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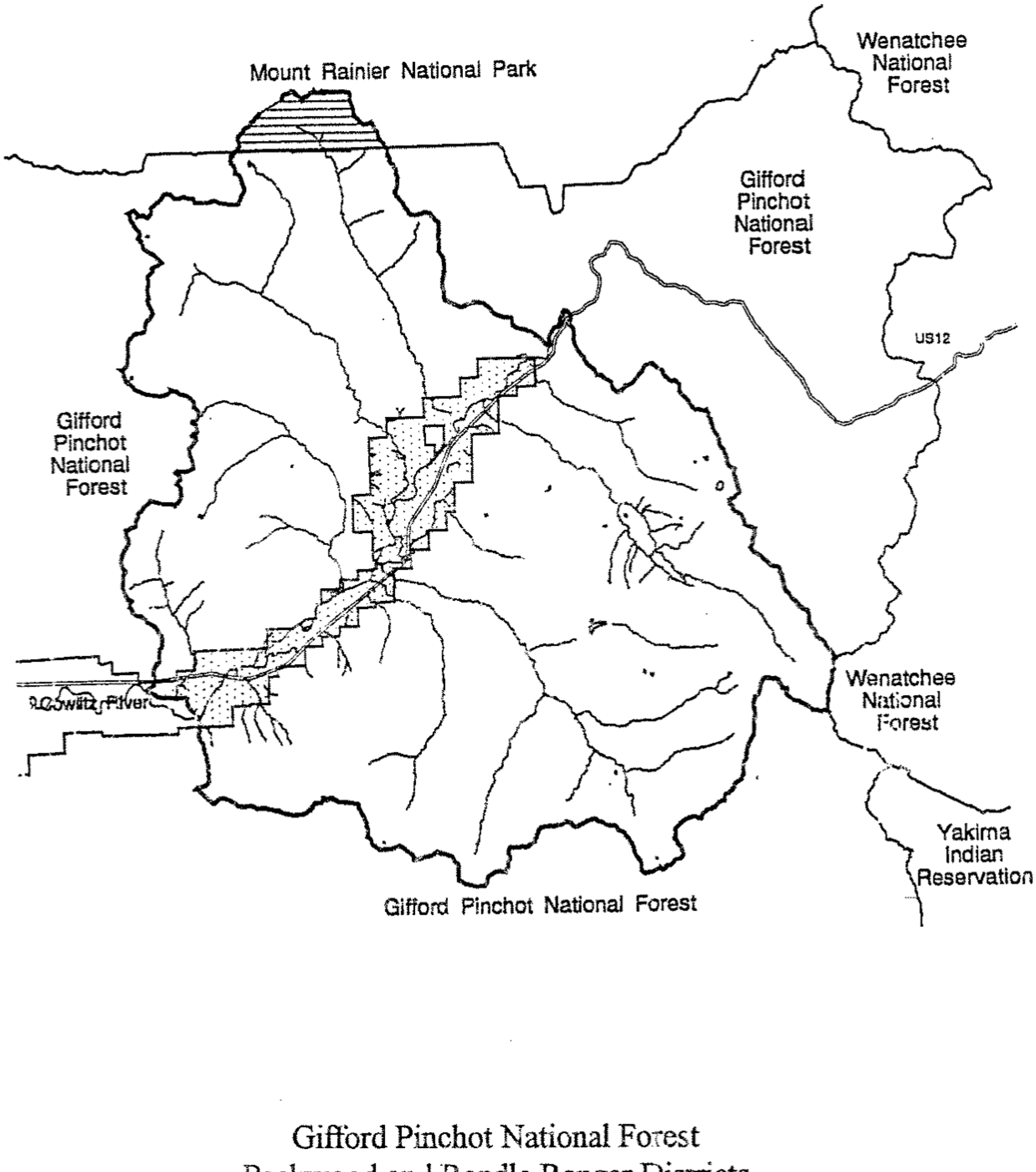
Upper Cowlitz Watershed Assessment



Gifford Pinchot National Forest
Packwood and Randle Ranger Districts
July 1, 1997

Upper Cowlitz Watershed Analysis Team Members

Team Leader	Dave Olson
Archaeologist	Rick McClure
Botanist	Mark Pistrang
Fire Planner	Dale Meyers
Fisheries Biologist	Terry Lawson
Geologist	Shawn Jones
GIS Specialist	Doug Brown
Hydrologist	John Gier
Recreation Planner	Dave Olson
Silviculturalist	Ron Pfeifer
Special Uses	Dick Dinkelmann
Wilderness Planner	Mike Rowan
Wildlife Biologist	Paul Miller
Writer/Editor	Dave Olson
Writer/Editor	Jeff Ricklefs

