fork Cowlitz River

Some improvement is expected as management direction on the tributaries to these rivers emphasizes watershed function. Management direction in the National Park, Wilderness, along the highways, and in campgrounds is unlikely to change in the near future.

Large Woody Debris

Map 24, Aquatics Concerns - Large Woody Debris, displays areas of concern pertaining to large woody debris in the Clear Fork watershed.

"At Risk" Streams - Woody debris is in an "at risk"condition in the following streams:

- Cortright Creek
- Purcell Creek

Various reaches of Cortright Creek and Purcell Creek lack woody debris. Both of the streams have been affected by a moderate amount of harvest in the past.

Potential for Improvement - This situation is expected to improve with implementation of Riparian Reserves.

Spawning Gravel

Map 29, Aquatics Concerns - Spawning Gravel, displays areas of concern pertaining to spawning gravel in the Clear Fork watershed.

"At Risk" Streams - Spawning gravel is an "at risk" condition in the following streams:

- Carlton Creek
- Cyrenus Creek
- Cortright Creek

Spawning gravel is confined to relatively small pockets in these streams because of the steep nature of the streams.

"Degraded" Streams - Spawning gravel is an "degraded" condition in the following streams:

- Lava Creek
- Little Lava Creek

Lava and Little Lava Creek have degraded spawning habitats because they lack suitably-sized gravels.

Potential for Improvement - The additional woody debris provided by Riparian Reserves will help to trap suitably-sized gravels. This improvement will be small, however, because the size of gravel that is suitable for spawning is usually transported out of steeper stream reaches.

Fine Sediment

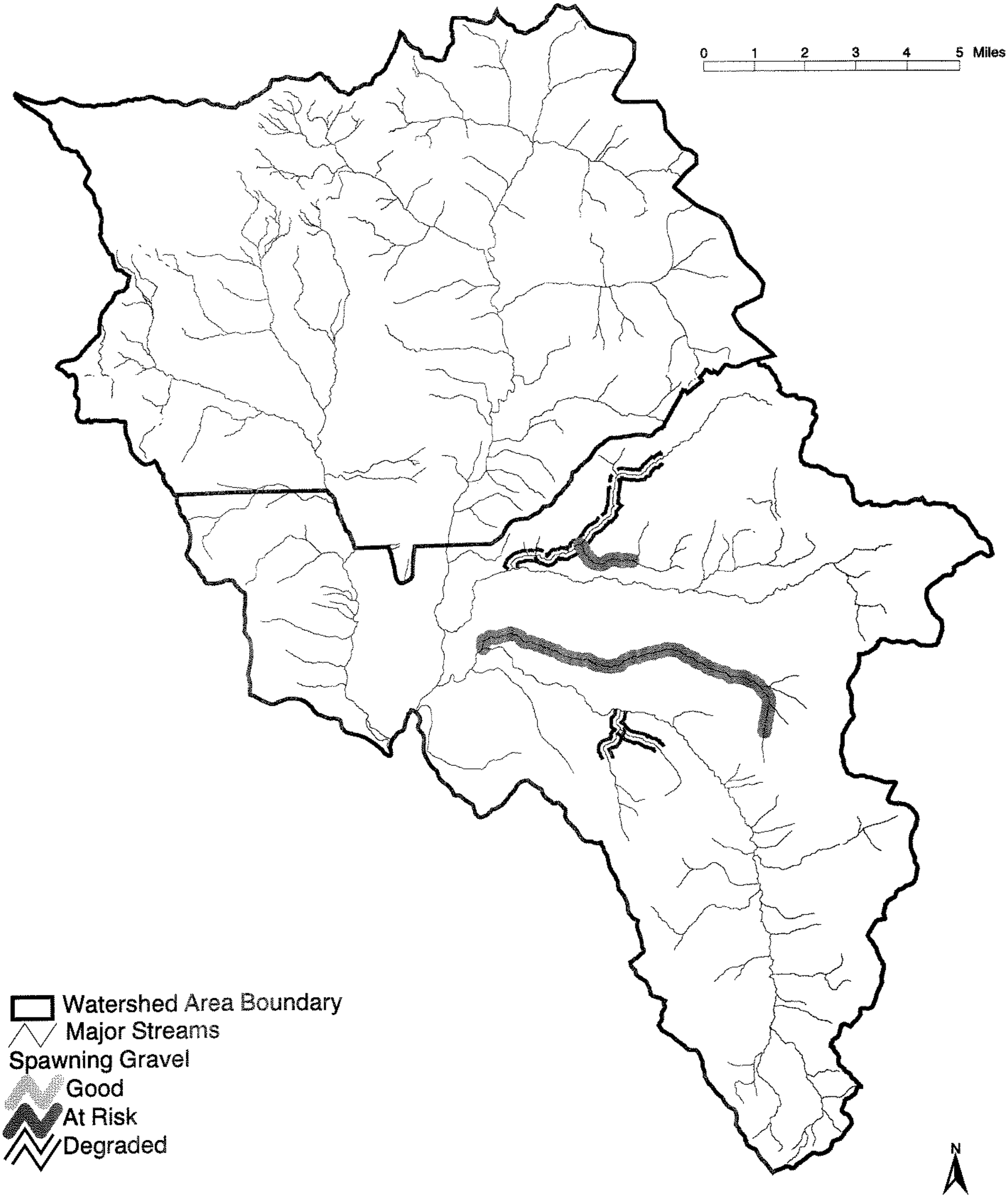
Map 30, Aquatics Concerns - Fine Sediment, displays areas of concern pertaining to fine sediment in the Clear Fork watershed.

"At Risk" Streams - Fine sediment is in an "at risk" condition in Cyrenus Creek. Fine sediments in Cyrenus Creek are at a level at which negative impacts to spawning success start to be observed. This increased amount of sediment may be related to the moderate amount of harvest activities in the

Map 29

CLEAR FORK WATERSHED ANALYSIS

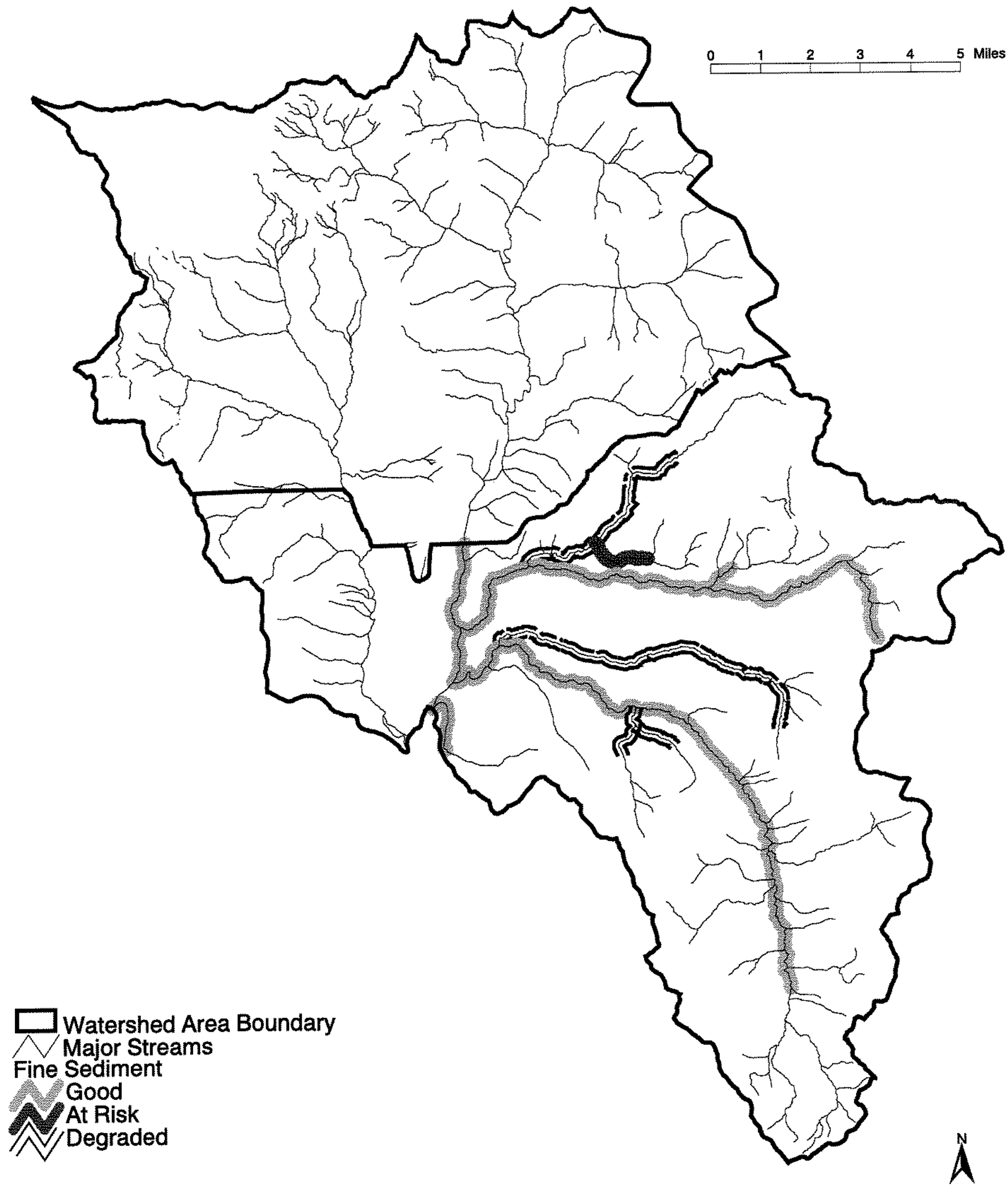
Aquatic Concerns - Spawning Gravel



Map 30

CLEAR FORK WATERSHED ANALYSIS

Aquatics Concerns - Fine Sediment



watershed. The amount of fine sediment delivery is expected to decline as trees in harvested areas increase in size and more emphasis is placed on restoring watershed function.

"Degraded" Streams - Fine sediment is in a degraded condition in the following streams:

- Cortright Creek
- Carlton Creek
- Lava Creek
- Little Lava Creek

Fine sediment in these streams is at the level at which spawning success is substantially reduced. This may be related to timber harvest and roading activities in these watersheds.

The degraded conditions in Lava and Little Lava Creeks are most likely due to natural sedimentation rates because of the low level of management in these sixth-field watersheds.

Potential for Recovery - The amount of fine sediment in Carlton and Cortright Creeks is expected to decline as trees in harvested areas increase in size and more emphasis is placed on restoring watershed function. Because the large amount of fine sediment in Lava and Little Lava Creeks is largely of natural origin, it is not likely to change substantially in the near future.

Recreational Fishing and Poaching

Increased hooking mortality associated with increased fishing is expected to range from 1-5 percent as fishing grows in popularity.

Poaching is expected to continue in scattered portions of the Clear Fork watershed. Poaching is probably most dominant in the lakes that are hiked into and in the heavy recreational areas.

Increased environmental education and awareness programs will help to discourage habitat pollution and poaching.

Chapter 5 - Sixth-field Watershed Evaluations

In the ensuing tables, each sixth-field watershed is evaluated in terms of meeting the nine Aquatic Conservation Strategy (ACS) objectives and one additional management objective of maintaining late-successional habitat across the landscape. A brief description of each of the ten objectives follows, with an explanation of the evaluation criteria that were used to assign the various ratings. ACS objectives are presented as they appear in the *Northwest Forest Plan* (USDA, USDI 1994).

1. "Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted." (ROD, page B-11)

Evaluation Criteria - Compare historic/reference and current conditions, examine aquatic features such as perennial streams, intermittent streams, wetlands, lakes and ponds. Note: We interpret this ACS objective to refer to the continued physical existence of the variety of aquatic features from historic or reference times to the present. It does not address the quality of aquatic conditions, as these are addressed in the other ACS objectives.

Assumptions - The overall drainage networks have increased due to roading - roads intercept groundwater which increases the network of channels carrying water. New intermittent and ephemeral streams exist as road cross drains cause water to flow where channels previously did not exist.

The following ratings were used:

Good: Watershed conditions display a natural and relatively undisturbed drainage system.

Fair: Watershed conditions display moderate human disturbance, with some road-caused interference of drainage patterns.

Poor: High road density (> 2.0 miles of road / sq. mi.) with numerous road systems affecting drainage patterns.

2. "Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species." (ROD, page B-11)

Evaluation Criteria - Compare historic/reference and current conditions, examine spatial and temporal connectivity of aquatic and riparian systems. Note: The basis of this evaluation was on *hydrologic* connectivity; *riparian* connectivity is addressed in ACS # 8.

The following ratings were used:

Good: No roads, no blockages, no culvert obstructions, and no dams.

Fair: Roading along the floodplain. Some wetlands/floodplains are disconnected.

Poor: Subsurface flow, impassable culverts.

Assumptions: Human and natural features which influence hydrologic connections include hydroelectric facilities (or other stream flow diversions), road crossings of streams (primarily used to address barriers to fish migration, and does not account for possible barriers for other aquatic species because of data gaps), roads built along floodplains and wetlands, sediment deposits instream (gravel bars) or flow routed subsurface.

3. "Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations." (ROD, page B-11)

Evaluation Criteria - Compare historic/reference and current conditions, examine the physical integrity of the following aquatic systems: a) shorelines (lakes and ponds); b) stream banks - includes observations regarding channel widening, channel migration, and occurrence of large woody debris (LWD) as it relates to pool formation and stream bank cutting; c) stream bottom configurations; and d) condition of upper banks and inner stream gorges of deeply incised streams.

The following ratings were used:

Good: Shorelines of lakes and ponds, streambank, channel conditions, channel migration, observed LWD concentrations, stream bottom configuration, upper bank and inner gorge conditions resemble natural (historic) conditions.

Fair: Shorelines of lakes and ponds display moderate increases in erosion due to management influences. Moderate alterations in streambank and channel conditions, channel migration, stream bottom configuration, upper bank and inner gorge areas when compared to historic conditions.

Poor: Shorelines of lakes and ponds display numerous signs of increased erosion due to management influences. Significant alterations in streambank and channel conditions, channel migration, stream bottom configuration, upper bank and inner gorge areas when compared to historic conditions.

4. "Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities." (ROD, page B-11)

Evaluation Criteria - Compare historic/reference and current conditions, examine water quality of aquatic, riparian, and wetland ecosystems:

a. biological - macroinvertebrates and fish (limited surveys occur in selected streams).
b. physical - stream temperature information occurs on selected streams; turbidity is approximated in ACS #5
c. chemical - pH

The following ratings were used:

Good: Stream temperatures 12°C - 14°C

Fair: Stream temperatures 14.1°C - 15.9°C

Poor: Stream temperatures 16°C +

Note: Unless specific statements are made in this section, no data is available with which to evaluate ACS Objective #4.

5. "Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport." (ROD, page B-11)

Evaluation Criteria - Compare historic/reference and current conditions, examine elements of the sediment regime (input, storage, and transport) including: timing, volume, rate, and character of sediment.

Assumptions - Erosion from roads delivers fine sediment to streams. Sediment delivered to streams from mass wasting is both fine and coarse.

The following ratings were used:

Good: The timing, volume, and rate of sediment delivery to streams is similar to historic conditions.

Fair: The timing, volume, and rate of sediment delivery to streams has been moderately altered due to management activities.

Poor: The timing, volume, and rate of sediment delivery to streams has been significantly altered throughout the basin area due to management activities.

6. "Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected." (ROD, page B-11)

Evaluation Criteria - Compare reference and current conditions, examine the ability of in-stream flows to create and sustain riparian, aquatic, and wetland habitats by looking at timing, magnitude, duration, and spatial distribution.

The following ratings were used:

ARP:	WAR:
Good: > 85%	**Good**: < 10%
Fair: 70 - 85%	**Fair**: 10 -15%
Poor: < 70%	**Poor**: ≥ 15%

Assumptions - Aggregate Recovery Percentage (ARP) and Water Available for Run-off (WAR) models were used to evaluate whether a subbasin was meeting this objective. Note: If a subbasin had an ARP of 70% or lower, or a WAR value greater than 15%, the sixth-field was initially given a poor rating in terms of in-stream flows. Qualitative observations of management activities were then used to modify this evaluation to arrive at a final rating.

* The ARP model considers non-forest as recovered.

7. "Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands." (ROD, page B-11)

Evaluation Criteria - Compare historic/reference and current conditions, examine floodplain inundation and the elevation of water tables in meadows and wetlands. All evaluations presented in the following tables are based on observation factors such as roading along floodplains or near wetlands. Road density in Riparian Reserves is the only quantitative data that exists for this topic.

Assumptions - The majority of inventoried wetlands are associated with either high ridges and talus slopes or floodplains adjacent to streams. The majority of wetlands under the forest canopy are not inventoried. The floodplain area considered for stream channels is the area located in the two-year peak flow riparian zone.

The following ratings were used:

Good: Natural and undisturbed floodplain and wetland conditions.

Fair: Moderate disturbance to wetlands, water tables, and channel conditions as a result of management activities.

Poor: Moderate to high disturbance of wetlands, water tables, and channel conditions as a result of management activities.

8. "Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability." (ROD, page B-11)

Evaluation Criteria - Compare historic/reference and current conditions, examine the composition and structural diversity of plant communities in riparian areas, looking specifically for functions regarding the following:

a. thermal regulation (summer and winter)
b. nutrient filtering
c. rate of surface and bank erosion and channel migration
d. amount and distribution of coarse woody debris
e. structural diversity of forest in the riparian zone

Assumptions - Because we don't have specific data to address each of the functions (a. through e.) above, we are using forest vegetation structure to act as a surrogate for these functions. Large tree forest generally provides all of the above functions (a. through e.).

Small tree forest generally provides functions a, b, and c. Grass/pole forest has the potential to provide functions a and b, though to a lesser degree than the other forest structural stages. Exceptions to the above will be described in the rationale column of the individual sixth-field evaluations. For a description of the physical characteristics used to define large tree, small tree, and grass/pole forest structure, see Chapter 3, Forest Vegetation - Vegetation Structural Stages.

The following ratings were used:

Good: The Riparian Reserves contain the amounts and types of forest structure needed to adequately provide all five of the riparian functions listed in the evaluation criteria.

Fair: The Riparian Reserves contain the amounts and types of forest structure needed to adequately provide at least three of the riparian functions listed in the evaluation criteria.

Poor: The Riparian Reserves contain the amounts and types of forest structure that adequately provide less than three of the riparian functions listed in the evaluation criteria.

9. "Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species." (ROD, page B-11)

Evaluation Criteria - Assess current conditions and examine the ability of the area to support well-distributed populations of native plants, invertebrates, and vertebrate riparian-dependent species by reviewing the following conditions:

a. forested riparian habitat connectivity
b. percent and distribution of small and large tree habitat in Riparian Reserves
c. riparian-dependent species presence (plants and animals)

Note: Data on species occurrence and populations in riparian areas is non-existent in this watershed.

The following ratings were used:

Good: Riparian Reserves that are dominated by connected large tree forest, or by some combination of large and small tree forest. Grass/pole forest and/or non-forest disruptions in the connectivity would be very small and would not represent a significant dispersal barrier for less mobile species.

Fair: Riparian reserves that possess a varied combination of large tree, small tree, and grass/pole forest. Large and small tree forest do not provide consistent connectivity throughout the sixth-field. Patches of non-forest habitat may also represent a dispersal barrier for less mobile species.

Poor: Riparian Reserves that are dominated by grass/pole forest, or by some combination of grass/pole and small tree forest. Large tree forest may exist in small isolated stands. Patches of non-forest habitat may also represent a dispersal barrier for less mobile species.

10. Late-Successional Habitat - Evaluate late-successional habitat within the watershed.

Evaluation Criteria - Assess and examine the current condition of late-successional habitats with respect to amount, distribution and condition. The following criteria will be used:

a. fragmentation/connectivity of late-successional forest habitat patches and Late-Successional Reserves (LSRs)
b. condition of late-successional forest habitat with respect to insects, disease, windthrow, etc.

Late-successional forest habitat will be evaluated within each sixth-field in accordance with the objectives of the existing land management allocations.

The following ratings were used:

Good: The sixth-field meets the objectives of the current management allocation with only minor exceptions.

Fair: The sixth-field is near the margin for meeting the current management allocation objectives.

Poor: The sixth-field does not meet the current management allocation objectives.

Ratings Confidence

The evaluation ratings are assigned a level of confidence for accuracy according to the following scale:

High: High confidence that the assigned rating is accurate. That confidence is based on data gathered from recent exams, surveys, and/or personal on-the-ground knowledge. Data directly pertains to the condition being evaluated.

Moderate: Moderate confidence that the assigned rating is accurate. That confidence is based on data gathered from a combination of exams, surveys, personal on-the-ground knowledge, aerial photograph interpretation, and/or professional judgement. Data collected in stand exams and surveys may not be recent.

Low: Low confidence that the assigned rating is accurate. That confidence is based on data gathered from aerial photograph interpretation and/or professional judgement. Lack of field data or data that pertains directly to the condition being evaluated.

Table 5-1: Sixth-field 01A - Lower Muddy Fork Cowlitz River

Management Objectives	Rating	Confidence	Rationale
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Little change from reference conditions. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 0.5 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** Blocked outside watershed, otherwise no change from reference conditions. **Riparian Fragmentation Index:** 0.02 road crossings/stream mile (Low)
3) Integrity of aquatic systems	Data Gap	N/A	**Pool Frequency:** Data gap **Woody Debris:** Data gap **Width/Depth**: Data gap **Pfankuch Stability:** Data gap
4) Water quality for healthy ecosystems	Good	Low	**Temperature:** Unknown, but watershed relatively unmanaged **Pollutants:** None expected
5) Appropriate sediment regime	Good	Moderate	**Mass Wasting:** High background rate of mass wasting, avalanches, episodic volcanic mudflows; very few mgt.-related slope failures. **Spawning Gravel:** Data gap **Fine Sediment:** Data gap
6) In stream flow	Good	High	**ARP:** 99% (Good) **WAR**: 10.7% (Fair) Peak flow magnitude and frequency is equivalent to reference conditions. Modification to vegetation primarily on National Forest land.
7) Floodplain function	Good	Moderate	**Road Density in RR:** 0.27 (Low) **Other**: Rivermile 0 to 1.5 have some development.
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	Much of the Riparian Reserves are large tree forest (26%), with a minor amount of small tree and grass/pole forest. There is a significant amount of non-forest (avalanche chutes, meadows, rock) in the Riparian Reserves at the upper elevations of Tatoosh Ridge.

Table 5-1: Sixth-field 01A - Lower Muddy Fork Cowlitz River

Management Objectives	Rating	Confidence	Rationale
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 26% large tree, 14% small tree, less than 1% grass/pole and 60% non-forest. The Riparian Reserves along the Muddy Fork and its side tributaries contain well-connected stands of large and small tree forest. Non-forest areas (meadows, rock, avalanche chutes) are a significant feature at the upper elevations along the Tatoosh Range. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Good	Moderate	32% of the sixth-field is large tree forest and 48% is non-forest. Large tree connectivity is good with a large contiguous patch running north/south in the eastern half of the sixth-field. A large patch of small tree forest in the southwest corner is nearing large tree size. The southeast corner of the small tree forest patch is affected by laminated root rot infections.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-2: Sixth-field 01B - Lower Ohanapecosh River			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Little change from reference conditions. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 2.3 (Moderate) Higher road density concentrated around a campground.
2) Connectivity between watersheds	Fair	High	**Connection To Anadromous:** Natural barriers to anadromous fish. **Riparian Fragmentation Index:** 1.73 road crossings/stream mile (High)
3) Integrity of aquatic systems	Good	High	**Pool Frequency:** Fair **Woody Debris:** Good **Width/Depth**: Good **Pfankuch Stability:** Good
4) Water quality for healthy ecosystems	Good	Low	**Temperature:** Unknown, but watershed relatively unmanaged **Pollutants:** None expected
5) Appropriate sediment regime	Good	Low	**Mass Wasting:** High background rate of mass wasting, episodic volcanic mudflows; very few mgt.-related slope failures known. **Spawning Gravel:** Data gap **Fine Sediment:** Good
6) In stream flow	Good	High	**ARP:** 92% (Good) **WAR**: 11.6% (Fair) Peak flow magnitude and frequency is equivalent to reference conditions. Modification to vegetation primarily on National Forest land.
7) Floodplain function	Fair	Moderate	**Road Density in RR:** 3.4 (High) **Other Development in RR**: Ohanapecosh Campground
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	Large tree forest dominates (86%) the Riparian Reserves throughout the sixth-field.

Table 5-2: Sixth-field 01B - Lower Ohanapecosh River

Management Objectives	Rating	Confidence	Rationale
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 86% large tree, 1% small tree, 4% grass/pole and 9% non-forest. The Riparian Reserves contain well-connected large tree forest throughout the sixth-field. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Good	Moderate	82% of the sixth-field is large tree forest. The majority of the sixth-field is one large contiguous patch of large tree forest, with only a small portion along the southeast edge being fragmented by grass/pole. The portion of the sixth-field within the National Forest boundary and east of Highway 123 is affected by laminated root rot.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-3: Sixth-field 01D - Lower Summit Creek

Management Objectives	Rating	Confidence	Rationale
1) Existence of aquatic features at landscape scale	Fair	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Some increase by extension of drainage network from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 3.4 (High)
2) Connectivity between watersheds	Fair	High	**Connection To Anadromous:** Natural barriers to anadromous fish. **Riparian Fragmentation Index:** 1.29 road crossings/stream mile (High)
3) Integrity of aquatic systems	Fair	Moderate	**Pool Frequency:** Poor **Woody Debris:** Data gap **Width/Depth**: Fair **Pfankuch Stability:** Good
4) Water quality for healthy ecosystems	Fair	Moderate	**Temperature:** Unknown **Pollutants:** None expected **Other**: Riparian fragmentation high, but source waters cold
5) Appropriate sediment regime	Fair	Moderate	**Mass Wasting:** Background rate is low; scattered sideslope and road failures have delivered sediment to lower Summit Creek. **Spawning Gravel:** Data gap **Fine Sediment:** Good
6) In stream flow	Fair	High	**ARP:** 80% (Fair) **WAR**: 12.0% (Fair) Relatively high road density and riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.
7) Floodplain function	Fair	High	**Road Density in RR:** 2.5 (High) **Other Development in RR**: Summit Creek and Soda Springs Campgrounds, 78 acres of private land may impact floodplain function.

Table 5-3: Sixth-field 01D - Lower Summit Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Fair	High	The Riparian Reserves in this sixth-field have been impacted by regeneration timber harvest. A 2.5-mile section in the middle portion of the Summit Creek mainstem is dominated by grass/pole, small tree, and non-forest. Many of the side tributaries are broken by grass/pole patches.
9) Habitat to support well-distributed populations of riparian species	Poor	High	The Riparian Reserves contain 39% large tree, 12% small tree, 18% grass/pole and 31% non-forest. The mainstem of Summit Creek is heavily fragmented, being dominated by grass/pole and non-forest areas. Large tree stands in the Riparian Reserves are isolated. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Poor	High	46% of the sixth-field is large tree forest fragmented by grass/pole forest. Large tree connectivity (east-west) is present, although the corridors are narrow. The western third of the sixth-field is affected by laminated root rot.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-4: Sixth-field 01E - Upper Summit Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Little change from reference conditions. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 0.1 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** Natural barriers to anadromous fish. **Riparian Fragmentation Index:** 0.02 road crossings/stream mile (Low)
3) Integrity of aquatic systems	Good	Moderate	**Pool Frequency:** Data gap for Summit Creek **Pool Frequency:** Fair for Buesch Creek **Woody Debris:** Data gap **Width/Depth**: Good **Pfankuch Stability:** Good for Buesch Creek. Data Gap for main Upper Summit Creek.
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown **Pollutants:** None expected **Other**: Riparian fragmentation low
5) Appropriate sediment regime	Good	High	**Mass Wasting:** Several naturally-occurring avalanche tracks and earthflows in this watershed; no management-related mass wasting. **Spawning Gravel:** Data gap **Fine Sediment:** Good
6) In stream flow	Good	High	**ARP:** 98% (Good) **WAR**: 11.7% (Fair) Peak flow magnitude and frequency is equivalent to reference conditions.
7) Floodplain function	Good	High	**Road Density in RR:** 0.0 **Other Development in RR**: Minor

Table 5-4: Sixth-field 01E - Upper Summit Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	The Riparian Reserves are dominated by small tree (49%) and large tree (24%) forest, with small tree being located in the higher elevations. The small tree forest borders on becoming large tree forest in the not-too-distant future. Much of the Riparian Reserves in the high elevation plateau surrounds small lakes and ponds.
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 24% large tree, 49% small tree, 2% grass/pole and 25% non-forest. Well-connected large tree forest occupies the Riparian Reserves in the lower (west) half of the sixth-field. Small tree forest dominates the high elevation plateau in the headwaters and is approaching large tree size. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Good	Moderate	29% of the sixth-field is large tree forest, with 51% small tree forest. Large tree forest is generally confined to the southwest quadrant of the sixth-field, although the small tree forest (which is nearing large tree size) provides continuous forested connectivity east-west across the sixth-field.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-5: Sixth-field 01F - Lower Carlton Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Some increase by extension of drainage network from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 1.6 (Low)
2) Connectivity between watersheds	Fair	High	**Connection To Anadromous:** Natural barriers to anadromous fish. **Riparian Fragmentation Index:** 0.98 road crossings/stream mile (Moderate)
3) Integrity of aquatic systems	Fair	Moderate	**Pool Frequency:** Fair **Woody Debris:** Data gap **Width/Depth**: Fair **Pfankuch Stability:** Fair
4) Water quality for healthy ecosystems	Good	High	**Temperature:** 1-day max. 13.5 degrees C and 7-day max. 12.7 degrees C. **Pollutants:** None expected **Other**: Riparian fragmentation moderate, but source waters cold
5) Appropriate sediment regime	Fair	Moderate	**Mass Wasting**: Naturally-occurring avalanche tracks and debris flows are present in this watershed; scattered road failures have delivered sediment to lower Carlton Creek. **Spawning Gravel:** Poor **Fine Sediment:** Poor
6) In stream flow	Fair	High	**ARP:** 85% (Fair) **WAR**: 10.8% (Fair) Relatively high road density in RR and riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.
7) Floodplain function	Fair	High	**Road Density in RR:** 2.6 (high) **Other Development in RR**: Minor

Table 5-5: Sixth-field 01F - Lower Carlton Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Poor	High	The Carlton Creek Riparian Reserves have been impacted by regeneration timber harvest. Most of the Carlton Creek mainstem (for approx. 4 miles) is bordered by grass/pole and/or small tree forest. Some of the side tributaries are also broken by grass/pole forest.
9) Habitat to support well-distributed populations of riparian species	Poor	High	The Riparian Reserves contain 23% large tree, 19% small tree, 23% grass/pole and 34% non-forest. Large tree forest along the Carlton Creek mainstem occurs only in isolated patches, being highly fragmented by grass/pole and non-forest along most of its length. Much of the large tree forest is located in somewhat fragmented side tributaries north of Carlton Creek. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Poor	High	28% of the sixth-field is large tree forest. Large tree forest north of Carlton Creek is well-fragmented by grass/pole patches, as is the small tree forest south of Carlton Creek. Large tree connectivity is poor because of non-forest and grass/pole areas. There is very poor or non-existent connectivity to adjacent sixth-fields. The west end of the sixth-field is affected by laminated root rot.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-6: Sixth-field 01G - Upper Carlton Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Little change from reference conditions. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 0.2 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** Natural barriers to anadromous fish. **Riparian Fragmentation Index:** 0.13 road crossings/stream mile (Low)
3) Integrity of aquatic systems	Fair	Moderate	**Pool Frequency:** Fair **Woody Debris:** Data gap **Width/Depth**: Good **Pfankuch Stability:** Fair
4) Water quality for healthy ecosystems	Good	High	**Temperature:** 1-day max. 1997 temperature recording was 13.5 degrees C, while a 7-day max. was 12.7 degrees C. **Pollutants:** None expected **Other**: Riparian fragmentation low
5) Appropriate sediment regime	Good	Moderate	**Mass Wasting:** Several naturally-occurring avalanche tracks, earthflows, and rockfalls are found in this watershed; little management-related mass wasting. **Spawning Gravel:** Fair **Fine Sediment:** Poor
6) In stream flow	Good	High	**ARP:** 98% (Good) **WAR**: 12.3% (Fair) Peak flow magnitude and frequency is equivalent to reference conditions.
7) Floodplain function	Good	High	**Road Density in RR:** 0.3 (Low) **Other**: Past management activities have only occurred in the lower 1/3 of the sixth-field (non-Wilderness)

Table 5-6: Sixth-field 01G - Upper Carlton Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	The Riparian Reserves are dominated by small tree (37%) and large tree (31%) forest. Most of the Carlton Creek mainstem is bordered by large tree forest, with the high elevation Riparian Reserves containing small tree forest which will become large tree forest in the next few decades.
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 31% large tree, 37% small tree, 2% grass/pole and 31% non-forest. There is well-connected large tree and/or small tree forest throughout the Riparian Reserves. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Good	Moderate	29% of the sixth-field is large tree forest. The sixth-field is primarily dominated by two forest patches; large tree in the northwest half and small tree in the southeast and northeast portions of the sixth-field. Large tree connectivity is present to the north into sixth-field 01S. There is considerable non-forest fragmentation scattered across the entire sixth-field.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-7: Sixth-field 01H - Cyrenus Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Minor increase by extension of drainage network from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 1.5 (Low)
2) Connectivity between watersheds	Fair	High	**Connection To Anadromous:** Natural barriers to anadromous fish. **Riparian Fragmentation Index:** 0.96 road crossings/stream mile (Moderate)
3) Integrity of aquatic systems	Fair	Moderate	**Pool Frequency:** Poor **Woody Debris:** Data gap **Width/Depth**: Good **Pfankuch Stability:** Fair
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown, but temperatures are expected to be in good (<14 degrees C) condition. **Pollutants:** None expected **Other**: Riparian fragmentation moderate, but source waters cold
5) Appropriate sediment regime	Good	Moderate	**Mass Wasting:** Low background rate for mass wasting; no management-related failures known. **Spawning Gravel:** Fair **Fine Sediment:** Fair
6) In stream flow	Fair	High	**ARP:** 86% (Good) **WAR**: 11.2% (Fair) Moderate road density in RR and riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.
7) Floodplain function	Fair	High	**Road Density in RR:** 1.6 (Moderate) **Other Development in RR**: Minor

Table 5-7: Sixth-field 01H - Cyrenus Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Fair	High	The Cyrenus Creek Riparian Reserves have been impacted by regeneration timber harvest. They are dominated by small tree (51%) and grass/pole (28%) forest with much of the Cyrenus Creek mainstem being grass/pole. The overall rating is "fair", but borders on "poor". Much of the small tree forest will become large tree forest in the not-too-distant future.
9) Habitat to support well-distributed populations of riparian species	Poor	High	The Riparian Reserves contain 11% large tree, 51% small tree, 28% grass/pole and 10% non-forest. Small tree and grass/pole forest dominate the Riparian Reserves. Large tree forest is limited and isolated. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Poor	High	10% of the sixth-field is large tree forest, 59% is small tree forest. There is large tree forest in the southeast corner that connects directly to sixth-field 01E. The small tree forest is growing close to large tree size and is well-connected to the north (sixth-fields 01F and 01G).