Acknowledgments

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UPPER COWLITZ WATERSHED ANALYSIS
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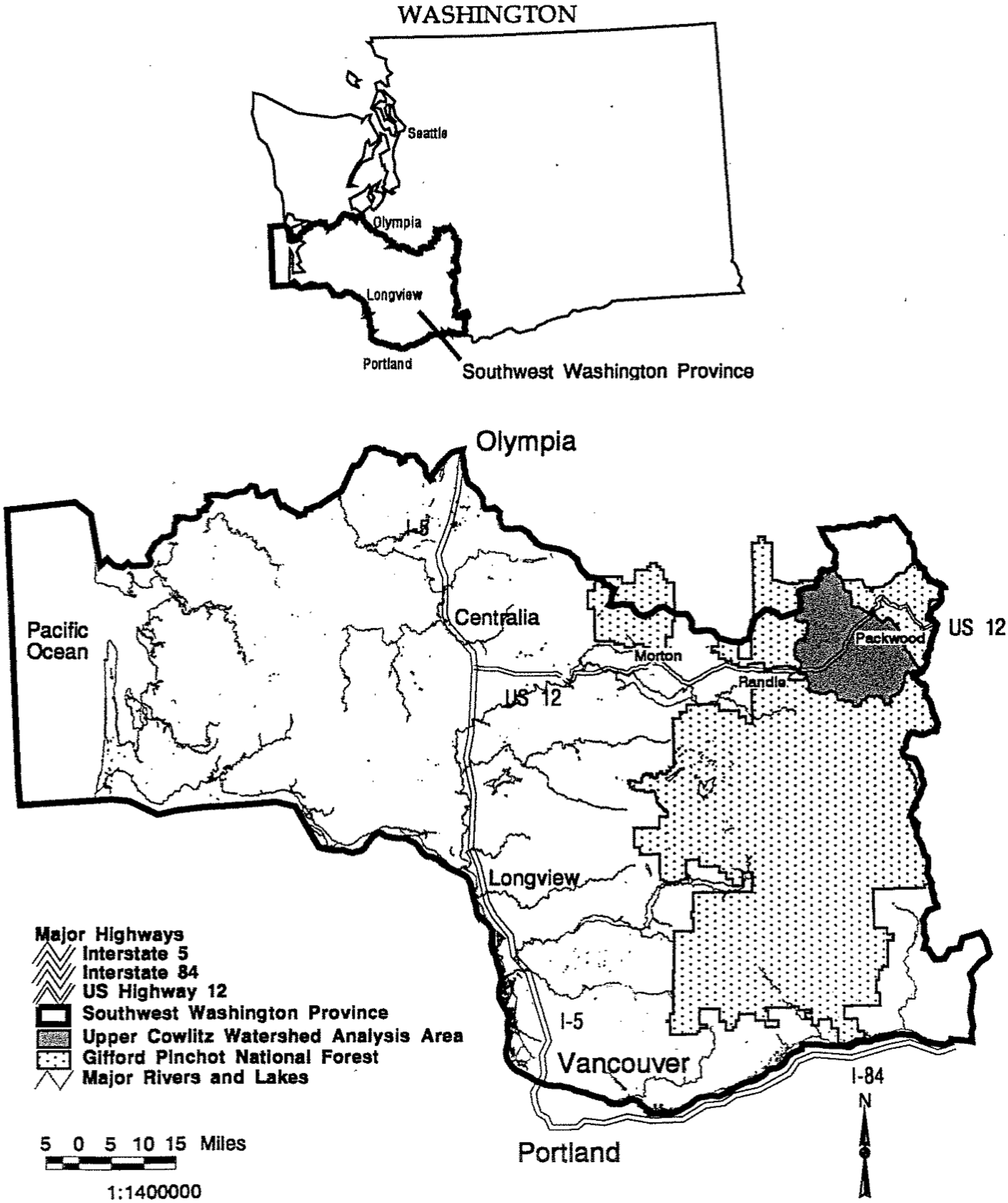
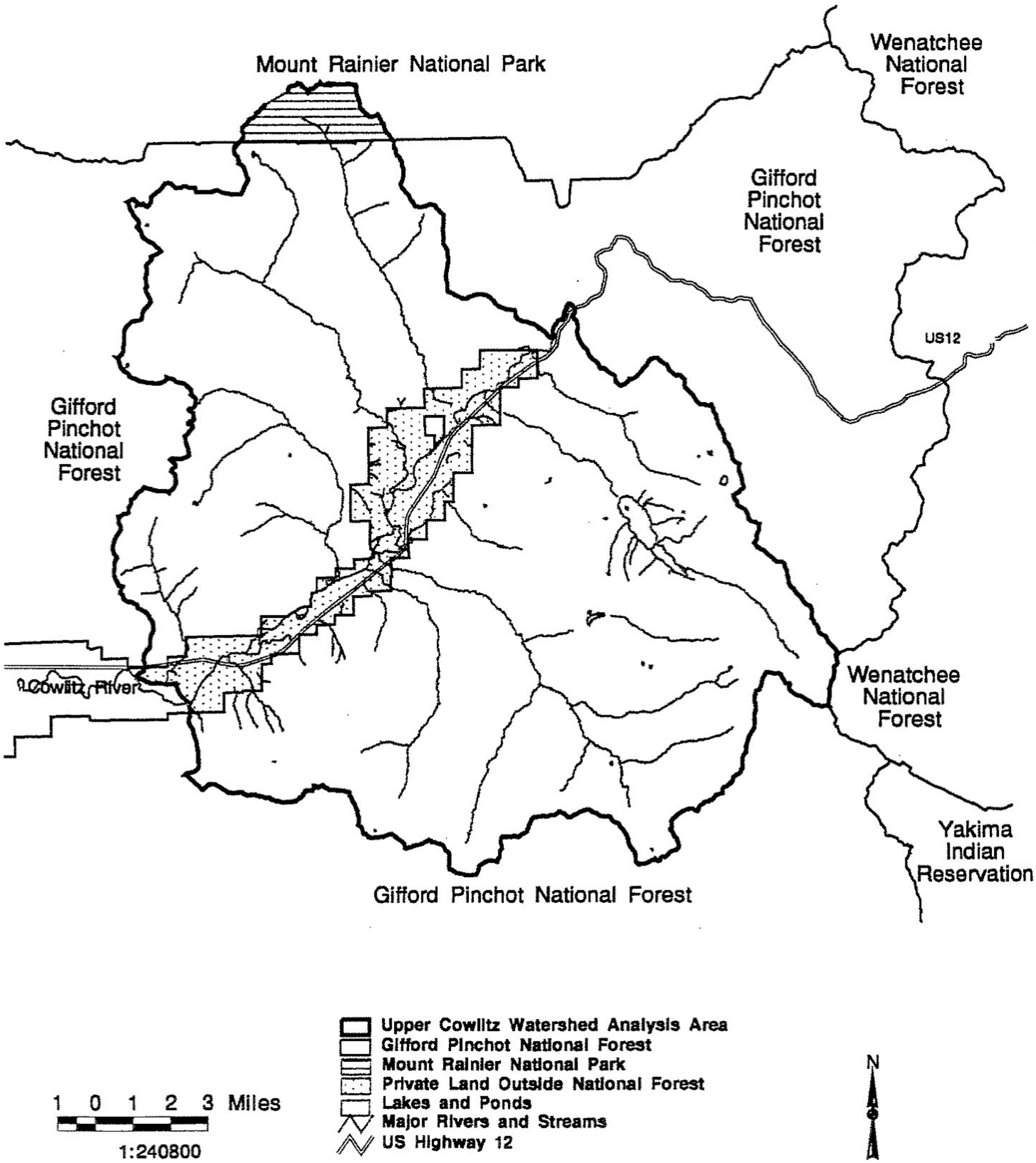


Map 2

UPPER COWLITZ WATERSHED ANALYSIS
Local Vicinity



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 scientifically-based 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, 1994).

Analysis Process

The process used to conduct the Upper Cowlitz 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.

The watershed was stratified by land ownership, by forest zone, and by Watershed Stratification Units (WSU's - formed by grouping sixth-field watersheds or sub-basins). Table 1-1 below lists the eleven WSU's as they relate to their general locations in the watershed. See Map 3 for a display of their locations.

Table 1-1 : Watershed Stratification Units (WSU's)

WSU	General Location
1	Dry Creek, Burton Creek, Wesel Creek, Karr Creek
2	Smith Creek
3	Johnson Creek, Deception Creek, Jordan Creek
4	Lake Creek
5	Coal Creek, Lost Creek
6	Hager Creek, Hall Creek, Snyder Creek, Hinkle Tinkle Creek
7	Butter Creek

Table 1-1 : Watershed Stratification Units (WSU's)	
WSU	**General Location**
8	Skate Creek, "Little" Johnson Creek
9	Willame Creek, North/West/South Forks Willame Cr.
10	Davis Creek
11	Kilborn Creek

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 lands only**, unless otherwise noted. Although it is important to characterize the entire analysis area regardless of land ownership, in many cases only data for the Forest Service portion was available. Data sources, data gaps, and any associated assumptions are clearly expressed at the front of each respective section in Chapter 3.

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

Watershed Overview

The upper Cowlitz River watershed encompasses 155,456 acres situated in and around the Cowlitz River valley near the towns of Randle and Packwood, Washington (Map 1). The area has a long history of human use with archaeological remains dating back to the early pre-historic period (ca. 7,000 to 3,500 years ago). Historic data suggest that the watershed has experienced a range of extreme conditions, at times being almost completely forested, and being devastated by the effects of the Mount Saint Helens volcano some 3,500 years ago.

Table 1-2: Summary of Land Ownership Within Watershed Stratification Units							
WSU #	**Total Acres**	**Private Acres**	**% Private**	**USFS Acres**	**% USFS**	**NPS Acres**	**%NPS**
1	15,781	4,511	28.6%	11,270	71.4%	0	0.0%
2	10,347	173	1.7%	10,174	98.3%	0	0.0%
3	31,103	52	0.2%	31,051	99.8%	0	0.0%

Table 1-2: Summary of Land Ownership Within Watershed Stratification Units							
WSU #	**Total Acres**	**Private Acres**	**% Private**	**USFS Acres**	**% USFS**	**NPS Acres**	**%NPS**
4	16,409	72	0.4%	16,337	99.6%	0	0.0%
5	6,613	51	0.8%	6,562	99.2%	0	0.0%
6	18,407	6,000	32.6%	12,407	67.4%	0	0.0%
7	12,104	198	1.6%	9,490	78.4%	2,416	20.0%
8	22,475	1,204	5.4%	20,847	92.8%	424	1.9%
9	13,435	18	0.1%	13,417	99.9%	0	0.0%
10	5,520	526	9.5%	4,994	90.5%	0	0.0%
11	3,262	24	0.7%	3,238	99.3%	0	0.0%
Total	**155,456**	**12,829**	**8.3%**	**139,787**	**89.9%**	**2,840**	**1.8%**

Currently, 8.3% of the watershed is in non-federal ownership (Table 1-2), with most of that land in an early structural stage, in the form of young forest, pasture and rangelands. The National Forest portion is fairly evenly distributed across several structural stages.

Federal land holdings within the Upper Cowlitz watershed include sections of the Gifford Pinchot National Forest and Mt. Rainier National Park. Private and state land holdings occur both within and outside of the National Forest boundary (see Map 2, Local Vicinity).

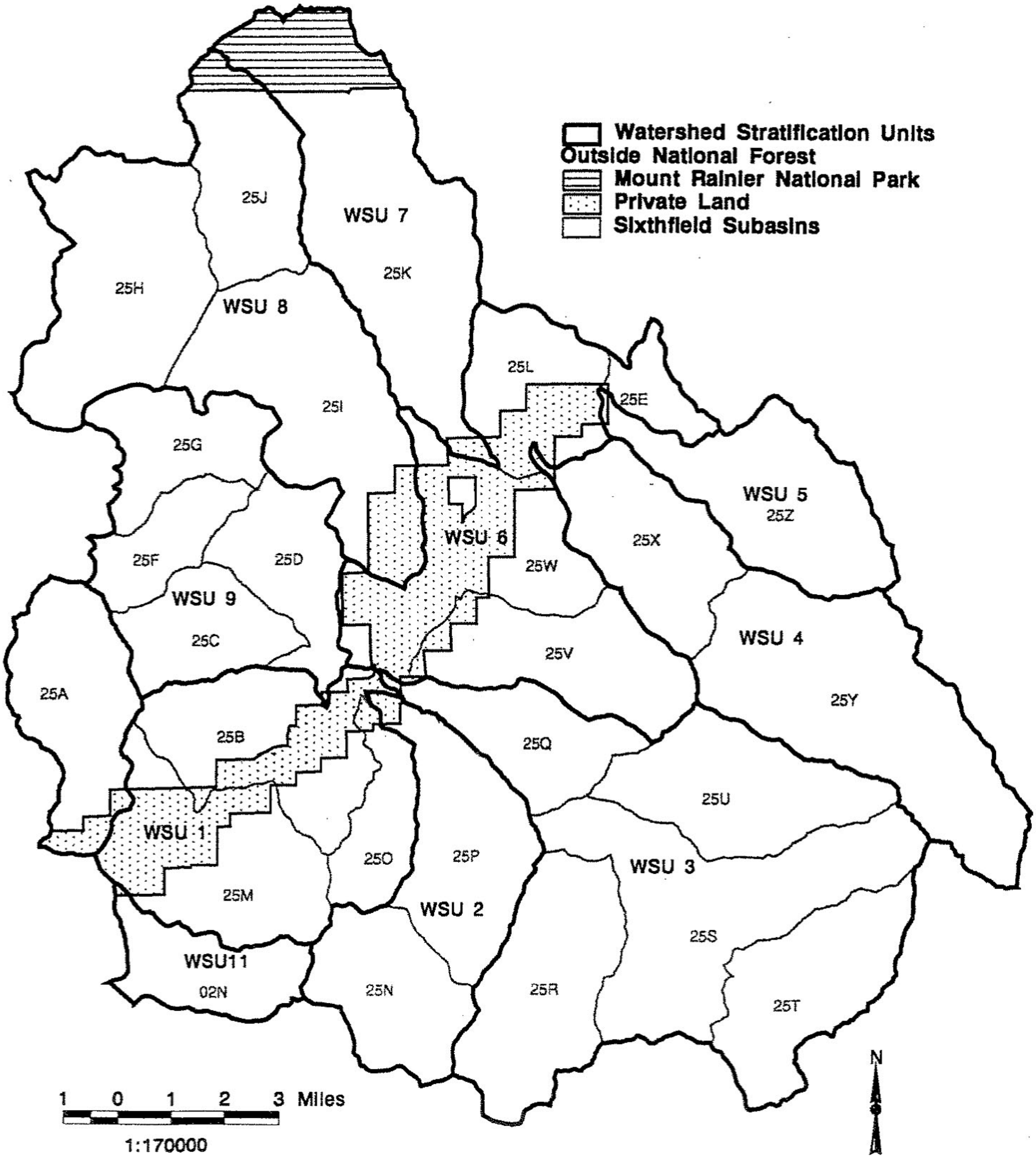
Major roads, in and out of the watershed, include US Highway 12 and Forest Roads 21, 47, 52, and 84. These roads provide access to numerous developed and dispersed recreational sites and other destinations within the watershed. Complete descriptions of the historic and current conditions for the major terrestrial, aquatic, and social elements found within the watershed are presented in Chapter 3 of this document.

Management Direction

Lands within the Upper Cowlitz watershed are managed according to direction provided by *Amendment 11, Gifford Pinchot National Forest, Land and Resource Management Plan*, herein referred to as Amendment 11. This document combines direction from the *Gifford Pinchot National Forest Land and Resource Management Plan (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, 1994)*, herein referred to as the Northwest Forest Plan.

Map 3

UPPER COWLITZ WATERSHED ANALYSIS
Watershed Stratification Unit Boundaries



Management direction is applied to specific lands using the overlaying direction from the 1994 Northwest Forest Plan and the underlying Management Area Category (MAC) direction of the 1990 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 Upper Cowlitz watershed.

Cispus Adaptive Management Area - lands where the development and testing of technical and social approaches to achieving desired ecological, economic and social objectives is emphasized with the overall of objective of managing on a ecosystem basis.

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

Congressionally Withdrawn Areas - includes lands within congressional designations that normally preclude timber harvest.

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

Matrix - lands where scheduled timber harvest is emphasized.