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-8: Sixth-field 01I - Lower Cortright Creek

Management Objectives	Rating	Confidence	Rationale
1) Existence of aquatic features at landscape scale	Fair	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Some increase by extension of drainage network from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 2.8 (Moderate)
2) Connectivity between watersheds	Fair	Moderate	**Connection To Anadromous:** Natural barriers to anadromous fish. **Riparian Fragmentation Index:** 1.60 road crossings/stream mile (High)
3) Integrity of aquatic systems	Fair	Moderate	**Pool Frequency:** Fair **Woody Debris:** Fair **Width/Depth Ratio:** Good **Pfankuch Stability:** Good
4) Water quality for healthy ecosystems	Good	High	**Temperature:** 1-day max. 12.1 degrees C and 7-day max. 11.2 degrees C. **Pollutants:** None expected **Other**: Riparian fragmentation high, but source waters cold.
5) Appropriate sediment regime	Fair	Moderate	**Sediment Delivery**: Several small, naturally-occurring avalanche tracks found in this watershed; scattered road failures have delivered sediment to lower Cortright Creek. **Spawning Gravel:** Fair **Fine Sediment:** Fair
6) In stream flow	Fair	Moderate	**ARP:** 88% (Good) **WAR**: 12.6% (Fair) Low road density and high riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.
7) Floodplain function	Fair	Moderate	**Road Density in RR:** 1.6 (Moderate) **Other Development in RR**: Minor

Table 5-8: Sixth-field 01I - Lower Cortright Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Good	High	Although regeneration timber harvest has impacted the Riparian Reserves, large tree forest still dominates (57%) them, especially adjacent to the Cortright Creek mainstem. Most of the grass/pole occurs in the lower (west) end of the sixth-field along the side tributaries north of the mainstem.
9) Habitat to support well-distributed populations of riparian species	Fair	High	The Riparian Reserves contain 57% large tree, 3% small tree, 18% grass/pole and 22% non-forest. The Riparian Reserves in the upper third of the subbasin are dominated by large tree, the lower third being dominated by grass/pole and non-forest. The mainstem of Cortright Creek is well-connected by large tree forest for much of its length, but side tributaries (especially in the lower two thirds of the subbasin) are well fragmented by grass/pole. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Fair	High	61% of the sixth-field is large tree forest. The eastern third of the sixth-field contains a large contiguous patch of large tree forest that is well connected to large tree forest in adjacent sixth-fields 01E, 01J, and 01K. The western two-thirds of the sixth-field contains well fragmented large tree forest with narrow corridors of large tree connectivity. The northwest third of the sixth-field is affected by laminated root rot.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-9: Sixth-field 01J - Upper Cortright Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Little change from reference conditions. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 0.5 (Low)
2) Connectivity between watersheds	Fair	High	**Connection To Anadromous:** Natural barriers to anadromous fish. **Riparian Fragmentation Index:** 0.57 road crossings/stream mile (Moderate)
3) Integrity of aquatic systems	Fair	Moderate	**Pool Frequency:** Poor **Woody Debris:** Data gap **Width/Depth Ratio:** Good **Pfankuch Stability:** Fair
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown, but Lower Cortright is good. **Pollutants:** None expected **Other**: Riparian fragmentation moderate, but source waters are cold.
5) Appropriate sediment regime	Good	Moderate	**Mass Wasting**: Numerous naturally-occurring avalanche tracks are mapped in this watershed; a couple of small road failures have delivered sediment to Upper Cortright Creek. **Spawning Gravel:** Fair **Fine Sediment:** Poor
6) In stream flow	Good	High	**ARP:** 88% (Good) **WAR**: 9.7% (Good) Low road density and moderate riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.
7) Floodplain function	Good	High	**Road Density in RR:** 0.6 (Low) **Other Development in RR**: Minor

Table 5-9: Sixth-field 01J - Upper Cortright Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Good	High	A small portion of the sixth-field has been impacted by regeneration timber harvest. The mainstem Cortright Creek is all large tree forest with some side tributaries broken by grass/pole forest. The high elevation plateau portion of the sixth-field is largely comprised of small tree forest with most of the Riparian Reserves there being located around small lakes and ponds.
9) Habitat to support well-distributed populations of riparian species	Fair	High	The Riparian Reserves contain 43% large tree, 27% small tree, 11% grass/pole and 19% non-forest. The mainstem of Cortright Creek is contiguous large tree forest, while the side tributaries containing large tree forest are well-fragmented by grass/pole. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Fair	High	36% of the sixth-field is large tree forest, 40% small tree forest. The western half of the sixth-field is large tree forest moderately fragmented by grass/pole stands (some created by wildfire, and some by harvest). The eastern half of the sixth-field contains a patch of small tree forest nearing large tree size. Connectivity to adjacent sixth-fields would be described as fair.

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserve.

Table 5-10: Sixth-field 01K - Lower Clear Fork Cowlitz River			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Minor increase by extension of drainage network from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 1.7 (Low)
2) Connectivity between watersheds	Fair	High	**Connection To Anadromous:** Natural barriers to anadromous fish in lower 0.5 RM of the Clear Fork Cowlitz River. **Riparian Fragmentation Index:** 1.25 road crossings/stream mile (High)
3) Integrity of aquatic systems	Fair	High	**Pool Frequency:** Clear Fork: Fair, Millridge Creek: Data gap. **Woody Debris:** Clear Fork: Good, Millridge Creek: Data gap. **Width/Depth Ratio:** Clear Fork: Good, Millridge Creek: Data gap. **Pfankuch Stability:** Clear Fork: Fair, Millridge Creek: Fair.
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown, but mainstem relatively unharvested and has a glacial origin. **Pollutants:** None expected **Other**: Riparian fragmentation high, but source waters cold.
5) Appropriate sediment regime	Good	Moderate	**Mass Wasting:** Two large, deep-seated, prehistoric landslides occur in this watershed. Several areas of sidecast during construction of U.S. Hwy 12 introduced sediment to the Clear Fork Cowlitz River, but fewer slides in decades since. Sediment delivery has changed little from background rate. **Spawning Gravel:** Fair **Fine Sediment:** Fair

Table 5-10: Sixth-field 01K - Lower Clear Fork Cowlitz River			
Management Objectives	**Rating**	**Confidence**	**Rationale**
6) In stream flow	Good	Moderate	**ARP:** 90% (Good) **WAR**: 11.0% (Fair) Moderate road density in Riparian Reserves and high riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.
7) Floodplain function	Fair	Moderate	**Road Density in RR:** 1.5 (Moderate) **Other**: Moderate past timber harvest in Riparian Reserves in the lower 50% of the subwatershed.
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	The Clear Fork Riparian Reserves have been slightly impacted by regeneration timber harvest. Large tree forest is the dominant (34%) forest vegetation in the Riparian Reserves, with a significant (45%) portion comprised of non-forest area (largely rock cliffs and talus) along the Clear Fork mainstem.
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 34% large tree, 16% small tree, 5% grass/pole and 45% non-forest. Large tree forests generally well-connected throughout much its length, however non-forest is also well-connected along the entire stream length. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.

Table 5-10: Sixth-field 01K - Lower Clear Fork Cowlitz River

Management Objectives	**Rating**	**Confidence**	**Rationale**
LS) Late-successional habitat	Fair	Moderate	42% of the sixth-field is large tree forest. Much of the sixth-field is composed of large tree, with grass/pole fragmentation along its north and south edges and near White Pass. The central portion of the sixth-field contains the largest portion of large tree forest, but is moderately fragmented by natural non-forest patches. U.S. Highway 12 linearly splits the entire sixth-field. The large tree forest in the western end of the sixth-field is very narrow and bisected by U.S. Highway 12. The eastern half provides good large tree connectivity to sixth-fields 01I, 01L, and 01Q.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** All but small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-11: Sixth-field 01L - Upper Clear Fork Cowlitz River			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Little change from reference conditions. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 0.0 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** No anadromous species present due to natural barriers in the Lower Clear Fork subwatershed. **Riparian Fragmentation Index:** 0.0 road crossings/stream mile (Low)
3) Integrity of aquatic systems	Fair	Low	**Pool Frequency:** Poor **Woody Debris:** Fair **Width/Depth Ratio:** Poor **Pfankuch Stability:** Fair
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown, but similar to the Lower Clear Fork, headwaters are glacially fed. **Pollutants:** None expected **Other**: Riparian fragmentation low
5) Appropriate sediment regime	Good	Data Gap	**Mass Wasting:** Numerous avalanche tracks and naturally-occurring landslides occur in this watershed, leading to a high background rate; no management-related failures known. **Spawning Gravel:** Good **Fine Sediment:** Fair
6) In stream flow	Good	High	**ARP:** 100% (Good) **WAR**: 9.7% (Good) Peak flow magnitude and frequency is equivalent to reference conditions.
7) Floodplain function	Good	High	**Road Density in RR:** 0.0 (Low) **Other Development in RR**: None
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	Large tree forest dominates (47%) the Riparian Reserves. There is also a significant amount (40%) of non-forest (meadows, rock, avalanche chutes) in the upper elevation Riparian Reserves.

Table 5-11: Sixth-field 01L - Upper Clear Fork Cowlitz River			
Management Objectives	**Rating**	**Confidence**	**Rationale**
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 47% large tree, 13% small tree, less than 1% grass/pole and 40% non-forest. There is contiguous large tree forest throughout the Clear Fork Cowlitz mainstem. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Good	Moderate	48% of the sixth-field is large tree forest. Much of the subbasin is one large contiguous patch of large tree forest that is well-connected to large tree forest in sixth-field 01K. There are significant areas of non-forest (37%) on the western border of the sixth-field and smaller amounts in the northeast portion of the sixth-field.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-12: Sixth-field 01M - Purcell Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Fair	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Minor increase by extension of drainage network from roads in the lower portion of the sixth-field **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 1.9 (Low)
2) Connectivity between watersheds	Fair	High	**Connection To Anadromous:** Natural barriers to anadromous fish in lower 0.2 RM of Purcell Creek **Riparian Fragmentation Index:** 1.18 road crossings/stream mile (High)
3) Integrity of aquatic systems	Fair	Moderate	**Pool Frequency:** Data Gap **Woody Debris:** Fair **Width/Depth Ratio:** Good **Pfankuch Stability:** Data Gap
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown, but expected to be <16 degrees C based on headwater sources. **Pollutants:** None expected **Other**: Riparian fragmentation low
5) Appropriate sediment regime	Fair	High	**Mass Wasting:** There is a small landslide mapped in the headwaters of Purcell Creek; there have been scattered road-related failures in this watershed. **Spawning Gravel:** Data Gap **Fine Sediment:** Good
6) In stream flow	Fair	High	**ARP:** 87% (Good) **WAR**: 11.5% (Fair) Moderate road density in Riparian Reserves and high riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.
7) Floodplain function	Fair	Moderate	**Road Density in RR:** 1.7 (Moderate) **Other**: Moderate past timber harvest in Riparian Reserves in the lower 70% of the subwatershed which is not in the Goat Rocks Wilderness.

Table 5-12: Sixth-field 01M - Purcell Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Poor	High	The Purcell Creek Riparian Reserves have been impacted by regeneration timber harvest. Small tree forest dominates (46%) the Riparian Reserves, while only 4% is comprised of large tree forest. Three tributaries to Purcell Creek are dominated by grass/pole forest.
9) Habitat to support well-distributed populations of riparian species	Poor	High	The Riparian Reserves contain 4% large tree, 46% small tree, 17% grass/pole and 33% non-forest. The Riparian Reserves are dominated by small tree and grass/pole forest, with only a small patch of large tree forest that connects to the Clear Fork Cowlitz River sixth-field (01K). There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Poor	High	4% of the sixth-field is large tree forest. The only small patch of large tree forest is bisected by U.S. Highway 12. The small tree forest outside of Wilderness is fragmented by grass/pole stands. The northwest third of the sixth-field is affected by laminated root rot. Small tree forest provides the only connectivity into adjacent sixth-fields 01N and 01R.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-13: Sixth-field 01N - Dam Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Minor increase by extension of drainage from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 1.7 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** Natural barriers to anadromous fish at confluence with the Clear Fork Cowlitz River **Riparian Fragmentation Index:** 0.93 road crossings/stream mile (Moderate)
3) Integrity of aquatic systems	Data gap	N/A	**Pool Frequency:** Data gap **Woody Debris:** Data gap **Width/Depth Ratio:** Data gap **Pfankuch Stability:** Data gap
4) Water quality for healthy ecosystems	Fair	Moderate	**Temperature:** Unknown **Pollutants:** None expected **Other**: Riparian fragmentation low
5) Appropriate sediment regime	Data gap	N/A	**Mass Wasting:** Several avalanche tracks and debris flows occur in this watershed; there have been scattered, small road-related failures. **Spawning Gravel:** Data gap **Fine Sediment:** Data gap
6) In stream flow	Fair	High	**ARP:** 80% (Fair) **WAR**: 12.6% (Fair) Moderate road density in Riparian Reserves and high riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.
7) Floodplain function	Fair	Moderate	**Road Density in RR:** 1.3 (Moderate) **Other**: High past timber harvest in Riparian Reserves in the lower 45% of the subwatershed.

Table 5-13: Sixth-field 01N - Dam Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Poor	High	The Dam Creek Riparian Reserves have been heavily impacted by regeneration timber harvest. Much of the mainstem of Dam Creek is in grass/pole forest, with only minor amounts of large tree forest remaining. Only 12% of the sixth-field's Riparian Reserves are comprised of large tree forest.
9) Habitat to support well-distributed populations of riparian species	Poor	High	The Riparian Reserves contain 12% large tree, 34% small tree, 23% grass/pole and 30% non-forest. The Dam Creek mainstem is dominated by contiguous grass/pole forest, with only small isolated patches of large tree forest in a few of the side tributaries. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Poor	High	12% of the sixth-field is large tree forest. The two large tree forest patches are well-isolated. The large amount of grass/pole forest (32%) means that it will be many decades before large tree forest is the dominant forest structure. Several narrow patches of small tree habitat provide the only connectivity to adjacent sixth-fields 01K, 01N and 01P. The northwest third of the sixth-field is affected by laminated root rot.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or late-successional reserve.

Table 5-14: Sixth-field 01P - Lava Creek

Management Objectives	Rating	Confidence	Rationale
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Minor increase by extension of drainage from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 1.6 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** Natural barriers to anadromous fish at confluence with the Clear Fork Cowlitz. Waterfalls located near confluence. **Riparian Fragmentation Index:** 0.26 road crossings/stream mile (Low)
3) Integrity of aquatic systems	Good	Moderate	**Pool Frequency:** Data gap **Woody Debris:** Good **Width/Depth Ratio:** Good **Pfankuch Stability:** Fair
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown, but expected to be less than 16 degrees C due to headwaters in Goat Rocks Wilderness. **Pollutants:** None expected **Other**: Riparian fragmentation 0.26 (Low)
5) Appropriate sediment regime	Fair	Moderate	**Mass Wasting**: Although there are a few slides associated with Forest Service roads, sediment delivery is not outside background rate. **Spawning Gravel:** Poor **Fine Sediment:** Poor
6) In stream flow	Good	High	**ARP:** 96% (Good) **WAR**: 11.9% (Fair) Because of low road density in Riparian Reserves and low Riparian Fragmentation Index, peak flows are expected to be similar to historic conditions.
7) Floodplain function	Good	High	**Road Density in RR:** 0.4 (Low) **Other Development in RR**: Minor

Table 5-14: Sixth-field 01P - Lava Creek

Management Objectives	Rating	Confidence	Rationale
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	Large tree forest comprises 41% of the Riparian Reserves. A significant portion (52%) of the Riparian Reserves are comprised of non-forest in the side tributaries of the sixth-field's upper elevations.
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 41% large tree, 3% small tree, 3% grass/pole and 52% non-forest. There is contiguous large tree forest on most of the mainstem and side tributaries, with only minor fragmentation by grass/pole forest. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Fair	Moderate	43% of the sixth-field is large tree forest. The sixth-field contains a large contiguous patch of large tree forest, but that patch contains only a narrow connection to the large tree forest on sixth-field 01K. There is a large block of non-forest (46%) at the upper elevations along the south and east edges of the sixth-field.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-15: Sixth-field 01Q - Little Lava Creek			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Minor increase by extension of drainage from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 0.5 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** Natural barriers to anadromous fish at confluence with the Clear Fork Cowlitz. **Riparian Fragmentation Index:** 0.17 road crossings/stream mile (Low)
3) Integrity of aquatic systems	Fair	Low	**Pool Frequency:** Poor **Woody Debris:** Good **Width/Depth Ratio:** Poor **Pfankuch Stability:** Fair
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown, but expected to be less than 16 degrees C. Originates in Goat Rocks Wilderness. **Pollutants:** None expected **Other**: Riparian fragmentation low
5) Appropriate sediment regime	Good	Moderate	**Mass Wasting:** A few small avalanche tracks have been mapped in this watershed; no management-related slides are known. **Spawning Gravel:** Data gap **Fine Sediment:** Data gap
6) In stream flow	Good	High	**ARP:** 98% (Good) **WAR**: 12.9% (Fair) Because of low road density in Riparian Reserves and low Riparian Fragmentation Index, peak flows are expected to be equivalent to historic conditions.
7) Floodplain function	Fair	Moderate	**Road Density in RR:** 0.2 (Low) **Other**: Moderate past timber harvest in Riparian Reserves in the lower 30% of the sixth-field, located outside Wilderness.

Table 5-15: Sixth-field 01Q - Little Lava Creek

Management Objectives	Rating	Confidence	Rationale
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	Large tree forest comprises 40% of the Riparian Reserves. A significant portion (42%) of the Riparian Reserves is comprised of non-forest in the side tributaries of the sixth-field's upper elevations.
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 40% large tree, 16% small tree, 2% grass/pole and 42% non-forest. There is contiguous large tree forest on most of the mainstem and side tributaries, with only minor fragmentation by grass/pole forest. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Fair	Moderate	45% of the sixth-field is large tree forest. Large tree forest occupies the northeast half of the sixth-field. Good large tree connectivity exists to sixth-field 01K along this sixth-field's southeast quadrant. Poor large tree connectivity is present in the northeast quadrant as a result of regeneration timber harvest.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-16: Sixth-field 01R - La Wis Wis			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Fair	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Moderate increase by extension of drainage from roads. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 3.8 (High)
2) Connectivity between watersheds	Fair	High	**Connection To Anadromous:** No barriers to anadromous fish. **Riparian Fragmentation Index:** 2.30 road crossings/stream mile (High)
3) Integrity of aquatic systems	Good	High	**Pool Frequency:** Ohanapecosh: Fair, Clear Fork Cowlitz: Fair. **Woody Debris:** Ohanapecosh: Good, Clear Fork Cowlitz: Good. **Width/Depth Ratio:** Ohanapecosh: Good, Clear Fork Cowlitz: Good. **Pfankuch Stability:** Ohanapecosh: Good, Clear Fork Cowlitz: Good
4) Water quality for healthy ecosystems	Good	High	**Temperature:** Unknown, but expected to be less than 16 degrees C. Tributaries originate in Goat Rocks, Tatoosh, and William O. Douglas Wilderness areas and Mt. Rainier National Park. **Pollutants:** None expected **Other**: Riparian fragmentation low
5) Appropriate sediment regime	Fair	Moderate	**Mass Wasting:** No avalanche tracks or slides mapped in this watershed, therefore, background rate is low. A couple of road-related failures have occurred. **Spawning Gravel:** Data gap **Fine Sediment:** Good
6) In stream flow	Fair	Moderate	**ARP:** 85% (Fair) **WAR**: 11.8% (Fair) High road density in Riparian Reserves and high riparian fragmentation may be contributing to increased flow release, which is not accounted for in ARP and WAR values.

Table 5-16: Sixth-field 01R - La Wis Wis			
Management Objectives	**Rating**	**Confidence**	**Rationale**
7) Floodplain function	Fair	High	**Road Density in RR:** 4.0 (High) **Other**: High past timber harvest in Riparian Reserves outside Wilderness are expected to have altered floodplain function and quality.
8) Structural diversity of plant communities in Riparian Reserves	Fair	High	The Ohanapecosh and Clear Fork Cowlitz mainstems are dominated by large tree forest, while the tributaries south and southeast of those rivers are dominated by grass/pole and small tree forest.
9) Habitat to support well-distributed populations of riparian species	Fair	High	The Riparian Reserves contain 53% large tree, 16% small tree, 16% grass/pole and 15% non-forest. The mainstem Clear Fork Cowlitz contains contiguous large tree forest, but most of the side tributaries are well-fragmented by grass/pole forest. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Fair	High	51% of the sixth-field is large tree forest. U.S. Highway 12 bisects the sixth-field and the majority of the large tree forest is on the west/northwest side of the highway. Large tree connectivity is present to sixth-fields 01A, 01B, 01D, and 01K, but the connections are narrow because of past regeneration timber harvest. La Wis Wis campground is located between the Clear Fork Cowlitz and the highway. Much of this sixth-field is affected by laminated root rot.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-17: Sixth-field 01S - Upper Ohanapecosh River			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Little change from reference conditions. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 0.3 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** Natural barriers to anadromous fish **Riparian Fragmentation Index:** .01 road crossings/stream mile (Low)
3) Integrity of aquatic systems	Data gap	N/A	**Pool Frequency:** Data gap **Woody Debris:** Data gap **Width/Depth Ratio:** Data gap **Pfankuch Stability:** Data gap
4) Water quality for healthy ecosystems	Good	Low	**Temperature:** Unknown, but watershed relatively unmanaged. **Pollutants:** None expected
5) Appropriate sediment regime	Good	Moderate	**Mass Wasting:** A number of avalanche tracks, landslides, and volcanic mudflows are known from this rugged watershed; a few road-related failures have also occurred, but the resulting sediment delivery is indistinguishable against the very high background rate. **Spawning Gravel:** Data gap **Fine Sediment:** Data gap
6) In stream flow	Good	High	**ARP:** 100% (Good) **WAR**: 9.9% (Good) Peak flow magnitude and frequency is equivalent to historical conditions. Little modification inside the National Park.
7) Floodplain function	Good	Moderate	**Road Density in RR:** 0.5 (low) **Other Development in RR**: Minor
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	Large tree forest (72%) dominates the Riparian Reserves, except for the high elevation headwaters where non-forest areas are dominant.

Table 5-17: Sixth-field 01S - Upper Ohanapecosh River

Management Objectives	Rating	Confidence	Rationale
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 72% large tree, 1% small tree, 1% grass/pole and 26% non-forest. Large tree forest is contiguous throughout the Riparian Reserves, except for the high elevation headwaters where non-forest areas are dominant. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Good	Moderate	59% of the sixth-field is large tree forest. A very large contiguous block of large tree forest covers most of the sixth-field. Highway 123 bisects the sixth-field from north to south. A significant amount of non-forest (36%) occurs in the headwaters of the subbasin (north edge).

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Table 5-18: Sixth-field 01T - Upper Muddy Fork Cowlitz River			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale	Good	High	**Perennial Streams**: Little change from reference conditions. **Intermittent Streams**: Little change from reference conditions. **Wetlands:** Little change from reference conditions. **Lakes and Ponds:** Little change from reference conditions. **Road Density**: 0.3 (Low)
2) Connectivity between watersheds	Good	High	**Connection To Anadromous:** Blocked outside watershed, otherwise no change from reference. **Riparian Fragmentation Index:** 0.02 road crossings/stream mile (Low)
3) Integrity of aquatic systems	Data gap	N/A	**Pool Frequency:** Data gap **Woody Debris:** Data gap **Width/Depth Ratio**: Data gap **Pfankuch Stability:** Data gap
4) Water quality for healthy ecosystems	Good	Low	**Temperature:** Unknown, but watershed relatively unmanaged **Pollutants:** None expected
5) Appropriate sediment regime	Good	High	**Mass Wasting:** A very large landslide, numerous avalanche tracks, and volcanic mudflows are known from this rugged watershed; a few road-related failures have also occurred, but the resulting sediment delivery is indistinguishable against the very high background rate. **Spawning Gravel:** Data gap **Fine Sediment:** Data gap
6) In stream flow	Good	High	**ARP:** 100% (Good) **WAR**: 10.6% (Fair) Peak flow magnitude and frequency is equivalent to historical conditions. Little modification inside the National Park.
7) Floodplain function	Good	Moderate	**Road Density in RR:** 0.23 (Low) **Other Development in RR**: Little known development in the subwatershed.

Table 5-18: Sixth-field 01T - Upper Muddy Fork Cowlitz River			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities in Riparian Reserves	Good	Moderate	Large tree forest (53%) comprises much of the Riparian Reserves, with much of the remaining reserves (45%) being comprised of non-forest areas in the high elevation headwaters on the southeast flank of Mt. Rainier.
9) Habitat to support well-distributed populations of riparian species	Good	Moderate	The Riparian Reserves contain 53% large tree, 1% small tree, less than 1% grass/pole and 45% non-forest. The lower section of the Muddy Fork Cowlitz and Nickel Creek contain contiguous large tree forest. The upper section of the Muddy Fork Cowlitz and Stevens Creek consist largely of non-forest, with isolated patches of disconnected large tree forest. There is no data available on the presence or absence of riparian-dependent species in this sixth-field.
LS) Late-successional habitat	Good	Moderate	35% of the sixth-field is large tree forest, 63% is non-forest. Large tree forest occurs in a large consolidated block confined to the southeast corner of the subbasin (mostly east of the Muddy Fork Cowlitz). Non-forest areas on the southeast flank of Mt. Rainier dominate the high elevation west and northwest portions of the sixth-field. Stevens Canyon Road bisects the southern half of the large tree block. Excellent large tree forest connectivity is present to sixth-fields 01A, 01B, and 01S.

Comments:

ACS #8: See Map 19, 1998 Vegetation Structure in Riparian Reserves.

LS Habitat: See Map 10, Current (1998) Vegetation Structure. **NOTE:** Except for small portions of two sixth-fields (01A and 01K), all sixth-fields are located in either National Forest Wilderness, Mt. Rainier National Park, or Late-Successional Reserves.

Chapter 6 - Management Recommendations

Introduction

The purpose of this chapter is to identify those management activities which will contribute to closing the gap between the present condition and the desired future condition of this watershed. All proposed activities will be consistent with the guidelines of the Gifford Pinchot Land and Resource Management Plan, as amended by the *Northwest Forest Plan*.

Historic/reference and current conditions of the watershed were described in Chapter 3. In order to best recommend the appropriate management activities that will close the gap between the present condition and the desired future condition of this watershed, we first need a picture of that desired future condition. It is important to note that current management direction plays a large role in defining future conditions. While we may desire to restore certain portions or elements of the watershed to conditions similar to those in historic times, the entire watershed will not reflect historic conditions.

Recommendations are provided at both the fifth-field watershed scale spanning the entire Clear Fork Cowlitz River watershed and at the sixth-field scale. This will help to avoid duplication of broad recommendations, while listing specific recommendations in sixth-field tables.

The following is a description of the desired future condition for the Clear Fork watershed.

Desired Future Condition

Vegetation

There are five broad categories of management direction that drive the course of vegetation development in the Clear Fork watershed: Administratively Withdrawn Areas, Congressionally Reserved Areas, Late-Successional Reserves, Riparian Reserves, and Matrix.

Administratively Withdrawn Areas

Administratively Withdrawn Areas within the Clear Fork watershed consist of three Management Area Categories (MAC's): Scenic River (NA), Developed Recreation (2L), and Administrative Sites (3W). These areas are not managed to provide timber outputs; there is no scheduled timber harvest. Vegetation in these areas (with exception of the Utility Sites and Corridors MAC) is generally the product of natural disturbance and succession. Fire (natural or human caused) is aggressively suppressed during periods of high fire hazard. Vegetation is varied in size, age, and species; ranging from natural openings of young immature trees or herb/shrub species to stands of mature and old-growth trees. Over time, forest stands in these allocations are expected to produce large trees, snags, multiple-layered canopies, and large coarse woody debris on the forest floor. Average tree diameters will exceed 21 inches on the majority of the acres. Trees will be smaller in stands located on less productive sites. Douglas-fir, western hemlock, or Pacific silver fir will be the dominant large trees in most of these stands. The proportion of each species is determined by elevation and aspect. Other associated tree species may include red alder, black cottonwood, western white pine, bigleaf maple, and Pacific yew (at lower elevations); and noble fir, mountain hemlock, subalpine fir, western white pine, and Engelmann spruce (at higher elevations). A relatively high percentage of the area (likely greater than 75%) in most of the MAC's is expected to remain in (or develop into) the large tree structural stage.

Congressionally Reserved Areas

Congressionally Reserved Areas consist of only one MAC, Wilderness (WW). The desired condition in Wilderness is the retention of primitive characteristics which are affected primarily by the forces of nature. No human-initiated vegetation management activities are allowed. Naturally-initiated fire may be allowed to burn uncontrolled under very specific conditions. Vegetation is the result of natural disturbance and succession. Desired vegetation conditions are similar to those described above. Large tree stands may be less frequent if fires are allowed to play a larger role in the area. Alpine areas where other vegetation predominates are also included.

Late-Successional Reserves

Late-Successional Reserves (LSR's) consist of lands set aside to protect and enhance conditions of late-successional and old-growth ecosystems. Late-Successional Reserves within the Clear Fork watershed consist of General Late-Successional Reserves (LS), Mountain Goat Winter Range (QL), and Mountain Goat Summer Range (ML). The long-term objective is to provide for the protection of current, and enhance the development of future, late-successional habitat for all species that depend on it. The goal of wildfire suppression is to limit the size of all fires. Regeneration harvest is prohibited, although it may have occurred in the past. Precommercial and commercial thinning may occur in stands up to 80 years of age if the purpose is to benefit the creation and/or maintenance of late-successional forest conditions. Future vegetation will be primarily the result of natural disturbance and succession, except in past harvest plantations or natural stands less than 80 years of age where thinnings will occur. The desired future condition of vegetation in LSR is similar to that described above for Administratively Withdrawn Areas.

Riparian Reserves

Riparian Reserves provide an area along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Riparian Reserves are used to maintain and restore riparian structures and functions of streams, confer benefits to riparian-dependent and associated species other than fish, enhance habitat conservation for organisms that are dependent on the transition zone between upslope and riparian areas, improve travel and dispersal corridors for many terrestrial animals and plants, and provide for greater connectivity of the watershed. Riparian Reserves also serve as connectivity corridors among the Late-Successional Reserves.

Matrix

Matrix within the Clear Fork watershed consists of the following MAC's: General Forest (TS), Deer and Elk Winter Range (ES), Visual Emphasis (VL, VM), Mountain Goat Winter Range (QM, QX), Mountain Goat Summer Range (MM, MX), and Scenic Rivers (NL). These allocations all have some level of scheduled timber harvest based on predetermined rotation ages. The timber harvests will include both thinnings and regeneration harvests. Fire is aggressively suppressed during periods of high fire hazard. As a result, the landscape within these allocations will consist of a mosaic of stands of many different sizes and ages at any one point-in-time. Stand sizes will range from grass/pole to large tree and will vary widely over the landscape, consistent with other resource objectives and limitations. The percent distribution of grass/pole, small tree, and large tree structural stages will vary over time, with each represented. Stand stocking, canopy closure, and structural development across the landscape will vary depending on the MAC and the amount and types of thinning (precommercial and commercial) and regeneration treatments. Structural diversity within stands will be affected by Riparian Reserves, TES/Survey and Manage species, aggregate retention patches, unthinned patches, and created canopy gaps. The tree species mix will be similar to that described for Administratively Withdrawn Areas. The desired future condition for Matrix land is specified by the MAC of that particular area.

Wildlife and Botanical Resources

The desired future condition relative to wildlife and botanical resources is to maintain viable populations of all native and desired non-native species known or suspected to occur within the watershed.

Habitat enhancement projects would be encouraged to maintain a diversity of habitat conditions. Projects may include prescribed or natural fire, meadow restoration, snag creation, increasing the amount of coarse woody debris, and revegetation with native species.

Within Late-Successional Reserves (LSR's), current grass/pole and small tree stands will be silviculturally treated, where appropriate, to develop large tree character at a quicker rate. Some roads within LSR's may be allowed to close naturally or could be mechanically obliterated. Within several decades, these factors would increase the amount of interior forested habitat within LSR's, thereby improving habitat conditions for dependent species, particularly those requiring large home ranges.

Populations of noxious weeds would be mapped and prioritized for treatment to contain and control established infestations. New infestations would have early treatment to contain the spread, and priority would be given to prevent the introduction of new species.

Within the National Forest deer and elk biological winter range (outside LSR's), optimal cover acreage would be at specified levels and well-distributed across the winter range. Forage openings would also be well-distributed and in amounts as specified by current GP Forest Plan guidelines.

In mountain goat ranges, optimal cover acreage would be maintained. In thermal cover stands, innovative commercial thinning approaches could be used to advance succession of stands to an optimal cover condition. Thinning would only be applied if the stands would benefit from a treatment. A fire management plan should be drafted to ensure continued viability of meadows and other goat foraging sites.

Threatened and endangered species surveys would be conducted to monitor population trends and recommend management actions. Special habitat sites would be located and protected where appropriate. The Forest Service would also continue to seek partnerships with individuals, county and state governments, and other federal agencies for species surveys, habitat improvements and general sharing of knowledge.

Aquatic Resources

The aquatic component of this analysis is based on data available from state, private, and U.S. Forest Service stream surveys, the current condition, and the ability to meet the Desired Future Condition (DFC) as defined in the National Marine Fisheries Service Matrix of Pathways and Indicators, a U.S. Fish and Wildlife Service document called *A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale*, the GP Forest Plan, Amendment 11, and state and federal laws and interpretation of ACS objectives.

The desired future condition of the various physical components of streams is evaluated primarily using NMFS Guidelines. Prior to 1989, LWD was rated as follows: < 25% of the stream reach containing LWD was considered "poor"; > 25% of the stream reach containing one piece of wood was considered "moderate"; and >25% of the stream reach containing multiple pieces of wood (abundant LWD) was considered "good". At that time, specific protocols regarding length and diameter measurements had not yet been developed. Since 1989, standards such as 80 or more pieces of LWD per mile are considered "good"; 40 - 80 pieces, "moderate"; and < 40 pieces, "poor". Note that these criteria apply only to streams west of the Cascade crest. Large woody debris was defined by the National Marine Fisheries Service (1996) as 24 inches in diameter and at least 50 feet in length. Evaluation of width-to-depth ratios was based on Rosgen's (1994) stream channel classification.