Management Allocation Categories (MACs)

The following table summarizes the MAC designations found on Map 4, Land Allocations, and gives the reference information where specific management direction can be found.

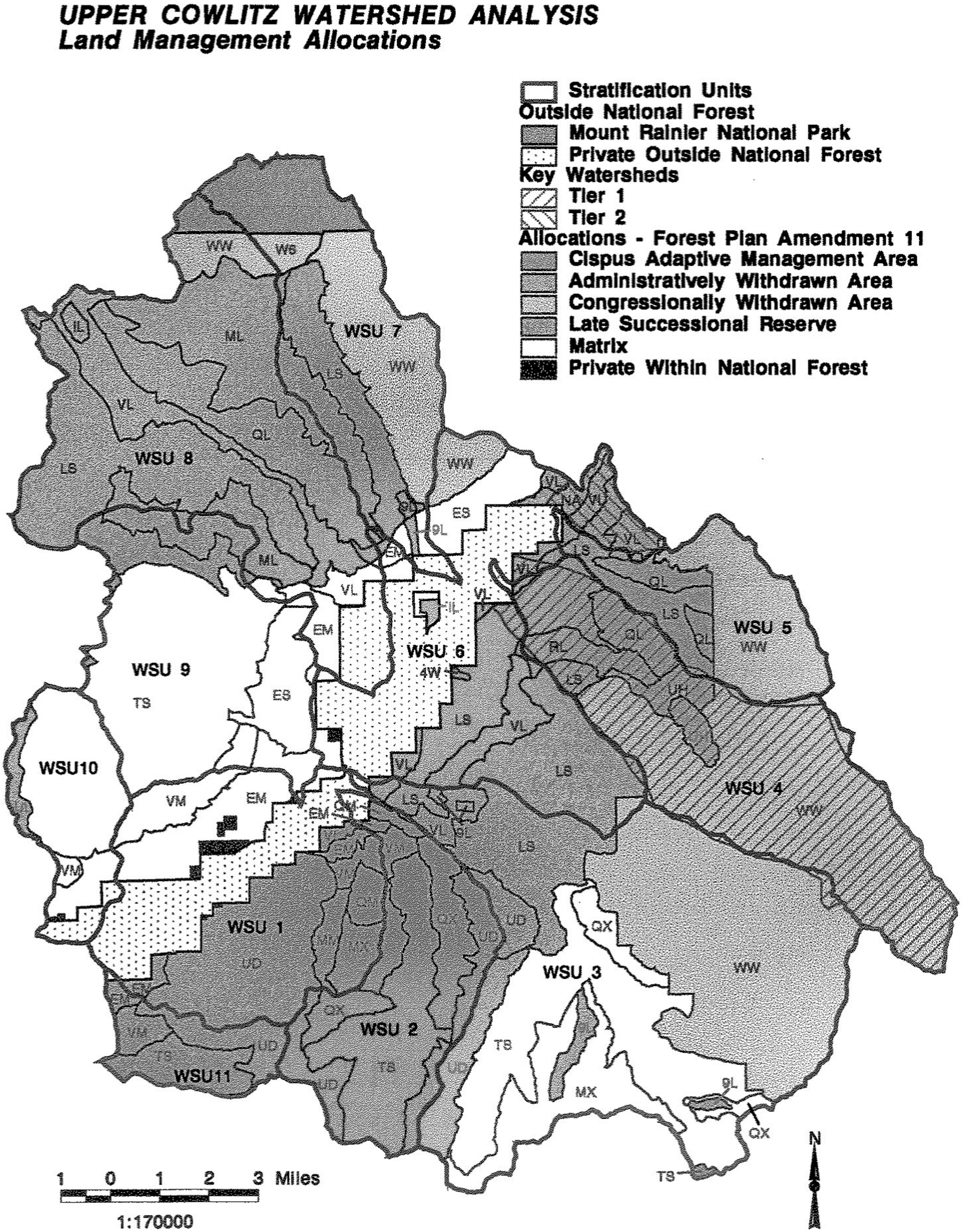

UPPER COWLITZ WATERSHED ANALYSIS
Land Management Allocations
Stratification Units
Outside National Forest
Mount Rainier National Park
Private Outside National Forest
Key Watersheds
Tier 1
Tier 2
Allocations - Forest Plan Amendment 11
Cispus Adaptive Management Area
Administratively Withdrawn Area
Congressionally Withdrawn Area
Late Successional Reserve
Matrix
Private Within National Forest
WSU 1
WSU 2
WSU 3
WSU 4
WSU 5
WSU 6
WSU 7
WSU 8
WSU 9
WSU10
WSU11
1 0 1 2 3 Miles
1:170000
N

Table 1-3: Management Area Categories

MAC Designation	Description	Amendment 11 Pages
LS	General Late Successional Reserves	Pages 5-31 to 5-32
EM and ES	Deer and Elk Winter Range	Pages 6-21 to 6-27
QX and QL	Mountain Goat Winter Range	Pages 5-33 to 5-36 and 6-28 to 6-32
WW	Wilderness	Pages 3-7 to 3-14
WG	Research Natural Area	Pages 4-10 to 4-13
ML, MM, MX	Mountain Goat Summer Range	Pages 5-33 to 5-36 and 6-28 to 6-32
RL	Roaded Recreation without Timber Harvest	Pages 4-14 to 4-16
UD, UH and UL	Unroaded Recreation without Timber Harvest	Pages 4-22 to 4-24
VL and VM	Visual Emphasis	Pages 5-49 to 5-51 and 6-41 to 6-44
9L	Special Interest	Pages 4-17 to 4-21
NA	Scenic River	Pages 5-52 to 5-56
IL	Wildlife Special Interest	Pages 5-57 to 5-59
TS	General Forest	Pages 6-25 to 6-27

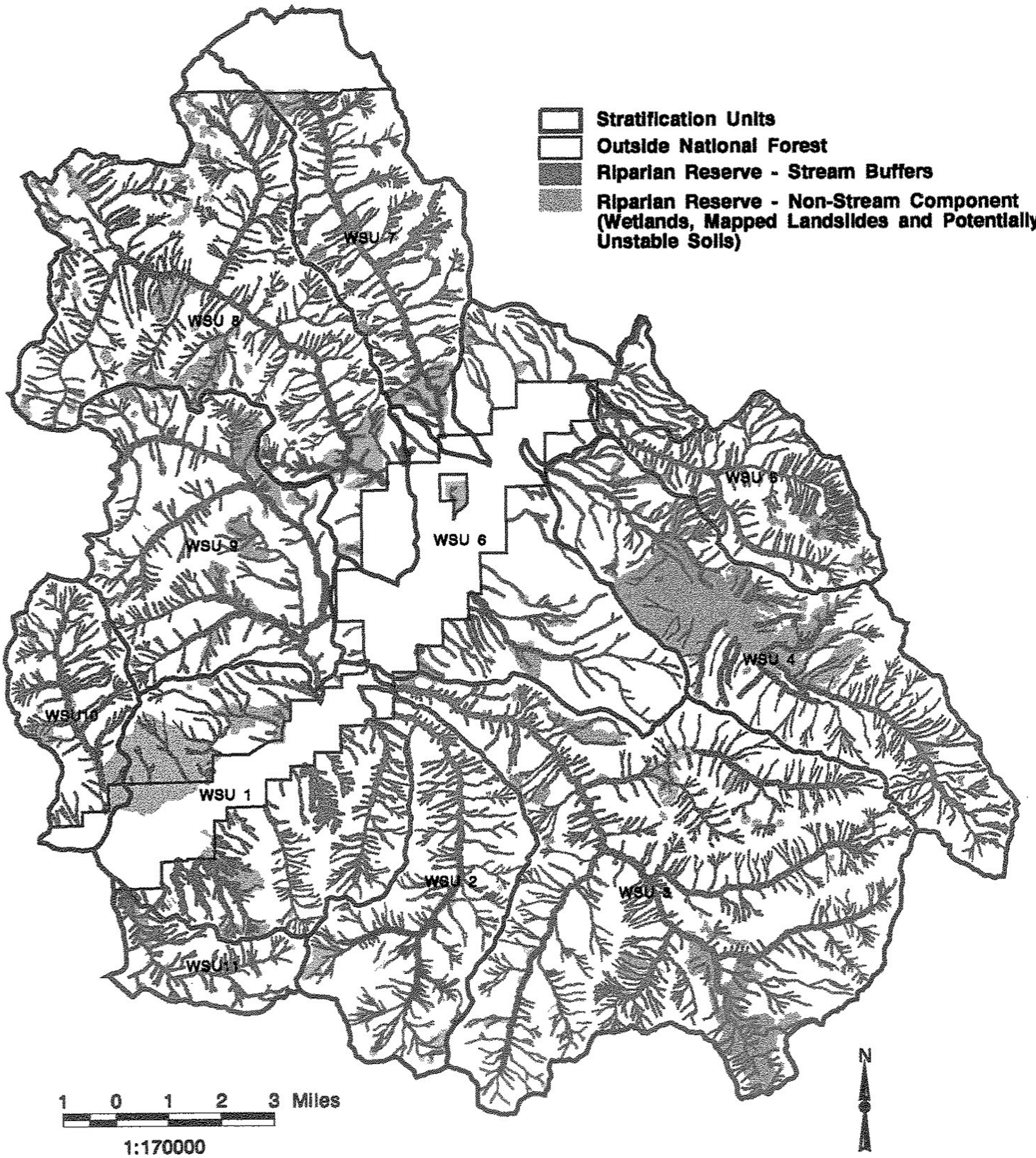
Other Northwest Forest Plan Designations

Riparian Reserves - this allocation includes areas along streams, wetlands, ponds, lakes, and unstable or 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). See Map 5, 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. Lands included within Inventoried Roadless areas that fall within Key Watersheds have special direction that precludes new road construction (Amendment 11, pages 2-10 to 2-11). See Map 4, Land Management Allocations.

Map 5

UPPER COWLITZ WATERSHED ANALYSIS
Riparian Reserves



Chapter 2 - Issues and Key Questions

Within any given land 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 those issues that were deemed most pertinent to management within the upper Cowlitz watershed. The issues and key management questions were developed by the interdisciplinary team in association with the line officer on the Packwood Ranger District. The analysis questions represent the fundamental information needs 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 issue to be addressed by this analysis is to determine whether changes to vegetation, soils, and aquatic features in the upper Cowlitz 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

Are cumulative human impacts preventing the attainment of ACS objectives anywhere in this watershed?

Are there road/trail crossings needing reconstruction for repair or prevention of flood damage?

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

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

Water Quality and Quantity - Analysis Questions

How does the existing landscape compare to the historic/reference (ca. 1880) landscape with regard to forest vegetation patch sizes, shapes, and distribution?

What is the extent of past road construction and use of crossings, campsites, diking, channelization, and floodplain isolation in riparian reserves?

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

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 6th field watershed level?

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

Are Policy Implementation Guidelines (PIG) desired conditions being met at all 6th field subwatershed levels?

What are the dominant stream channel and habitat forming processes in the channel network?

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

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

The issue of economic outputs from the upper Cowlitz watershed is analyzed in the context of the sensitivity of resources required to 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 relative to potential timber harvest, recreational activities, mining activities, fishing and hunting, 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, pre-commercial and commercial thinning appropriate?

Outside of riparian reserves, where and under what circumstances is stocking manipulation, pre-commercial and commercial thinning appropriate?

Are there sensitive habitats within the watershed where vegetation management or other activities should be avoided? Where are they?

What is the proportion of the various riparian reserve types (wetlands, streams, and unstable areas) within the watershed?

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 (ATM 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 have the acres of different structural stages varied over time?

Do current conditions (structural stages) appear to be within an appropriate range given our management direction?

What were the results of past management activities in terms of forest types, spatial distribution, amounts, and temporal distribution?

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?

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

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 upper Cowlitz 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 Forest Plan and ROD standards and guidelines?

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

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

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

How does the current condition of this habitat affect species viability?

How much nesting, roosting, foraging, and dispersal habitat exists for 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 species etc?

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 any of the American Marten network habitat sites?

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 upper Cowlitz 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

Where are there particularly sensitive or special areas which need protection beyond Forest Plan or ROD standards and guidelines?

Does there appear to be a natural cumulative effects problem anywhere in the watershed?

Given adjacent land ownership, what can we assume about future management of private lands within the watershed?

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

Which riparian corridors need protection from human use such as road and trail construction?

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

Ecosystem Function - Analysis Questions

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

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

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

What were historical peak flows?

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 private lands?

What major issues are being faced on adjacent private lands?

Within the riparian corridors, what is the degree of canopy closure, large woody debris recruitment, shading, and stream bank stability?

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 effect ecosystem function?

Chapter 3 - Historic and Current Conditions

Purpose

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 an "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 known from the upper Cowlitz 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.

Social Elements

Past Human Uses

Data Sources

Information on past human use of the analysis area was obtained from reference material on file with the Heritage Program, Gifford Pinchot National Forest. Descriptions of prehistoric human use are based on the interpretation of archaeological data from sites within the upper Cowlitz study area, but necessarily draw upon studies developed for other sites in the entire upper Cowlitz River watershed. The characterization of regional trends incorporates temporal and spatial models of prehistoric land use in the Cascades recently summarized by Burtchard (1997). Much of the data on Taitnapam culture come from interviews with local native people conducted by University of Washington anthropologist Melville Jacobs in 1927. Supplemental ethnographic data include taped interviews with Mary Kiona (ca. 1870-1970), a former resident of the area. Data on historic non-native use comes from a variety of archival source material also on file with the Heritage Program, including diary excerpts, published articles, transcripts of oral history interviews, and several atlases summarizing Forest Service management activities, including grazing permit administration.

Reference (Historic) and Current Conditions

Prehistoric Land Use Patterns

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

Archaeological evidence from sites in the upper Cowlitz watershed suggest 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 upper Cowlitz 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 upper Cowlitz 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 stone from Oregon sources suggests a southern network of exchange that may have involved contact with lower Cowlitz River, Columbia River, or Portland Basin groups. The distribution of toolstone materials in local archaeological sites indicates that local bands - groups living within the analysis area - ranged as far east as the crest of the Cascade Range during annual subsistence forays.