Water temperatures below 16° Celsius and dissolved oxygen standards above 9.5 mg/l for class AA waters are commonly used state standards. The desired future condition for peak flow is to achieve an ARP value > 85% and WAR thresholds < 10% as defined in the Gifford Pinchot Cumulative Assessment Report (USDA Forest Service 1988) and the Washington State Peakflow Module (1988). Other desired future conditions for the aquatic component are to meet the ACS objectives (see Chapter 5 of this document for interpretation of ACS objectives), and to meet NMFS and USFWS matrix values.

Sediment delivery to streams via erosion and mass wasting processes has been, and will continue to be, a natural part of the aquatic system. The rates of sediment delivery varied substantially during natural (pre-management) conditions, with relatively higher rates occurring during times of disturbance such as wildfire, flood, earthquake, and volcanic eruption, and lower rates delivered during "quiet" times between disturbance events. With the advent of intensive forest management during the 1950's, road construction and timber harvest have often contributed to sediment delivery rates many times greater than what occurred under most natural conditions, except perhaps during the more extreme disturbance events. As long as roads exist on steep and rugged slopes within the Clear Fork Cowlitz River basin, sediment delivery rates will continue to be elevated above the background rate. However, aquatic systems in the basin have experienced many disturbances, and are resilient and adaptable to change. What is desired, is a reduction in the chronic, near-annual rates of sediment delivery, and a reduction in the magnitude of sediment pulses that occur during the increasingly frequent major flood events.

It is desired that stream channel systems and the associated floodplain areas are not blocked as a result of management activities. When reviewing the timing, variability, and duration of floodplain inundation, 2-year peak flow levels were used for all tributaries of the mainstem Clear Fork Cowlitz River, while 100-year peak flow levels were used along the Clear Fork Cowlitz River itself. The desired future condition of Riparian Reserves is continued large tree development. However, some of the privately owned land may never reach this stage, due to road systems and residential development.

Human Uses within the Watershed

Lands within the Clear Fork watershed will provide a variety of human uses in a variety of vegetation and land form settings.

Road facilities provide access for passenger and high clearance vehicles to a variety of developed and dispersed recreation settings (ie. lakes, streams, trailheads). Where necessary to allow for reliable access, road surface drainage is improved or roads are closed and converted to trails. Roads to trailheads, dispersed camping areas, and other popular recreation sites are maintained to meet user needs per direction in the Access and Travel Management plans (Appendix A).

Winter and summer trails provide access to a variety of destinations and scenery. Trail facilities are well-maintained for intended users. Trails that are difficult to maintain and that receive light use may be abandoned. Recreation access to areas with semi-primitive and primitive settings will be in greatest demand. These include areas without roads or other evidence of management activities where existing and proposed trails provide access.

Use within designated Wilderness will be managed to provide opportunities for solitude and to minimize physical site impacts. Overnight use adjacent to Wilderness lakes and streams will be managed to protect riparian vegetation and maintain high water quality while providing for reasonable access. Fire will be allowed to burn under certain conditions to encourage natural vegetation patterns.

Vegetative scenery from primary roads in the watershed is varied, and roadside vegetation should be managed to allow for a variety of viewing opportunities into stands. Natural looking stands and vegetative landscape will dominate views from road and trail travel corridors.

Recommendations at the Fifth-Field Watershed Scale

Recommendations provided here span the sixth-field subwatersheds and are provided to eliminate the need for duplication within the sixth-field management recommendation tables.

Boundary Changes of Riparian Reserves

This watershed analysis does not identify site-specific, or general changes in Riparian Reserve boundaries. Interim Riparian Reserves, as they are prescribed in the *Northwest Forest Plan*, are recommended based on the evaluation of each sixth-field relative to ACS objectives 1 through 9. Deviation from this course should only occur after thorough review by an interdisciplinary team comprised of a hydrologist, soil scientist, botanist, wildlife biologist, fisheries biologist, and silviculturist. The most likely streams to have changes are Class IV streams. It is likely that project-specific surveys will identify many Class IV streams. Any changes to Riparian Reserves should be based on "on-the-ground" reviews, and determining that such a change would not affect maintenance of the Aquatic Conservation Strategy objectives. Any changes to Riparian Reserve boundaries are to be evaluated and documented as part of the NEPA process.

Regeneration Harvest Within Riparian Reserves

Pages C-31 and C-32 of the ROD describe conditions of acceptable regeneration harvest and salvage activities within Riparian Reserves. Recommendations other than those identified in the *Northwest Forest Plan* should be developed through interdisciplinary, site-specific analysis.

Commercial Thinning Within Riparian Reserves

Commercial thinning may be appropriate within Riparian Reserves when the harvest activities are *specifically designed to accelerate the improvement of aquatic/wildlife conditions and/or the development of late-successional corridors.* Site-specific review by an interdisciplinary team should be the mechanism by which such prescriptions are recommended. Measures to minimize disturbance to soil, vegetation, and aquatic features should be identified prior to implementation.

Other Silvicultural Activities (Inside and Outside of Riparian Reserves)

Other silvicultural activities (including precommercial thinning, pruning, fertilization, and conifer release) should be reviewed by an interdisciplinary team to develop joint proposals for such activities both inside and outside of Riparian Reserves. Within Riparian Reserves, proposals should be designed to improve aquatic conditions and promote the Aquatic Conservation Strategy objectives.

Connectivity of Riparian Reserves

Restoration activities in the Clear Fork watershed should initially focus on restoring connectivity in Riparian Reserves associated with lower Ohanapecosh River, lower Clear Fork Cowlitz River, Millridge Creek, lower Summit Creek, lower Cortright Creek, and Purcell Creek. Restoring connectivity along these watercourses will provide habitat and travel corridors which lead throughout the watershed. Connectivity would be provided between the LSR's. These corridors would also provide connectivity to the adjacent watersheds. Restoration could include planting riparian species, fencing riparian area in pastures, precommercial and commercial thinnings designed to promote late-successional habitat conditions, and snag and coarse woody debris placement and/or creation.

Roads

Substantial cumulative hydrologic effects observed in portions of this watershed are largely attributable to erosion and mass wasting associated with roads. It is apparent that a need exists to reduce the impacts of these roads on aquatic conditions. The challenge is how best to effectively meet management goals while simultaneously reducing the hydrologic effects that an extensive road network on steep slopes produces.

In making these determinations, it is important to note that harvest opportunities under the current management guidelines are limited in this fifth-field watershed over at least the next 10 years. In particular, regeneration harvest will be limited to the small amount of Matrix in the fifth-field because most of the watershed consists of Wilderness, Mount Rainier National Park, and Late-Successional Reserves (LSR's), which do not allow regeneration harvest. In addition, there are several flood-damaged sites within the fifth-field watershed, and it is a concern that the existing condition of the road system is susceptible to severe storm events that may occur in the future. Continued storm damage in the future may occur at a rate that we are not able to repair on a sustainable basis, and cumulative effects to the watershed could continue at an undesirable rate.

Taking all of these factors together, a cost-effective alternative worth considering is the concept of placing portions of the road network into "storage". By this, we mean determining which roads will not be needed for a given time (e.g., 10-25 years), evaluating those roads to determine which portions are at risk of some type of damage from storm events, and weatherizing those portions of road to withstand a span of time with no maintenance, such that storm damage during that time is minimized. It is anticipated that main trunk roads and other roads actually needed over the next 10-25 years will remain open and be maintained. The emphasis here is to reduce the risk of monetary and ecological costs from leaving roads open that won't be used for management activities during the 10-25 year window.

The sequence of steps required to implement this idea of road system storage might look something like:

1. ATM Phase II Road Condition Surveys were completed in this watershed in 1996. These surveys identified "at risk" segments of roads, and will help prioritize roads needing stabilization or decommissioning. An evaluation and update of precommercial and commercial thinning needs in the watershed should be completed in order to determine which roads will be needed to accomplish this work.

2. Review and revise the existing Access and Travel Management (ATM) plan to reflect new information from road condition surveys and timber management assessments. When planning for road stabilization needs, be sure to consult with adjacent private and commercial landowners regarding their needs for access and cost-share agreements.

3. Repair roads needed for Timber Stand Improvement (TSI) work and begin precommercial and commercial thinning. On roads determined to not be needed for TSI work, evaluate, design, and begin stabilization work (e.g., remove culverts, pullback unstable shoulder, install waterbars, etc), on roads or segments of roads determined to pose some risk to aquatic conditions. Roads not posing any risk will be dealt with as suggested in the ATM Plan.

4. As TSI work is completed along given roads, design and implement necessary stabilization work on those road systems as well. The idea is to deal with stability concerns as we proceed with TSI work.

5. Maintain records of construction needs for each "weatherized" road (e.g., size and number of culverts needed per road, estimated quantities of material needed, etc). The idea is to have a rough design on the shelf for when a given road is reopened in the future, while recognizing that future construction will need specific survey and design.

Wilderness and Trails

Access to trailheads has become a key issue as road maintenance becomes problematic in many areas. Opportunities to relocate trailheads, where the relocation can improve the Forest Service's ability to maintain access and/or provide additional high quality trail miles, should be examined.

In order to preserve Wilderness values, access to non-trailed areas along the Wilderness boundary should be discouraged. In some areas, road access near the Wilderness boundary has resulted in development of user-built trails into Wilderness, short cut routes into system trails, and increased use and associated physical impacts in areas that previously exhibited few physical impacts.

Several trail development opportunities have been listed in the Roads-to-Trails Assessment (1995) and additional opportunities may exist. An inventory of additional trail possibilities may be appropriate with emphasis on low elevation opportunities close to U.S. Highway 12. This may involve cooperative ventures with state and private landowners along the U.S. Highway 12 corridor.

Dispersed Recreation

There is currently minimal documentation of dispersed recreation activities and associated dispersed site impacts. Dispersed use can include hunting, fishing, camping, picnicking, nature study, berry picking, etc. An inventory of dispersed sites indicating relative site impacts, type of use and site density by area is recommended to help determine the extent of use, and need for management. A primary consideration is preservation of dispersed recreation opportunities either by maintaining access to areas of significant dispersed use and/or development of additional dispersed opportunities to offset losses which may have occurred due to changes in access.

Special Forest Products

There are many opportunities to increase the harvest and gathering of special forest products while providing for their long-term sustainability. The Clear Fork watershed has lands where new harvest opportunities should be explored, including those within Late-Successional Reserves (LSRs) following the Forestwide Late-Successional Reserve Assessment (USDA Forest Service 1997e). Where feasible, stewardship forest product contracts should be established. They allow for more close administration of on-the-ground harvesting. There is also interest in the local community to expand the gathering, storage, and processing of forest products to provide additional local employment.

Recommendations at the Sixth-field Scale

The following tables contain recommendations and concerns related to specific management activities for each sixth-field watershed. It is important to note that the recommendations are based on current resource conditions and management direction that are not expected to change dramatically. While a sixth-field may not have identified opportunities for certain management activities now, it does not preclude future opportunities.

Table 6-1: 01A - Lower Muddy Fork Cowlitz River

89% Wilderness, 9% Late-Successional Reserves, 2% Matrix

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no regeneration harvest opportunities. Matrix (ES and NL) - Only 2% of this watershed is Matrix of which approximately 50% has already been regeneration harvested. Therefore, approximately 50% of the Matrix land is eligible for regeneration harvest. Harvest opportunities are extremely limited in the next 10 years.	Wildlife concerns: The LSR is entirely within CHU WA-37. There is one known spotted owl pair within the sixth-field. The Matrix land is within marbled murrelet zone 2 and deer and elk biological winter range. The Matrix land borders anadromous fish habitat and is listed steelhead habitat. Aquatic concerns in Matrix: riparian fragmentation (RM 0 - 0.5), lack of LWD, unstable stream channel types (D0-5/G3), sediment transport and storage (RM 0 - 0.5, see Table 4-6).
Commercial Thinning	Matrix - There will be approximately 50 acres of managed stand thinning available between 2005 and 2010. LSR - There will be approximately 25 acres of managed stand thinning available in the next 2 years. Wilderness - No commercial thinning opportunities.	Wildlife concerns: One known spotted owl pair and critical habitat exist within the sixth-field. Marbled murrelet zone 2 and deer and elk biological winter range are located within Matrix. Lack of LWD in Matrix.
Roads	Restoration opportunities exist on Forest Road 1270.	Slight increase in mass wasting potential compared with reference conditions.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	Reconstruct/stabilize trail tread - Tatoosh Lakes Trail 161B. Reconstruct portion of Tatoosh Trail 161 to control rutting/erosion. Manage use at Jody's Bridge area to minimize sanitation problems and shoreline impacts.	Water quality - Jody's Bridge area. Jody's Bridge area is within listed steelhead habitat.
Other Issues	Prevent illegal harvest of special forest products in Tatoosh Wilderness. Survey Muddy Fork Cowlitz and named tributaries to establish reference conditions.	Illegal harvest of beargrass and salal in Tatoosh Wilderness. Lack of stream survey data for this sixth-field.

Table 6-2: 01B - Lower Ohanapecosh River

72% Wilderness, 28% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	Wilderness (Mount Rainier National Park) and LSR - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - limited opportunities exist (probably less than 100 acres within the next 10 years) in older managed stands.	Wildlife concerns: The LSR is entirely within CHU WA-37. Approximately 33% of the sixth-field is deer and elk biological winter range. The west half of the sixth-field is in marbled murrelet zone 2. Some allocated mountain goat winter range in the eastern portion of the LSR. Aquatic concerns: riparian fragmentation (RM 0.9 - 1.1), moderate road density (2.3 miles of road per square mile), high road density in Riparian Reserves (3.4 miles of road per square mile), high number (1.73) of road crossings per stream mile, floodplain concerns (RM 0.5 - 1.5), sediment transport and storage concerns (RM 0.5 - 1.2).
Roads	There may be opportunities to reduce open road density within deer and elk biological winter range.	Wildlife concerns: At the watershed scale, open road densities exceed standards and guidelines set forth in the GPLRMP for deer and elk biological winter range.
Other Restoration	Reduce number of road crossings per stream mile. Reduce road density within the sixth-field and Riparian Reserves.	High number (1.73) of road crossings per stream mile. Moderate road density (2.3 miles of road per square mile) in the sixth-field. High road density in Riparian Reserves (3.4 miles of road per square mile). Sediment transport and storage concern (RM 0.5 - 1.2 of the Ohanapecosh River).
Recreation and Trails	None identified at this time.	None identified at this time.

Table 6-2: 01B - Lower Ohanapecosh River

72% Wilderness, 28% Late-Successional Reserves

Activity	Recommendations	Concerns
Other Issues	Survey Ohanapecosh River and named tributaries to establish reference conditions.	Several suspected spotted owl activity centers within National Park lands in this sixth-field. Lack of stream survey data for this sixth-field.

Table 6-3: 01D - Lower Summit Creek

4% Wilderness, 93% Late-Successional Reserves, 3% Private, < 1% Administratively Withdrawn

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - limited opportunities exist (probably less than 160 acres within the next 10 years) in older managed stands.	Wildlife concerns: Approximately 90% of the sixth-field is within CHU WA-37. One known spotted owl pair exists with the sixth-field. Approximately 600 acres of deer and elk biological winter range exists in the far west portion of the sixth-field. Aquatic concerns: moderate peak flows, riparian fragmentation (RM 0.5 - 1.4), high road density (3.4 miles of road per square mile), high road density in Riparian Reserves (2.5 miles of road per square mile), high number (1.29) of road crossings per stream mile, floodplain concerns (RM 0 - 0.4), insufficient LWD (RM 0.2 - 0.4 and 0.7 - 2.5), channel sensitivity concerns (RM 0 - 2.45, A3) and sediment transport and storage concerns (RM 0 - 2.45). One TES plant site exists within the sixth-field.
Roads	There may be opportunities to reduce open road density within deer and elk biological winter range. Repair road failures along 4510 road system.	Wildlife concerns: At the watershed scale, open road densities exceed standards and guidelines set forth in the GPLRMP for deer and elk biological winter range. Road failures along the 4510 road system (washed out culverts and cutbank failures). Moderate rate of mass failures compared with reference conditions within the watershed.

Table 6-3: 01D - Lower Summit Creek

4% Wilderness, 93% Late-Successional Reserves, 3% Private, < 1% Administratively Withdrawn

Activity	Recommendations	Concerns
Other Restoration	Reduce number of road crossings per stream mile. Reduce road density within the sixth-field and within Riparian Reserves. Recruit LWD into RM 0.2 - 0.4 and 0.7 - 2.5. Potential stream channel restoration.	High number (1.29) of road crossings per stream mile. High road density (3.4 miles of road per square mile). High road density in Riparian Reserves (2.5 miles of road per square mile). Sediment transport and storage concern (RM 0 - 2.45 of the Ohanapecosh). Insufficient LWD (RM 0.2 - 0.4 and 0.7 - 2.5), channel sensitivity concerns (RM 0 - 2.45, A3).
Recreation and Trails	Construct trailhead parking area at Soda Springs campground to serve the Cowlitz Trail. Upgrade/reconstruct Summit and Soda Springs Campgrounds to improve traffic flow and campsite definition.	No trailhead parking contributes to campground congestion. Campsites at both campgrounds are poorly defined.
Other Issues	None identified at this time.	None identified at this time.

Table 6-4: 01E - Upper Summit Creek

97% Wilderness, 3% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	Wilderness and LSR - no opportunities exist.	None identified at this time.
Commercial Thinning	Wilderness - no opportunities exist. LSR - no opportunities within the next 10 years.	None identified at this time.
Roads	None identified at this time.	None identified at this time.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	Reconstruct portions of Cowlitz Trail 44, Jug Lake Trail 43, Judkin Trail 47, Kincaid Trail 42 and Pothole Trail 45 to stabilize trail tread and control erosion.	Trail erosion.
Other Issues	None identified at this time.	None identified at this time.