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

Initial human use of the upper Cowlitz area 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) suggest 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 upper Cowlitz basin shows a hiatus in occupation that lasted for nearly 2,000 years.

In re-evaluating potential casual mechanisms which may underlie the hiatus, Kenneth Reid (1993) suggests that we consider the cooling effects of neoglaciation, documented between 3,700 and 2,000 BP (1950 BC to 50 BC). A temporal correlation between glaciation records and vulcanism was noted by Loren Davis, in his recent assessment of vulcanism and culture change in southern Washington (Davis 1995). Davis acknowledges that direct effects of the Mount St. Helens eruptions were more extensive proximal to the volcano, but hypothesizes that more lasting and widespread *indirect* effects may have resulted from atmospheric loading of sulfuric aerosols during eruptive events.

Tephra studies by Mullineaux (1981) and others demonstrate that the western portion of the analysis area was within the zone of thickest tephra deposition, directly downwind from the eruption. Archaeological sites near Packwood, to the east, and near Morton, to the west, lack the deposits of the Smith Creek (set Y) pumice so common in soil profiles near Randle. One of the sites near Morton 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 upper Cowlitz 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.

The Taitnapam

During the 19th century the upper Cowlitz study area lay within the territory of the Taitnapam, or upper Cowlitz, Indians. These people spoke Northern Sahaptin, a language shared with several groups living east of the Cascade Range. Settlements were scattered along the Cowlitz River and larger tributaries between Mossyrock and Packwood. The total population of Taitnapam circa 1840 was estimated at 350 (Ray 1974) but may have been as high as 1000 before epidemic diseases swept through the area at the onset of the historic period (Ellis *et al.* 1991).

Individual settlements were the basis of band organization. Village/band populations varied in size from 20 to 75 people. Settlements were comprised of one or more large cedar wood gable-roof houses occupied by multiple family groups. Two settlements are reported from within the analysis area, including *chawachas*, located "where the present town of Packwood lies", and *temxex*, located southwest of Packwood (Hajda *et al.* 1995, Smith 1964). Using the average estimated populations of settlements prior to the effects of disease, the inferred proto historic resident population of the upper Cowlitz analysis area may have been between 50 and 75 individuals, although at least one source describes *chawachas as* "a thriving Indian village... with several hundred members" (Tompkins 1933). The Cowlitz-Yakima Trail connected these settlements with other Taitnapam communities to the west, fishing sites on the upper river, and Yakima villages to the east of Cowlitz Pass. The Klickitat Trail, a trans-Cascades route through Cispus Pass, connected the Cowlitz valley with other Yakima settlements. Indian trails up Johnson Creek, Skate Creek, and Backbone Ridge have also been reported.

Deer were the most frequently hunted game. Curtis (1913) reports that they were taken at all seasons. Elk, bear, and mountain goats were also hunted, 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. The use of dogs in fall/winter elk hunting is indicated by Curtis (1913). 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 Taitnapam include mountain beaver, marmot, and grouse (Kiona 1964; Smith 1964). Grouse were probably obtained during the late summer when they congregate in huckleberry patches.

Within the upper Cowlitz River watershed, coho salmon, chinook salmon, steelhead, grayling, cutthroat trout, Dolly Varden, and suckers were caught for food (Costima 1934, Yole 1934). Various data suggest that the "grayling" described by native consultants may actually be mountain whitefish. Fish identified as Dolly Varden may actually be bull trout. A variety of methods were used to obtain the fish. According to Jim Yoke and Lewy Costima, dip nets, spears, traps, and line hooks were used. Dip nets made of soft maple and willow were used specifically for salmon. Spears consisting of a pole and detachable point, sometimes double-tined, were also used for salmon and steelhead. Hooks on long ropes were used for trout. Traps were placed in shallow streambeds and apparently included "dams", in Costima's terminology, and basket traps. Packwood Lake is one of the places mentioned where these techniques were used. In addition to immediate use, some fish were dried on racks and stored for future consumption.

A variety of plant foods were gathered by the Taitnapam 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). Huckleberry gathering was usually done by the women and children based at mountain camps during the late summer. Berries were pressed into cakes or dried to a raisin-like form on mats laid atop wooden racks or directly on the ground. Taitnapam from Cowlitz valley settlements traditionally used berry patches on Tatoosh ridge, within the analysis area. Fires were purposefully set to promote productivity of huckleberries in mountain locations (Kiona 1964, 1965).

Salal berries, wild strawberries, red elderberries, thimbleberries, salmonberries, blackberries, and the berries of Oregon grape were also eaten (Gunther 1945). Camas was the most important root food. The bulbs of the Camas and several other lilies were collected and baked in earth ovens. Greens of wild celery (water parsley), wood sorrel, and rhizomes of several ferns were collected and eaten in the spring. A wild onion, probably *Alium cernuum*, was gathered on Skyo Mountain (Kiona 1965). Some Taitnapam traveled over the mountains to the Tieton River valley to collect bitterroot and *Lomatium* (Yoke 1934).

Interaction with non-native people began in the period ca. 1833-1840 as local Indian people took their furs to the Hudson's Bay Company trading post at Cowlitz Farm, near present-day Toledo. By 1882, however, few Indians remained in the area, which had been almost totally depopulated by smallpox, according to Tompkins (1933). The smallpox epidemic occurred in 1853, but the effects of endemic malaria in the 1830s and the appearance of measles at Cowlitz

Farm in 1848 may also have contributed to a 85% population loss by 1860 (Boyd 1990). Government treaty negotiations in 1855 proposed removal of the Taitnapam, grouped with the Cowlitz, to a new reservation on the coast of Washington. Tribal leaders objected to the proposal and treaty negotiations came to a halt. Despite this, the United States government formally and unilaterally extinguished Indian title to all lands in the upper Cowlitz River basin in 1864.

The upper reaches of the Cowlitz River remained isolated. It was not until 1861 that non-native explorers first reached the Cowlitz valley near present-day Packwood, encountering Indian people at the village of *chawachas* (Hajda *et al.* 1995). The expedition, led by William Packwood and James Longmire, consisted of a reconnaissance party from Olympia, scouting the location for a road to the Yakima Valley via Skate Creek (DeLacy 1861). Until the 1880s, non-native visitation was infrequent. The accounts of two mountaineering expeditions describe *chawachas* in 1870, but reports of Northern Pacific Railroad surveys in 1878 and 1880 make no mention of Indian camps or villages. At least one native of *chawachas*, Jim Yoke, continued to live in the Packwood area through the period of non-native settlement, filing a homestead claim to ensure title to the land.

Historic Period Land Use Patterns

A significant shift in human land use occurred between 1880 and 1890. It was during this decade that the cultural composition of the area 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 began to establish land claims in the area in 1883 and 1884. The settlers brought with them the traditions of agricultural subsistence, property ownership, and the desire to become part of a regional market economy.

Agricultural subsistence required land suitable for cultivation or the grazing of livestock. For most settlers this initially meant the hard labor of clearing maple and alder thickets along the Cowlitz River. Using slash and burn methods, and "stump-grubbing", pastures and fields were established throughout the valley bottom (Anonymous 1890). Horses were initially scarce, so oxen were used as the first draft animals (Fechtner 1939). Oats, wheat, potatoes, carrots, onions, cabbage and other vegetables were raised for personal use, and timothy raised as feed for livestock (Davis 1902). Horses, dairy and beef cattle, hogs, sheep, chickens and turkeys were raised on the family farms. Beef cattle raised in the valley were driven to market in Chehalis. Turkeys were taken to Elbe and shipped by rail to Tacoma markets (Fenby 1981).

By 1890 there were 20 families living along in Cowlitz River valley bottom within the analysis area (PCSP 1954). The primary access to their farms and ranches was by way of the old Indian trail (Cowlitz-Yakima Trail) which followed the north side of the Cowlitz valley, and was essentially limited to packhorses. In 1910 this route was improved to accommodate wagon traffic. The earliest wave of settlers to the area came from many different places. Although German, Irish, and Canadian immigrants were among the number, most were of American birth. After 1900 the local population grew as large numbers of Appalachian highlanders migrated to the area from the hills of Kentucky, Tennessee, Virginia, West Virginia, and North Carolina (Clevenger 1938). Most were drawn by prospects of economic improvement that included land, seasonal employment, and the opportunity to supplement small-scale farming with subsistence hunting and fishing. Within a generation, the lifestyle, folklore, philosophy, and religious traditions of the Appalachian region had become the foundation of the local culture.

The post office of Sulphur Springs, on a homestead opposite the mouth of Johnson Creek, served the area settlers beginning in 1890. The town of Randle, established in the same year, served residents of the upper "Big Bottom" for twenty years as the nearest place to purchase goods and supplies. As a more local commercial center, the town of Packwood was established not so much to serve the scattered local farming community as to capitalize upon an influx of workers hired for the construction of a hydroelectric project at Packwood Lake. After several years of reconnaissance and survey, the Valley Development Company initiated developments that were to have included a dam at Packwood Lake and a penstock and flume line to divert water to an electric power generating plant. In 1910 the company hired 125 men as construction workers, 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, named Lewis to honor the president of the Valley Development Company. The name was changed to Packwood in 1930.

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. Several of these claims were developed on lands 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 Lewis (Packwood) in 1923.

Grazing permit administration was but one aspect of early National Forest management. During the 1920s and 1930s, personnel based at the Packwood Ranger Station were also involved in trail construction and maintenance to improve access for general forest administration and fire suppression. Fire patrols and lookout stations were established for fire detection. Within the analysis area, fire lookout stations were built on Tatoosh Mountain, Pompey Peak, Dry Creek, Smith Point and Hawkeye Peak. In 1933 the Army established a Civilian Conservation Corps (CCC) at Packwood. CCC enrollees were engaged in a variety of "forest improvement projects" in the District from 1933 to 1942. Major accomplishments within the analysis area included construction of a complex of buildings at the Packwood Ranger Station.

The agricultural focus of the Upper Cowlitz area was gradually replaced by an economy oriented toward exploitation of 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 (PCSP 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).

Heritage Resources

Evidence of past human use in the study area exists in the form of prehistoric and historic archaeological sites and features, standing historic structures, trails, and historic landscapes. Natural landscape features associated with the oral traditions and religious beliefs of the Taitnapam people also occur within the area. Heritage resources are documented through the process of cultural resource inventory by field surveys for specific land management activities. Since 1975 a large number of survey projects have been conducted within the analysis area, most in conjunction with the timber sale program. A total of 85 cultural resource sites have been identified within the analysis area as a result of these surveys.

The largest number of cultural resource properties are represented by historic buildings, structures, and sites, from the period ca. 1890-1942. Examples of existing buildings from National Forest land include Packwood Lake Guard Station (1910) two historic residences at the Packwood Ranger Station (1931), and a barn at the Skate Creek compound (1937). Documented historic period archaeological sites include the locations of several former fire lookout stations, trail shelters, collapsed cabins, and former timber claim "homesteads" with no remaining standing structures. Many additional undocumented sites and buildings exist on private land, among them several homes and farms associated with non-native pioneer families, and several buildings in the town of Packwood, including the Packwood Hotel.

A number of historic trails have been identified during cultural resource surveys. Among the best preserved of these is the Klickitat Trail (#7), recently determined eligible to the National Register of Historic Places (Roulette 1997). A few segments of the Cowlitz-Yakima Trail have also been identified within the analysis area.

Thirty-five prehistoric archaeological sites have been recorded on National Forest and private lands within the analysis area (Table 3-1). The sites represent occupation by Native American peoples from ca. 4000 B.C. to the historic period. Distribution spans the entire range of ecological zones represented within the study area, from the Cowlitz River floodplain to the crest of the Cascade Range. Site types include rock shelters, subsurface lithic scatters, and toolstone quarries. Peeled cedar tree sites, most probably of historic period age, are included among the total number of prehistoric sites. Additional, as yet undocumented sites likely exist throughout the analysis area.

Table 3-1: Cultural Resource Site Inventory.
Upper Cowlitz Watershed Analysis Area

WSU	Prehistoric Sites	Historic Sites	Historic Trails	NRHP Sites
1	1	6	2	2
2	0	1	1	1
3	12	3	1	9
4	8	6	0	2
5	0	2	0	0
6	7	13	0	8
7	3	2	0	2
8	3	3	1	0
9	0	2	1	0
10	1	6	1	0
11	1	0	0	0
total	**36**	**44**	**3***	**24**

* Three trails total, overlapping several sub-basins. (formally documented trails only)

An inventory of ethnographic sites conducted 1992-1995 identified 30 traditional cultural places within the analysis area (Hajda *et al* 1995). These places are of possible significance to descendants of local Taitnapam families, including enrolled members of the Yakima Indian Nation. The locations include traditional camps, fishing locations, and places where subsistence resources were gathered. *Paxutaasha* and *sim-sim*, for example, were traditional berry patches in the Tatoosh Range; *Likalwit* was a major fishing site located at the junction of the Clear Fork and Muddy Fork.

Recreational Uses

Data Sources/Data Gaps

Information on recreation use 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 a recreation database (Infrastructure), road counter summaries, the wilderness use database (WILDPERM) and from the observations of personnel. Historic information on recreational use and dispersed site inventories and conditions are rare or nonexistent for most areas including wilderness.

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 and Goat Rocks Wildernesses. An informal dispersed site survey was conducted for a portion of the Skate Creek corridor in 1990. 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 90's.

There is limited information on the amount and type of recreation that is occurring on private lands within the watershed.

Assumptions

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

Reference (Historic) and Current Conditions

Historic Conditions

Prior to 1940 most of the National Forest in the upper Cowlitz watershed area was unroaded. On the 1939 Columbia National Forest Map, the only significant Forest Service roads in existence in the upper Cowlitz watershed were 5 miles of what is now known as Forest Road 21 (Johnson Creek Road) and approximately 1 mile of what is now known as Forest Road 5290. All other roads, including what is now Highway 12, were on private or non-National Forest land in the vicinity of the town of Packwood. The trail system at this time was fairly extensive and most trails networked to a trail system that had trailheads at or near the Cowlitz River and Highway 12. As the area became more heavily roaded, numerous trails were shortened or abandoned including trails along Skate Creek, Skate Mountain, Davis Mountain and Snyder Mountain.