Table 6-5: 01F - Lower Carlton Creek

100% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - very limited opportunities exist (probably less than 30 acres within the next 10 years) in older managed stands.	Wildlife concerns: Approximately 75% of the sixth-field is in CHU WA-37. Approximately 50% of the sixth-field is mountain goat winter range. Aquatic concerns: moderate peak flows (85% ARP), scattered riparian fragmentation (RM 0 - 1.4), high road density in Riparian Reserves (2.6 miles of road per square mile), moderate number (0.98) of road crossings per stream mile, insufficient LWD (RM 0.1 - 0.9), moderate - high channel sensitivity (RM 3.3 - 4.3, C3).
Roads	Repair bridges on Forest Road 44. Repair wash-outs and small cutbank failures along the Forest Road 44 system.	Forest Road 44 is closed after milepost 1.68 (the Hornquist Bridge) because two bridges have failed, the Hornquist Bridge and a bridge at milepost 5.37). Forest Roads 44, 4400026 and 4400064 - some washed out culverts and small cutbank failures.
Other Restoration	Reduce number of road crossings per stream mile. Reduce road density within Riparian Reserves. Recruit LWD into RM 0.1 - 0.9. Potential stream channel restoration.	Moderate number (0.98) of road crossings per stream mile. High road density in Riparian Reserves (2.6 miles of road per square mile). Insufficient LWD (RM 0.1 - 0.9), channel sensitivity concerns (RM 3.3 - 4.3, C3).
Recreation and Trails	Establish access to Carlton Trail 22 (possibly utilize a combination of relocating trail and road sections and new trail construction to connect the Carlton Trail 22 to the Kincaid Trail 42 - utilize the Kincaid/Soda Springs 44A trailhead). Reconstruct portion of the Kincaid Trail to control rutting/erosion.	Road bridges have snow damage which prevents vehicle access to current trailhead. Trail rutting and erosion on portion of the Kincaid Trail.

Table 6-5: 01F - Lower Carlton Creek

100% Late-Successional Reserves

Activity	Recommendations	Concerns
Other Issues	Resurvey streams in sixth-field for LWD.	Lack of LWD data for streams within the watershed.

Table 6-6: 01G - Upper Carlton Creek

69% Wilderness, 31% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - The only possible thinning opportunities would be in older managed stands, but it is very unlikely that any of those stands will reach commercial size within the next 10 years.	Wildlife concerns: Approximately 20% of the sixth-field is in CHU WA-37. One known spotted owl pair exists within the sixth-field. Some allocated mountain goat winter range in the northwest portion of the sixth-field. Aquatic concerns: riparian fragmentation (RM 1.4 - 1.8).
Roads	None identified at this time.	None identified at this time.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	Construct approximately 1 mile of trail to connect existing Carlton Trail 22 to abandoned road section between failed bridges at mileposts 1.68 and 5.37 on Forest Road 44 to provide a connection to the Kincaid/Soda Springs 44A trailhead accessed by Forest Road 4510.	Failed bridge at milepost 5.37 prevents access to Carlton Trail (last 1 mile of Forest Road 44 beyond the failed bridge is abandoned).
Other Issues	None identified at this time.	None identified at this time.

Table 6-7: 01H - Cyrenus Creek

100% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - very limited opportunities for thinning (probably 40 acres or less within the next 10 years) in older managed stands.	Wildlife concerns: Approximately 33% of the sixth-field is in CHU WA-37. Aquatic concerns: moderate peak flows, riparian fragmentation (RM 0.1 - 1.2), moderate road density in Riparian Reserves (1.6 miles of road per square mile), moderate number (0.96) of road crossings per stream mile, scattered insufficient LWD (RM 0 -0.7), and sediment transport and storage concerns (RM 0 - 0.7).
Roads	None identified at this time.	None identified at this time.
Other Restoration	Reduce number of road crossings per stream mile. Reduce road density within Riparian Reserves. Recruit LWD into RM 0 - 0.7.	Moderate number (0.96) of road crossings per stream mile. Moderate road density in Riparian Reserves (1.6 miles of road per square mile). Scattered insufficient LWD (RM 0 -0.7).
Recreation and Trails	Reconstruct portion of Kincaid Trail to control erosion/rutting.	Erosion on Kincaid Trail.
Other Issues	None identified at this time.	None identified at this time.

Table 6-8: 01I - Lower Cortright Creek

5% Wilderness, 95% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - limited opportunities exist (probably less than 200 acres within the next 10 years) in older managed stands.	Wildlife concerns: Approximately 90% of the LSR is in CHU WA-37. There are three known spotted owl activity centers within the sixth-field. Approximately 150 acres of deer and elk biological winter range exist in the far west portion of the sixth-field. Aquatic concerns: moderate peak flows (88% ARP), scattered riparian fragmentation (RM 0 - 1.6), moderate road density (2.8 miles of road per square mile), moderate road density in Riparian Reserves (1.6 miles of road per square mile), high number (1.6) of road crossings per stream mile, insufficient LWD (RM 0.3 - 1.3), moderate - high channel sensitivity (RM 1 - 4.4, A3, B3, C3, G2) and sediment transport and storage concerns (RM 0.3 - 4.4). One TES plant site exists within this sixth-field.
Roads	Repair flood-damaged site on Forest Road 4810405.	Flood-damaged site on Forest Road 4810405.
Other Restoration	Opportunity for in-stream restoration structures.	Low pool frequency from RM 2.5 - 4.2.
Recreation and Trails	None identified at this time.	None identified at this time.
Other Issues	None identified at this time.	None identified at this time.

Table 6-9: 01J - Upper Cortright Creek

63% Wilderness, 37% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - very limited opportunities for thinning (probably less than 50 acres within the next 10 years) in older managed stands.	Wildlife concern: Approximately 50% of the LSR is in CHU WA-37. Aquatic concerns: moderate peak flows (88% ARP), moderate numbers (0.57) of road crossings per stream mile.
Roads	Repair flood-damaged site on Forest Road 4500	Flood-damaged site on Forest Road 4500
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	None identified at this time.	None identified at this time.
Other Issues	None identified at this time.	None identified at this time.

Table 6-10: 01K - Lower Clear Fork Cowlitz River

21% Wilderness, 46% Late-Successional Reserves, 14% Matrix, 19% Administratively Withdrawn

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no regeneration harvest opportunities. Matrix (MM, VL, NL) - limited opportunities for regeneration harvest. These opportunities are available immediately.	Wildlife concerns: Approximately 90% of the sixth-field is spotted owl critical habitat. Two known spotted owl pairs exist within the sixth-field. Some allocated mountain goat summer range exists that may permit limited harvest. Approximately 200 acres of deer and elk biological winter range exists at the west end of the sixth-field. There are 3 known TES and 3 known Survey and Manage plant sites within the sixth-field. Approximately 1 mile of anadromous fish habitat exists within LSR (listed steelhead habitat exists within the lower one mile).
Commercial Thinning	Wilderness - no opportunities exist. Matrix and LSR - The only possible thinning opportunities would be in older managed stands, but it is very unlikely that any of those stands will reach commercial size within the next 10 years.	Wildlife concerns: Approximately 90% of the sixth-field is spotted owl critical habitat. Some mountain goat summer range exists that may permit limited harvest. Two known spotted owl pairs exist within the sixth-field. One known Survey and Manage amphibian site exists within the LSR. Approximately 200 acres of deer and elk biological winter range exists at the west end of the sixth-field.

Table 6-10: 01K - Lower Clear Fork Cowlitz River

21% Wilderness, 46% Late-Successional Reserves, 14% Matrix, 19% Administratively Withdrawn

Activity	Recommendations	Concerns
Roads	There may be opportunities to reduce open road density within deer and elk biological winter range. Repair minor wash-outs on Forest Road 1284. Decommission last 1 to 2 miles of Forest Road 46.	Wildlife concerns: The current open road density in deer and elk biological winter range exceeds standards and guidelines set forth in the GP Forest Plan. Forest Road 1284 provides access to the Sand Lake trailhead and wash-outs are making it impassable to passenger cars. Poor drainage along the Clear Lost Trail. Chronic road maintenance problems (wash-outs) along Forest Road 46 due to steep grades and unstable soils. Slight increase in mass wasting potential compared with reference conditions.
Other Restoration	Recruitment of LWD into Millridge Creek. Reduction in number of road crossings per stream mile. Stream channel restoration between river mile (RM) 0.6 and 1.2. Reduce road density within Riparian Reserves.	Deficit of LWD in stream systems. Moderate road density in Riparian Reserves (1.5 miles of road per square mile), high number (1.25) of road crossings per stream mile. Aquatic concerns: floodplain instability (RM 0.6 - 1.2), moderately-highly sensitive stream channel types (G3, C3, A3 and B3), sediment transport, sediment storage and delivery (scattered RM 0.6 - 9.5)
Recreation and Trails	Reconstruct portions of Clear Lost Trail 76 to improve drainage and prevent damage to wet areas. Relocate Clear Fork Trailhead and decommission last 1 to 2 miles of Forest Road 46.	Poor drainage along the Clear Lost Trail. Chronic road maintenance problems (wash-outs) along Forest Road 46 due to steep grades and unstable soils.
Other Issues	None identified at this time.	None identified at this time.

Table 6-11: 01L - Upper Clear Fork Cowlitz River

100% Wilderness

Activity	Recommendations	Concerns
Regeneration Harvest	Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	Wilderness - no opportunities exist.	None identified at this time.
Roads	None identified at this time.	None identified at this time.
Other Restoration	Opportunity for stream channel restoration.	Scattered stream channel response to sediment transport and storage (RM 9.5 - 12.1, B3 and C3).
Recreation and Trails	Reconstruct/stabilize trail tread, control rutting/erosion, and improve drainage on Clear Fork and Clear Lost Trails. Monitor use of Coyote Lake.	Trail erosion on Clear Fork and Clear Lost Trails. Vegetation loss and shoreline damage potential at Coyote Lake.
Other Issues	Maintain known TES activity center. Maintain Survey and Manage plant sites.	One known spotted owl pair within this sixth-field. One known Survey and Manage plant site within the sixth-field.

Table 6-12: 01M - Purcell Creek

42% Wilderness, 58% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	Wilderness - no opportunities exist. LSR - limited opportunities for thinning (probably less than 100 acres within the next 10 years) in older managed stands.	Wildlife concerns: The LSR is located entirely within CHU WA-37. Approximately 75-80% of the sixth-field (including the portion available for thinning) is deer and elk biological winter range. River mile 0 - 0.2 is anadromous fish habitat (listed steelhead habitat) and is deficient in LWD. Aquatic concerns: moderate peak flows, riparian fragmentation (RM 0.1 - 0.4), moderate road density in Riparian Reserves (1.7 miles of road per square mile), high number (1.18) of road crossings per stream mile, floodplain concern (RM 0 - 0.3), sediment transport and storage concern.
Roads	There may be opportunities to reduce open road density within deer and elk biological winter range. Repair Forest Road 4612.	Wildlife concerns: At the watershed scale, open road densities exceed standards and guidelines set forth in the GP Forest Plan for deer and elk biological winter range. Flood-damaged site on Forest Road 4612. Moderate increase in mass wasting potential compared to reference conditions in the watershed.
Other Restoration	Reduce number of road crossings per stream mile. Reduce road densities within Riparian Reserves.	High number (1.18) of road crossings per stream mile. Moderate road density in Riparian Reserves (1.7 miles of road per square mile).
Recreation and Trails	Repair/stabilize Forest Road 4612 to provide access to Bluff Lake Trailhead.	Forest Road 4612 is slumping approximately 0.25 miles below the Trailhead.
Other Issues	None identified at this time.	None identified at this time.

Table 6-13: 01N - Dam Creek

48% Wilderness, 52% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no opportunities exist	None identified at this time.
Commercial Thinning	LSR - limited opportunities for thinning (probably less than 140 acres in the next 10 years) in older managed stands.	Wildlife concerns: Approximately 50% of the LSR is in CHU WA-37. One known spotted owl pair exists in the sixth-field. Approximately 100 acres of deer and elk biological winter range in the far north portion of the sixth-field. Aquatic concerns: moderate peak flows (80% ARP), riparian fragmentation (RM 0.1 - 0.4), moderate road density (1.3 miles of road per square mile), moderate number (0.93) of road crossings per stream mile, insufficient LWD (RM 0.2 - 1.4), and sediment transport and storage concerns (RM 0.2 - 1.4).
Roads	Repair road failures along the Forest Road 46 system.	Road failures along Forest Road 46 system.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	None identified at this time.	None identified at this time.
Other Issues	None identified at this time.	None identified at this time.

Table 6-14: 01P - Lava Creek

86% Wilderness, 14% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - no thinning opportunities exist within the next 10 years.	None identified at this time.
Roads	None identified at this time.	None identified at this time.
Other Restoration	Opportunities for LWD recruitment and stream channel restoration.	Aquatic concerns: floodplain concerns, insufficient LWD, moderate-high stream channel sensitivity (RM 0.4 - 1.3, B4) and sediment transport and storage concerns (RM 0.4 - 1.3).
Recreation and Trails	Reconstruct portion of Clear Lost Trail to improve drainage.	Chronically wet trail tread and damage to wet areas along Clear Lost Trail.
Other Issues	Maintain TES activity center.	The LSR is entirely within CHU WA-37. One known spotted owl pair exists within the sixth-field.

Table 6-15: 01Q - Little Lava Creek

77% Wilderness, 23% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - The only possible thinning opportunities would be in older managed stands (probably 100 acres or less), but those stands may not reach commercial size within the next 10 years.	Wildlife concerns: The LSR is entirely within CHU WA-37. Aquatic concerns: insufficient LWD, moderate - high channel sensitivity (RM 0 - 1.5, B4) and sediment transport and storage concerns (RM 0 - 1.5).
Roads	None identified at this time.	None identified at this time.
Other Restoration	Opportunities for LWD recruitment and stream channel restoration.	Insufficient LWD, moderate - high channel sensitivity (RM 0 - 1.5, B4) and sediment transport and storage concerns (RM 0 - 1.5).
Recreation and Trails	Relocate Clear Fork Trailhead and decommission last 1 to 2 miles of Forest Road 46. Construct/reestablish new trail to maintain access.	Continued access to Clear Fork Trail. Chronic road maintenance problems (wash-outs) along Forest Road 46 due to steep grades and unstable soils approaching current trailhead (see sixth-field 01K). Poor drainage along the Clear Lost Trail.
Other Issues	None identified at this time.	None identified at this time.

Table 6-16: 01R - La Wis Wis

100% Late-Successional Reserves

Activity	Recommendations	Concerns
Regeneration Harvest	LSR - no opportunities exist.	None identified at this time.
Commercial Thinning	LSR - limited opportunities for thinning exist (probably less than 100 acres within the next 10 years) in older managed stands.	Wildlife concerns: This sixth-field is located entirely within CHU WA-37. Approximately 75-80% of the sixth-field is deer and elk biological winter range. The entire length of the river within this sixth-field is anadromous fish habitat (listed steelhead habitat). Aquatic concerns: moderate peak flows, riparian fragmentation (RM 0 - 0.4 of the lower Clear Fork Cowlitz and RM 0.5 - 1.2 of the Ohanapecosh), high road density (3.8 miles of road per square mile), high road density in Riparian Reserves (4.0 miles of road per square mile), high number (2.3) of road crossings per stream mile, floodplain concern (RM 0 - 0.5 of Lower Clear Fork and 0.5 - 1.2 of the Ohanapecosh), high - moderately high channel sensitivity (RM 0 - 0.1, G5 and RM 0.1 - 0.7, A3), sediment transport and storage concern (RM 0 - 0.5 of Lower Clear Fork and 0.5 - 1.2 of the Ohanapecosh). There is one Survey and Manage plant site within the sixth-field.
Roads	There may be opportunities to reduce open road density within deer and elk biological winter range. Repair flood damage on Forest Road 1272162.	Wildlife concerns: At the watershed scale, open road densities exceed standards and guidelines set forth in the GP Forest Plan for deer and elk biological winter range. Flood damage on Forest Road 1272162.

Table 6-16: 01R - La Wis Wis

100% Late-Successional Reserves

Activity	Recommendations	Concerns
Other Restoration	Reduce number of road crossings per stream mile. Reduce road density within the sixth-field and Riparian Reserves.	High number (2.3) of road crossings per stream mile. High road density (3.8 miles of road per square mile). High road density in Riparian Reserves (4.0 miles of road per square mile). Sediment transport and storage concern (RM 0 - 0.5 of Lower Clear Fork and 0 - 0.5 of the Ohanapecosh).
Recreation and Trails	Evaluate bank stabilization potential in the vicinity of the confluence of the Ohanapecosh and Clear Fork Cowlitz Rivers.	Bank instability in the vicinity of the confluence of the Ohanapecosh and Clear Fork Cowlitz Rivers (at La Wis Wis campground).
Other Issues	Potential for interpretive site for anadromous fisheries at the campground to educate the public about reintroduction efforts and fisheries concerns. Potential for interpretive display on wildlife habitat in the campground.	None identified at this time

Table 6-17: 01S - Upper Ohanapecosh River

100% Wilderness (Mount Rainier National Park)

Activity	Recommendations	Concerns
Regeneration Harvest	Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	Wilderness - no opportunities exist.	None identified at this time.
Roads	None identified at this time.	None identified at this time.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	None identified at this time.	None identified at this time.
Other Issues	Survey the Ohanapecosh River and named tributaries to establish reference conditions. Maintain TES activity centers.	Lack of stream survey data for this sixth-field. Several suspected spotted owl activity centers in this sixth-field.

Table 6-18: 01T - Upper Muddy Fork Cowlitz River

100% Wilderness (Mount Rainier National Park)

Activity	Recommendations	Concerns
Regeneration Harvest	Wilderness - no opportunities exist.	None identified at this time.
Commercial Thinning	Wilderness - no opportunities exist.	None identified at this time.
Roads	Repair road-related failures along the Steven's Canyon turnoff from Highway 123.	Road-related failures along the Steven's Canyon turnoff from Highway 123.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	None identified at this time.	None identified at this time.
Other Issues	Survey Muddy Fork Cowlitz River and named tributaries to establish reference conditions.	Lack of stream survey data for this sixth-field.

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APPENDIX A. Access and Travel Management (ATM) Plan for Roads within the Clear Fork Watershed

The following table provides road numbers and section numbers for roads within the Clear Fork watershed, as well as locations where each road begins and ends, and the length of each road that is within the watershed. This table also lists the present and future desired condition of each road, along with closure dates for any road that is listed as closed to all traffic.

ROAD NUMBER	ROAD SECTIONS	ROAD BEGINS FROM	ROAD ENDING	LENGTH (miles)	ROAD MANAGEMENT		CLOSURE DATES	
					PRESENT	DESIRED FUTURE	FROM	TO
1270000	01	US HWY 12	RD 1270020	0.5	Open / passenger cars	Open / passenger cars		
1270000	02	RD 1270020	TR 164	1.6	Open / passenger cars	Open / passenger cars		
1270000	03	TR 164	SEC 20	1.7	Closed / all traffic	Closed / all traffic	01/01	12/31
1270016	01	RD 1270	SEC 30	0.7	Open / high clearance	Open / high clearance		
1270019	01	RD 1270	SEC 31	0.2	Open / high clearance	Closing naturally		
1270020	01	RD 1270	SEC 30	0.1	Open / high clearance	Closing naturally		
1270024	01	RD 1270	SEC 30	0.6	Closed / all traffic	Decommission		
1270032	01	RD 1270	SEC 30	0.4	Closing naturally	Decommission		
1270047	01	RD 1270	SEC 20	0.3	Closed / all traffic	Closed / all traffic	01/01	12/31
1270405	01	RD 1270020	SEC 36	0.2	Closing naturally	Closing naturally		
1272000	01	US HWY 12	RD 1273	0.6	Seasonally open / cars	Seasonally open / cars	10/31	5/27
1272000	02	RD 1273	Campground	1.8	Seasonally open/ cars	Seasonally open / cars	10/31	5/27
1273000	01	RD 1272	SEC 29	0.58	Seasonally open/ cars	Seasonally open/ cars	10/31	5/27
1275000	01	US HWY 12	US HWY 12	0.14	Open / passenger cars	Open / passenger cars		
1276000	01	US HWY 12	SEC 25	5.2	Open / high clearance	Open / high clearance		
1276027	01	RD 1276	SEC 24	1.74	Open / high clearance	Closing naturally		
1276030	01	RD 1276	SEC 22	0.3	Closed / all traffic	Closed / all traffic	01/01	12/31
1276042	01	RD 1276	SEC 25	0.5	Closed / all traffic	Closed / all traffic	01/01	12/31
1276043	01	RD 1276	SEC 26	0.4	Closed / all traffic	Closed / all traffic	01/01	12/31
1276046	01	RD 1276	SEC 25	0.4	Closed / all traffic	Closed / all traffic	01/01	12/31
1276050	01	RD 1276	SEC 25	0.17	Closed / all traffic	Closed / all traffic	01/01	12/31
1276058	01	RD 1276	SEC 25	0.4	Closed / all traffic	Closed / all traffic	01/01	12/31
1284000	01	US HWY 12	RD 1284011	0.1	Seasonally open / cars	Seas. open / high clear.	SNOW	CLOSE
1284000	02	RD 1284011	TR 60	2.8	Seas. open / high clear.	Seas. open / high clear.	12/01	04/30
1284011	01	RD 1284	State Shed	0.2	Open / high clearance	Open / high clearance		
1284016	01	RD 1284	SEC 3	0.6	Closed / all traffic	Closed / all traffic	01/01	12/31
1284017	01	RD 1284	SEC 3	0.81	Closed / all traffic	Closed / all traffic	01/01	12/31
1284024	01	RD 1284	SEC 10	0.19	Closed / all traffic	Closed / all traffic	01/01	12/31
1284030	01	RD 1284	SEC 9	0.29	Closed / all traffic	Closed / all traffic	01/01	12/31

ROAD NUMBER	ROAD SECTIONS	ROAD BEGINS FROM	ROAD ENDING	LENGTH (miles)	ROAD MANAGEMENT		CLOSURE DATES	
					PRESENT	DESIRED FUTURE	FROM	TO
1284034	01	RD 1284	SEC 9	0.3	Closed / all traffic	Closed / all traffic	01/01	12/31
4400000	01A	ST HWY 123	TRL 22	5.4	Open / high clearance*	Open / high clearance*		
4400000	01B	ST HWY 123	TRL 22	0.8	Open / high clearance	Decommission		
4400000	02	TRL 22	SEC 36	0.3	Closed / all traffic	Stabilized closed	01/01	12/31
4400016	01	RD 4400	SEC 9	0.21	Closed / all traffic	Closed / all traffic	01/01	12/31
4400017	01	RD 4400	SEC 17	1.7	Seas. open / high clear.	Seas. open / high clear.	12/01	04/01
4400019	01	RD 4400	SEC 9	0.2	Closed / all traffic	Closed / all traffic	01/01	12/31
4400024	01	RD 4400	SEC 9	0.4	Closed / all traffic	Closed / all traffic	01/01	12/31
4400025	01	RD 4400	SEC 9	0.5	Closed / all traffic	Closed / all traffic	01/01	12/31
4400026	01	RD 4400	SEC 10	0.7	Open / high clearance	Seas. open / high clear.	12/01	04/01
4400049	01	RD 4400	SEC 12	1.33	Closed / all traffic	Stabilized closed	01/01	12/31
4400064	01	RD 4400	SEC 11	1.3	Closed / all traffic	Stabilized closed	01/01	12/31
4400071	01	RD 4400	SEC 36	0.48	Closed / all traffic	Stabilized closed	01/01	12/31
4400405	01	RD 4400017	SEC 17	0.3	Closed / all traffic	Stabilized closed	01/01	12/31
4500000	01	US HWY 12	RD 4510	0.4	Open / passenger cars	Open / passenger cars		
4500000	02	RD 4510	TRL 57	8.4	Open / high clearance	Open / high clearance		
4500000	03	TRL 57	SEC 15	3.1	Open / high clearance	Open / high clearance		
4500032	01	RD 4500	SEC 22	0.39	Closed / all traffic	Closed / all traffic	01/01	12/31
4500053	01	RD 4500	SEC 24	0.6	Open / high clearance	Closing naturally		
4500077	01	RD 4500	SEC 33	2.4	Closing naturally	Closing naturally		
4500106	01	RD 4500	MP 0.8	0.8	Open / high clearance	Decommission		
4500106	02	MP 0.8	SEC 15	1.2	Closed / all traffic	Closed / all traffic	01/01	12/31
4500115	01	RD 4500	SEC 23	0.18	Closed / all traffic	Closed / all traffic	01/01	12/31
4500405	01	RD 4500032	SEC 23	0.2	Closed / all traffic	Closed / all traffic	01/01	12/31
4500415	01	RD 4500077	SEC 28	0.3	Closing naturally	Closing naturally		
4510000	01	RD 4500	TRL 44A	5.11	Open / passenger cars	Open passenger cars		
4510000	02	TRL 44A	SEC 7	1	Closed / all traffic	Closed / all traffic	01/01	12/31
4510016	01	RD 4510	SEC 16	0.22	Closed / all traffic	Closed / all traffic	01/01	12/31
4510026	01	RD 4510	SEC 16	2.1	Seas. open / high clear.	Seas. open / high clear.	12/01	04/01
4510029	01	RD 4510	SEC 14	1.34	Open / high clearance	Closing naturally		
4510052	01	RD 4510	SEC 18	0.69	Open / passenger cars	Open / passenger cars		
4510405	01	RD 4510026	SEC 15	0.1	Closed / all traffic	Closed / all traffic	01/01	12/31
4510410	01	RD 4510029	SEC 15	0.4	Closing naturally	Closed / all traffic	01/01	12/31
4600000	01B	RD 4610	TRL 61	7.7	Open / passenger cars	Open / high clearance		
4600025	01	RD 4600	SEC 29	0.5	Open / high clearance	Closing naturally		
4600035	01	RD 4600	SEC 28	1.1	Open / high clearance	Closed / all traffic	01/01	12/31
4600061	01	RD 4600	SEC 35	1.3	Open / high clearance	Open / high clearance		

ROAD NUMBER	ROAD SECTIONS	ROAD BEGINS FROM	ROAD ENDING	LENGTH (miles)	ROAD MANAGEMENT		CLOSURE DATES	
					PRESENT	DESIRED FUTURE	FROM	TO
4600062	01	RD 4600	SEC 27	1.1	Open / high clearance	Closing naturally		
4600070	01	RD 4600	SEC 35	0.23	Closed / all traffic	Closed / all traffic	01/01	12/31
4600079	01	RD 4600	SEC 35	0.7	Closing naturally	Decommission		
4600084	01	RD 4600	SEC 35	0.56	Closed / all traffic	Closed / all traffic	01/01	12/31
4600086	01	RD 4600	SEC 36	0.2	Closing naturally	Closing naturally		
4600405	01	RD 4600025	SEC 29	0.2	Closed / all traffic	Closed / all traffic	01/01	12/31
4600420	01	RD 4600062	SEC 27	0.52	Closed / all traffic	Closed / all traffic	01/01	12/31
4610018	01	RD 4610	SEC 28	1.45	Open / high clearance	Closing naturally		
4612000	01	RD 4610	TRL 65	1.25	Open / high clearance	Open / high clearance		
4612000	02	TRL 65	SEC 34	2.1	Open / high clearance	Decommission		
4612028	01	RD 4612	SEC 32	0.2	Closed / all traffic	Closed / all traffic	01/01	12/31
4612045	01	RD 4612	SEC 33	0.1	Closed / all traffic	Closed / all traffic	01/01	12/31
4612049	01	RD 4612	SEC 28	0.2	Closing naturally	Closing naturally		
4900022	01	ST HWY 123	SEC 20	0.4	Closed / all traffic	Closing naturally		
4900035	01	ST HWY 123	SEC 17	0.7	Open / high clearance	Open / high clearance		
4900405	01	RD 4900035	SEC 8	0.2	Open / high clearance	Open / high clearance		
5290000	02	Forest bndry	TRL 161	1.5	Seas. open / high clear.	Seas. open / high clear.	12/01	04/01

* The first 1.68 miles of Forest Road 44 is open (up to the Hornquist bridge). Beyond this point, the road is closed to all traffic due to bridge failures. The segment of Forest Road 44 beyond the Hornquist bridge is to be placed in a stabilized closed condition due to lack of funds to replace the two failed bridges at mileposts 1.68 and 5.37.

APPENDIX B. Comparison of Historic and Current Vegetation and Non-Forest Structure by Sixth-field Subbasins

		Year 1880		*Year 1998*	
Sixth-field	**Structural Stage**	**Acres**	**%**	**Acres**	**%**
01A	Grass/Pole	5,370	49	198	2
	Small Tree	330	3	1,936	18
	Large Tree	0	0	3,562	32
	Non-Forest	5,208	48	5,212	48
01B	Grass/Pole	120	2	279	5
	Small Tree	4,243	79	132	3
	Large Tree	460	9	4,412	82
	Non-Forest	528	10	528	10
01D	Grass/Pole	12	<1	907	30
	Small Tree	1,895	62	363	12
	Large Tree	774	25	1,410	46
	Non-Forest	379	13	380	12
01E	Grass/Pole	321	3	331	3
	Small Tree	6,712	67	5,081	51
	Large Tree	1,265	13	2,886	29
	Non-Forest	1,723	17	1,723	17
01F	Grass/Pole	4	<1	452	20
	Small Tree	852	38	491	22
	Large Tree	720	33	631	28
	Non-Forest	654	29	656	29
01G	Grass/Pole	14	<1	132	3
	Small Tree	2,385	51	1,856	40
	Large Tree	963	21	1,374	29
	Non-Forest	1,274	28	1,274	28

APPENDIX B. Comparison of Historic and Current Vegetation and Non-Forest Structure by Sixth-field Subbasins					
		Year 1880		***Year 1998***	
Sixth-field	**Structural Stage**	**Acres**	**%**	**Acres**	**%**
01H	Grass/Pole	0	0	260	22
	Small Tree	792	68	685	59
	Large Tree	270	23	117	10
	Non-Forest	101	9	101	9
01I	Grass/Pole	0	0	973	24
	Small Tree	3,474	86	58	1
	Large Tree	9	<1	2,452	61
	Non-Forest	554	14	554	14
01J	Grass/Pole	1,173	38	412	13
	Small Tree	1,595	51	1,230	40
	Large Tree	0	0	1,126	36
	Non-Forest	334	11	334	11
01K	Grass/Pole	167	2	747	8
	Small Tree	5,730	62	1,878	21
	Large Tree	809	9	3,868	42
	Non-Forest	2,462	27	2,675	29
01L	Grass/Pole	561	5	51	<1
	Small Tree	2,303	18	1,863	15
	Large Tree	5,046	40	5,990	48
	Non-Forest	4,635	37	4,640	37
01M	Grass/Pole	0	0	371	19
	Small Tree	1,472	75	1,182	60
	Large Tree	157	8	72	4
	Non-Forest	336	17	340	17

APPENDIX B. Comparison of Historic and Current Vegetation and Non-Forest Structure by Sixth-field Subbasins					
		Year 1880		***Year 1998***	
Sixth-field	**Structural Stage**	**Acres**	**%**	**Acres**	**%**
01N	Grass/Pole	154	7	695	32
	Small Tree	1,269	59	828	38
	Large Tree	357	17	257	12
	Non-Forest	379	17	379	18
01P	Grass/Pole	26	1	120	5
	Small Tree	686	29	149	6
	Large Tree	580	24	1,023	43
	Non-Forest	1,095	46	1,095	46
01Q	Grass/Pole	0	0	70	5
	Small Tree	744	50	357	24
	Large Tree	354	24	671	45
	Non-Forest	381	26	381	26
01R	Grass/Pole	159	9	320	18
	Small Tree	1,133	63	420	24
	Large Tree	387	22	914	51
	Non-Forest	106	6	131	7
01S	Grass/Pole	0	0	881	2
	Small Tree	8,069	21	713	2
	Large Tree	15,953	42	22,420	59
	Non-Forest	13,749	37	13,757	36
01T	Grass/Pole	5,190	22	197	1
	Small Tree	1,684	7	169	1
	Large Tree	2,030	8	8,488	35
	Non-Forest	15,235	63	15,285	63

APPENDIX C. Stream Survey Data

Buesch Creek Stream Survey Data

Reach	Year	Length	%	Type	Pool	Rate	Stability	Spawn Gravel	Rating	Sediment	Rating	Dom Sub	Sub Dom-Sub	Gradient	W/D	Key-Spawning
1	81	660	2	Aa+	120	Fair	Good			10	Good	SB	CO	20	<7	
2	81	1320	5	A	88	Fair	Good			10	Good	LB	SB	ND	<7	
3	81	660	2	A	248	Fair	Fair			20	Fair	CO	GR	5	15-25	
4	81	660	2	ND	40	Fair						ND	ND	ND	ND	
5	81	660	2	ND								ND	ND	ND	ND	
6	81	1320	5	ND	56	Fair						ND	ND	ND	ND	
7	83	3960	15	B			Good	0	Poor	0	Good	SB	CO	3	8-15	
8	83	4490	17	B			Fair	0	Poor	10	Good	CO	GR	2	15-25	
9	83	3700	14	A			Good	0	Poor	0	Good	GR	LB	8	8-15	
10	83	5700	21	A			Good	0	Poor	0	Good	BR	LB	8	<7	
11	83	3960	15	Cb			Fair	Some	Fair	35	Poor	SA	GR	1	>25	
12				Aa+			Good	0	Poor	5	Good	LB	SB	20	<7	

Cortright Creek Stream Survey Data

Reach	Year	Length	%	Type	Pool	PF Rate	Woody Debris	Wood Rate	Stability	Spawn Gravel	Rating	Sedi-ment	Rating	Dom Sub	Sub Dom Sub	Gradi-ent	W/D	Key Spawning
1	89	1078	3	Aa+	54	Good	99	Good	Good	none	Poor	<25	Good	BR		19	8-15	
2	89	1002	2	Aa+	74	Good	143	Good	Good	none	Poor	<25	Good	BR	CO	17	<7	
3	89	657	2	Aa+	57	Good	66	Fair	Good	low	Fair	25-50	Fair	SB	CO	11	<7	
4	89	460	1	Aa+	103	Good	150	Good	Good	low	Fair	<25	Good	BR		13	<7	
5	89	1231	3	A	26	Poor	113	Good	Fair	low	Fair	<25	Good	SB	LB	10	<7	
6	89	645	2	Aa+	49	Fair	59	Fair	Good	low	Fair	<25	Good	LB	SB	15	<7	
7	89	1747	4	Aa+	63	Good	110	Good	Good	low	Fair	<25	Good	CO		12	<7	
8	89	1009	2	A	53	Good	84	Good	Good	none	Poor	<25	Good	BR	CO	10	<7	
9	89	897	2	A	36	Fair	30	Poor	Good	low	Fair	25-50	Fair	CO	SB	6	<7	
10	89	590	1	A	54	Good	18	Poor	Good	none	Poor	<25	Good	BR		5	<7	
11	89	700	2	A	68	Good	54	Fair	Good	none	Poor	<25	Good	BR	CO	8	<7	
12	89	1986	5	A	32	Fair	113	Good	Good	low	Fair	<25	Good	BR	CO	6	<7	
13	89	1392	3	A	23	Poor	16	Poor	Good	low	Fair	50-75	Poor	CO		4	<7	
14	89	672	2	Cb	48	Fair	203	Good	Fair	low	Fair	<25	Good	CO	SB	3	15-25	Spawning
15	89	695	2	Cb	23	Poor	54	Fair	Fair	low	Fair	<25	Good	CO		3	15-25	Spawning
16	89	1435	3	B	19	Poor	56	Fair	Fair	low	Fair	<25	Good	SB	CO	3	8-15	Spawning
17	89	1390	3	G	23	Fair	27	Poor	Fair	none	Poor	25_50	Fair	SB	CO	4	<7	
18	89	1098	3	A	29	Fair	15	Poor	Good	none	Poor	75-100	Poor	SB	CO	5	<7	
19	89	577	1	F	29	Fair	48	Fair	Good	low	Fair			BR		4	18	
20	89	880	2	B	12	Poor	12	Poor	Fair	none	Poor	25-50	Fair	CO	SB	4	8-15	
21	89	654	2	B	25	Fair	138	Good	Good	low	Fair	<25	Good	CO		4	8-15	
22	89	1409	3	Cb	42	Good	46	Fair	Good	low	Fair	50-75	Poor	CO	SB	3	26	
23	89	1204	3	A	36	Good	54	Fair	Good	moder-ate	Good	50-75	Poor	CO	SB	4	<7	
24	89	920	2	A	52	Good	35	Poor	Good	low	Fair	75-100	Poor	BR	SB	10	<7	
25	89	1783	4	A	25	Fair	42	Fair	Fair	moder-ate	Good	25-50	Fair	SB	CO	6	<7	
26	89	805	2	G	6	Poor	27	Poor	Fair	low	Fair	<25	Good	CO		1	8-15	Spawning
27	89	2600	6	A	26	Fair	23	Poor	Good	none	Poor	75-100	Poor	BR	CO	3	<7	
28	89	629	1	Aa+	70%	Good			Good	low	Fair	75-100	Poor	BR		13	<7	
29	89	1080	3	A	35%	Fair			Good	mod-erae	Good	50-75	Poor	SB	CO	3	<7	
30	89	3790	9	B	20%	Poor			Poor	low	Fair	75-100	Poor	SB	CO	4	>25	
31	89	4065	10	B	35%	Fair			Fair	low	Fair	75-100	Poor	SB	LB	7	15-25	
32	89	2890	7	Aa+	10%	Poor			Fair	none	Poor	75-100	Poor	BR	LB	15	8-15	

Carlton Creek Stream Survey Data																
Reach	Year	Length	%	Type	Pool	PF Rate	Stability	Spawn Gravel	Rating	Sedi-ment	Rating	Dom Sub	Sub Dom Sub	Gradient	W/D	Key Spawn-ing
1	80	7920	35	B	28%	Fair	Fair	0	Poor	10	Good	LB	BR	ND	8-15	
2	80	9505	42	A	27%	Fair	Fair	0	Poor	10	Good	BR	CO	ND	15-25	
3	80	5280	23	C	27%	Fair	Fair	some	Fair	30	Poor	CO	SB	ND	15-25	Spawning

Cyrenus Creek Stream Survey Data																
Reach	Year	Length	%	Type	Pool	PF Rate	Stability	Spawn Gravel	Rating	Sediment	Rating	Dom Sub	Sub Dom Sub	Gradient	W/D	Key Spawning
1	79	580	6	B	16	Poor	Good	Fair	Fair	0	Good	BR	CO	ND	<7	
2	79	290	3	B	160	Good	Good	Fair	Fair	0	Good	BR	CO	ND	8-15	
3	79	8000	82	B	17	Poor	Fair	Fair	Fair	15	Fair	CO	GR	ND	8-15	Spawning
4	79	860	9	B	22	Poor		Fair	Fair			CO	BR	ND		

Lava Creek Sream Survey Data																
Reach	Year	Length	%	Type	Woody	Wood Rate	Stability	Spawn Gravel	Rating	Sedi-ment	Rating	Dom Sub	Sub Dom Sub	Gradi-ent	W/D	Key Spawning
1	84	1980	29	Aa+	106	Good	Good	Poor	Poor	Poor	Poor	BR	CO	12	>25	
2	84	4884	71	B	200	Good	Fair	Poor	Poor	Poor	Poor	GR	CO	4	15-25	Spawning

Little Lava Creek Stream Survey																		
Reach	Year	Length	%	Type	Pool Fre-quency	PF Rate	Woody Debris	Wood Rate	Stabil-ity	Spawn Gravel	Rating	Sedi-ment	Rating	Dom Sub	Sub Dom Sub	Gradi-ent	W/D	Key Spawning
1	84	7788	100	B	<1%	Poor	100	Good	Fair					GR	CO	3	>25	Spawning

Ohanapecosh River Stream Survey Data

Reach	Year	Length	%	Type	Pool	PF Rate	Woody Debris	Wood Rate	Stability	Spawn Gravel	Rating	Sediment	Rating	Dom Sub	Sub Dom Sub	Gradient	W/D	Sinuosity	Key Spawning
1	92	564	6	B3	19	Fair	19	Poor	Good	None	Poor	>35%	POOR	CO	SB	3	15-25	1.1	Spawning
2	92	2910	28	B2	35	Good	120	Good	Good			<35%	Good	CO	BR	3	<7	1.1	Spawning
3	92	1072	10	A2	20	Fair	40	Poor	Good	None	Poor	<35%	Good	BR	LB	6	<7	1.1	
4	92	2473	24	A2	20	Fair	209	Good	Fair			<35%	Good	SB	BR	4	<7	1.1	
5	92	1631	16	A2	33	Fair	249	Good	Good			<35%	Good	LB	SB	6	<7	1	
6	92	912	9	B3	0	Poor	190	Good	Good			<35%	Good	SB	CO	3	8-15	1.1	Spawning
7	92	676	7	B2	32	Fair	468	Good	Good			<35%	Good	BR	GR	6	<7	1.1	

Purcell Creek Stream Survey Data

Reach	Year	Length	%	Type	Woody Debris	Wood Rate	Stability	Sediment	Rating	Dom Sub	Sub Dom Sub	Gradient	W/D	Key Spawning
1	83	1580	11	Cb	<50	Poor	Fair	0	Good	SB	CO	2	8-15	Spawning
2	83	3000	21	B	<80	Fair	Fair	0	Good	SB	CO	4	8-15	
4	83	1580	11	B	150	Good	Fair	15	Fair	SB	CO	5	15-25	
6	83	1320	9	Ba	150	Good	Fair	15	Fair	SB	CO	7	8-15	
3	83	1320	9	Aa+	<50	Poor	Good	15	Fair	CO	SB	3	8-15	
5	83	3000	21	A	100	Good	Good	10	Good	SB	CO	25	8-15	
7	83	2270	16	Aa+	100	Good	Good	0	Good	BR	SB	20	8-15	

Summit Creek Stream Survey Data

Reach	Year	Length	%	Type	Pool	PF Rate	Woody Debris	Wood Rate	Stability	Sediment	Rating	Dom Sub	Sub Dom Sub	Gradient	W/D	Key Spawning
1	79	3960	21	A	35	Fair			Good	10	Good	CO	GR	10	8-15	
2	79	5280	27	A	18	Poor			Good	5	Good	CO	GR	10	<7	
3	79	3696	19	A	30	Fair			Good	5	Good	CO	SB	10	8_15	
4	79	6336	33		22	Poor				0	Good	ND	ND	ND	ND	Spawning
1	83	11880	100				<50	Poor	Good	0	Good			5	ND	
1	97	12400	32	A										6		
2	97	20170	52	A										5		
3	97	6341	16	A	20	Poor	8	Poor	GOOD					6	18.76	

Clear Fork Stream Survey Data

Reach	Year	Length	%	Type	Pool	PF Rate	Woody Debris	Wood Rate	Stabil-ity	Spawn Gravel	Rating	Sedi-ment	Rating	Dom Sub	Sub Dom Sub	Gradi-ent	W/D	Sinu-osity	Key Spawn-ing
1	92	2973	4	G	20	Fair	52	Fair	Good			35%	Fair	CO	SB	3	8-15	1.6	Spawn-ing
2	92	4411	6	Ba	27	Fair	235	Good	Fair			<35	Good	CO	LB	6	11.13	32	
3	92	3168	4	A		ND		ND	Fair			<35	Good	ND	ND	6	<7	1	
4	92	3432	5	Cb	19	Fair	151	Good	Fair			<35	Good	CO	SB	1	<7	1.4	Spawn-ing
5	92	3593	5	A	24	Fair	54	Fair	Good			<35	Good	CO	SB	6	<7	1	
6	92	1647	2	A	32	Fair	62	Fair	Fair			<35	Good	CO	SB	5	<7	1	
7	92	1547	2	A	31	Fair	41	Fair	Good			<35	Good	CO	SA	6	<7	1.2	
8	92	1569	2	A	34	Fair	253	Good	Good			<35	Good	CO	SB	6	<7	1	
9	92	1989	3	Ba	14	Fair	183	Good	Fair			<35	Good	CO	SB	3	8-15	1.2	Spawn-ing
10	92	7214	10	A	25	Fair	216	Good	Poor			<35	Good	CO	SB	7	8-15	0.75	
11	92	5409	8	A	33	Fair	36	Poor	Good			<35	Good	CO	SB	5	<7	1	
12	92	14342	20	B	17	Fair	82	Good	Fair			<35	Good	CO	SB	4	8-15	2.1	
13	87	670	1	Ba3	16	FAIR	low	FAIR		moder-ate	GOOD			SB	CO				Spawn-ing
14	87	380	1	Ba3	14	FAIR	none	POOR		moder-ate	GOOD			SB	CO	3			Spawn-ing
15	87	3000	5	B3	16	FAIR	moder-ate	GOOD	FAIR	moder-ate	GOOD	MOD	FAIR	CO	GR	1	>25		Spawn-ing
16	87	840	1	B3	0	POOR	low	FAIR	FAIR	low	FAIR			CO	SB		>25		
17	87	525	1	B2	0	POOR	moder-ate	GOOD	FAIR	low	FAIR			SB	CO		>25		
18	87	870	2	B3	13	FAIR	low	FAIR	FAIR	low	FAIR			CO	SB		>25		
19	87	1100	2	B2	0	POOR	none	POOR	GOOD	low	FAIR	MOD	FAIR	SB	CO	2	15-25		
20	87	770	1	B2	13	FAIR	moder-ate	GOOD	FAIR	low	FAIR	MOD	FAIR	SB	CO	1	>25		
21	87	2200	4	B3	3	POOR	low	FAIR	FAIR	moder-ate	GOOD			CO	GR		>25		
22	87	550	1	B3	0	POOR	low	FAIR	GOOD	none	POOR	MOD	FAIR	SB	CO	3	8-15		
23	87	530	1	B2	20	FAIR	low	FAIR		low	FAIR			SB	CO				
24	87	1720	3	B2	3	POOR	moder-ate	GOOD		low	FAIR			SB	CO	3			
25	87	1050	2	B3	10	POOR	low	FAIR		None	POOR			SB	CO	4			

Clear Fork Stream Survey Data

Reach	Year	Length	%	Type	Pool	PF Rate	Woody Debris	Wood Rate	Stabil-ity	Spawn Gravel	Rating	Sedi-ment	Rating	Dom Sub	Sub Dom Sub	Gradi-ent	W/D	Sinu-osity	Key Spawn-ing
26	87	1910	3	B3	6	POOR	low	FAIR		moder-ate	GOOD			CO	SB				Spawn-ing
27	87	920	2	B4	18	FAIR	moder-ate	GOOD		moder-ate	GOOD			CO	GR	1			Spawn-ing
28	87	1120	2	B3	10	POOR	low	FAIR		moder-ate	GOOD			CO	SB				Spawn-ing
29	87	1120	2	B4	10	POOR	moder-ate	GOOD		moder-ate	GOOD			CO	GR	2			Spawn-ing

Reach - Stream Survey Reach #
Year - Year of stream survey
Length - Length of survey reach
Type - Rosgen Channel Type
Pool - Pools/mile or % of area in Pool
PF Rate - Rating for pool frequency
Woody Debris - Woody debris frequency or relative amount of channel effected by wood
Wood Rate - Rating for Woody debris
Stability - Pfankuch Stream stability Rating
Spawning Gravel - Amount of spawning gravel
Rating - Rating for spawning Gravel
Sediment - Cobble embeddedness or percent surface fines
Rating - Rating for Sediment
Dom sub - Dominant Substrate / Sub Dom Sub - Subdominant Substrate

- BR - Bedrock
- CO - Cobble
- GR - Gravel
- LB - Large Boulder
- ND - No Data
- SA - Sand
- SB - Small Boulder

Gradient - Stream channel slope
W/D - Width to Depth Ratio

Sinuosity
Key Spawning - Key Spawning Reaches.

Risk of potential stream impacts from increased peak flows:

(1) By Stream Type: Note that Aa stream types are included with the closest A type (i.e. A4a with A4)

Stream Types = A1, A2, A3, A6, B1, B2, B3, B6, C1, C2, E6, F1, F2, G1, G2, and G6.
Moderate Risk = 10-20%
High Risk = 20%+

Stream Types =A4, A5, B4, B5, C3, C4, C5, C6, A11, (D), E3, E4, E5, F4, F5, F6, G3, G4, and G5
Moderate Risk = 10-15%
High Risk = 15%+

(2) By Substrate (for use if the stream type is not known): When the dominant and codominant particle sizes are known, use the smaller particle as the critical grain size.

Bedrock, Boulder, Cobble, and Clay (where dominant is also clay)
Moderate Risk = 10-20%
High Risk = 20%+

Gravel, Sand, and Silt
Moderate Risk = 10-15%
High Risk = 15%+

With no information
High Risk = 10-15%
High Risk = 15%+

APPENDIX D. Partial Fish Stocking Records

Stream/Lake	Species	Year
Clear Fork Cowlitz River	Cutthroat Trout	1931
	Rainbow Trout	1931,1938,1940,1941, 1948,
	Eastern Brook Trout	1929,1930
	Montana Black Spot Trout	1938
Carlton Creek	Cutthroat Trout	1931, 1954
	Rainbow Trout	1937,1938,1939,1942,1947
	Eastern Brook Trout	pre 1936
Cortright Creek	Eastern Brook Trout	pre-1936
	Cutthroat Trout	1931,1954
	Rainbow Trout	1938,1940,1942,1947
Lava Creek	Eastern Brook Trout	1932,1937
	Rainbow Trout	1938
Little Lava Creek	Eastern Brook Trout	no year given
Millridge Creek	Rainbow Trout	1941
Summit Creek	Eastern Brook Trout	1924
	Cutthroat Trout	1931
	Rainbow Trout	1931,1938,1939,1940,1941, 1942, 1944,1945,1946,1947, 1948, 1949,1950,1952,1953, 1954
Backbone Lake	Eastern Brook Trout	1932,1940
	Rainbow Trout	1941,1942,1947,1951
	Cutthroat Trout	1954
Bluff Lake	Eastern Brook Trout	1932
	Rainbow Trout	1941,1942,1947,1951
Lily Lake	Eastern Brook Trout	1929
	Montana Black Spot Trout	1938
	Rainbow Trout	1941,1948
	Cutthroat Trout	1953
Knuppenberg Lake	Cutthroat Trout	1931
	Rainbow Trout	1941
	Eastern Brook Trout	1954
	Brown Trout	Year Unknown
Benchmark Lake	Eastern Brook Trout	pre-1936
	Rainbow Trout	1941,1942
Jug Lake	Eastern Brook Trout	1922, 1924,1929
	Montana Black Spot Trout	1938
	Rainbow Trout	1941,1942,1947
Jess Lake	Rainbow Trout	pre-1936, 1952
Penoyyer Lake	Eastern Brook Trout	pre-1936
Frying Pan Lake	Eastern Brook Trout	1924
	Rainbow Trout	1937,1941,1942,1947

Stream/Lake	**Species**	**Year**
Snow Lake	Eastern Brook Trout	1924
	Rainbow Trout	1942,1947
Henry Lake	Rainbow Trout	1947
	Cutthroat Trout	1954
Chain Lakes	Rainbow Trout	1942,1947
	Cutthroat Trout	1953
Dumbbell Lake	Rainbow Trout	1940,1941,1942,1947,1950, 1952
	Cutthroat Trout	1944
Pipe Lake	Rainbow Trout	1947
Tatoosh Lake	Rainbow Trout	1940
Louise Lake	Eastern Brook Trout	Unknown
Marsh Lakes	Cutthroat Trout	Unknown
Snow Lake	Cutthroat Trout	Unknown
	Rainbow Trout	Unknown
	Brook Trout	Unknown
Bench Lake	Cutthroat Trout	Unknown
	Rainbow Trout	Unknown
	Brook Trout	Unknown
Tree Lakes	Rainbow Trout	Unknown
	Cutthroat Trout	Unknown