At various times prior to the 1970's, three small campgrounds existed adjacent to Highway 12 within the upper Cowlitz watershed. Coal Creek campground was located approximately 3 miles east of Packwood on the south side of the highway at Coal Creek. River Bar Campground was located on the north side of the highway, also approximately 3 miles east of Packwood (just east of the Coal Creek Campground site) along the shore of the Cowlitz River. Approximately 8 miles west of the town of Packwood was Maple Grove Campground. These campgrounds were abandoned because of problems with flooding and vandalism.

Packwood Lake - Small primitive campground, rustic cabin rentals, small store, boat rentals. Campground facilities were removed in 1989 and the cabins, store and boat rentals were discontinued because of concerns with maintenance, safety, sanitation, fishing pressure on wild fish populations and poor prospects for economic viability of the operation.

The two privately operated campgrounds outside the National Forest boundary, NACO West Rainier Park and Packwood RV Park were built in 1988 and 1975, respectively.

Wilderness - The Goat Rocks Primitive Area became the Goat Rocks Wilderness by an act of Congress in 1964. Additions were made to the Goat Rocks Wilderness in 1984 along with the creation of Tatoosh Wilderness. Portions of both of these wildernesses lie within the upper Cowlitz watershed.

Current Conditions

There are currently no developed campgrounds on National Forest lands within this watershed, although LaWisWis campground (approximately 100 units) is just outside the watershed to the east. Two private recreational parks are within the watershed: Packwood RV Park (75 camp units) in the heart of the town of Packwood and NACO West Rainier Park (700 camp units) approximately 6 miles west of town. Approximately 11,000 people stayed at the Naco West Rainier Park in 1996.

Dispersed Recreation (general/non-wilderness) - Road counts indicate that the heaviest road use occurs along Road 5200 with 50,515 vehicles annually (219 vehicles daily). Use on this road has increased 12% since 1993. A significant portion of this traffic is commercial and passenger vehicles traveling to and from the southern Puget Sound via Highway 12. A total of 20,388 vehicles were recorded on Road 2100 in 1996, a 38% reduction since 1993. Highway 12, which bisects the watershed, accommodates 1.7 million vehicles annually (4,800 daily). Table 3-2 shows relative use levels based on road counts for several roads within the watershed. (Road counts are not available for all roads).

Forest Road 5200 along Skate Creek is an area known to have extensive camping and fishing activity. In a 4 ½ mile stretch starting approximately 7 miles from the town of Packwood, approximately 24 dispersed recreation sites were identified with evidence that nearly half are being periodically used as overnight campsites. Sanitation, litter and stream side vegetation trampling have been noted in these areas. Other areas with relatively high levels of dispersed recreation activity include: the Jackpot Lake area along FR 20 in WSU 2 (primary activities are hiking, hunting, berry picking); the upper Hager Lake drainage on the FR 48 system in WSUs 3 and 5 (primary activities are hiking, hunting); Johnson Creek drainage along FR 21 in WSU 3 (primary activities are hiking, hunting). Road condition surveys conducted in this watershed in 1994, 1995 and 1996 have been valuable in confirming popular dispersed recreation areas by including documentation of fire rings along roadways. Heavy concentrations of fire rings were noted in the Skate Creek area in WSU 8, the Hager Lake/Snyder Lake area in WSU 5, and the Long Lake/Willame Lake area in WSU 9. All of the non-wilderness trails in this watershed are considered to have low or low to moderate use levels.

Table 3-2: Road Counts

Road #	Average Daily Vehicle Count	Yearly Vehicle Count	% Change (since 1993)	Year of Last Vehicle Count
Highway 12	4,800	1,700,000	+ 6%	1996
5200	219	50,515	+ 12%	1996
2100	56	20,388	- 30%	1996
1260	58	4,341	NA	1994
4700	83	4,640	NA	1994

Highway 12 is a designated National Scenic Byway from the Gifford Pinchot National Forest boundary near Coal Creek to the east near Naches, Washington. Approximately 2 miles of the Byway are within this watershed.

Recent local projects within the watershed include the creation of a rest area approximately 5 miles west of Packwood on Highway 12 and a community sports field that is currently under construction between Cannon Road and Skate Creek Road.

Trails

There are currently 24 trails and 93 trail miles within the watershed. General maintenance 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 and Special Uses, for trail locations.

The Access and Travel Management (ATM) Plan identified several Roads-to-Trails opportunities within the upper Cowlitz watershed. Many of the Roads-to-Trails proposals need further study to determine feasibility of a road-to-trail conversion although it is anticipated that most would be viable projects. The following is a brief summary of Roads-to-Trails projects in the upper Cowlitz watershed.

- Long Lake/Willame Lake, WSU 9 (see also Middle Cowlitz WA); Potential for approximately 16 miles of new trail with approximately 12 miles within this watershed.
- Silver Loop (formerly Sawtooth Loop), WSU 8 (a portion is within the Nisqually River drainage); Potential for approximately 14 new trail miles with approximately 3 - 4 miles within this watershed.
- Lookout Mtn., WSU 8 (a portion is within the Nisqually River drainage); Potential for approximately 3.6 new trail miles with approximately 2 miles within this watershed.
- Road 2020/South Point Loop, WSU 2; Potential for approximately 13 new trail miles.
- Dry Creek Pass, WSUs 1 & 2; Potential for approximately 12 new trail miles.
- Purcell Mountain Loop, WSU 10; Potential for approximately 3 new trail miles.
- Angry Mountain Trail Extension, WSU 3 ; Potential for approximately 0.6 new trail miles.
- Klickitat Trail, WSU 2; Reestablishes trail route where road and trail currently coexist.

In addition, since the ATM and Roads-to-Trails proposals were developed in 1995, additional possible trail projects have been identified. These include:

- Jordan Creek Trail #94, WSU 3 - possible trailhead relocation ; Potential for approximately 1 to 1.5 new trail miles.

- Tatoosh Trail #161 (Butter Crk. Trailhead), WSU 7 - possible trailhead relocation; Potential for approximately 2 new trail miles.
- Dry Creek Trail #125, WSU 2 - improve access/trailhead.
- Purcell Mtn. Trail # 284, WSU 10 - improve access/trailhead.
- Johnson Creek Sno-park, WSU 3 - expand and improve the existing parking facilities for up to 30 vehicles and construct late season snow parking along Road 2100 between Glacier Creek and Wright Lake.
- Road 52/47 Sno-park, WSU 8 - formalize parking for snowmobile use on Road 5200 by designating this as a sno-park, request plowing, signing and sanitation funds.

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 and Special Uses). An additional area, tentatively known as the Stonewall Roadless Area, was identified in 1990 and also meets the RARE II criteria. There are 30,413 acres of Rare II Roadless Area within the watershed plus approximately 4,000 acres of the Stonewall Roadless Area that are within the watershed.

Wilderness Use and Site Information

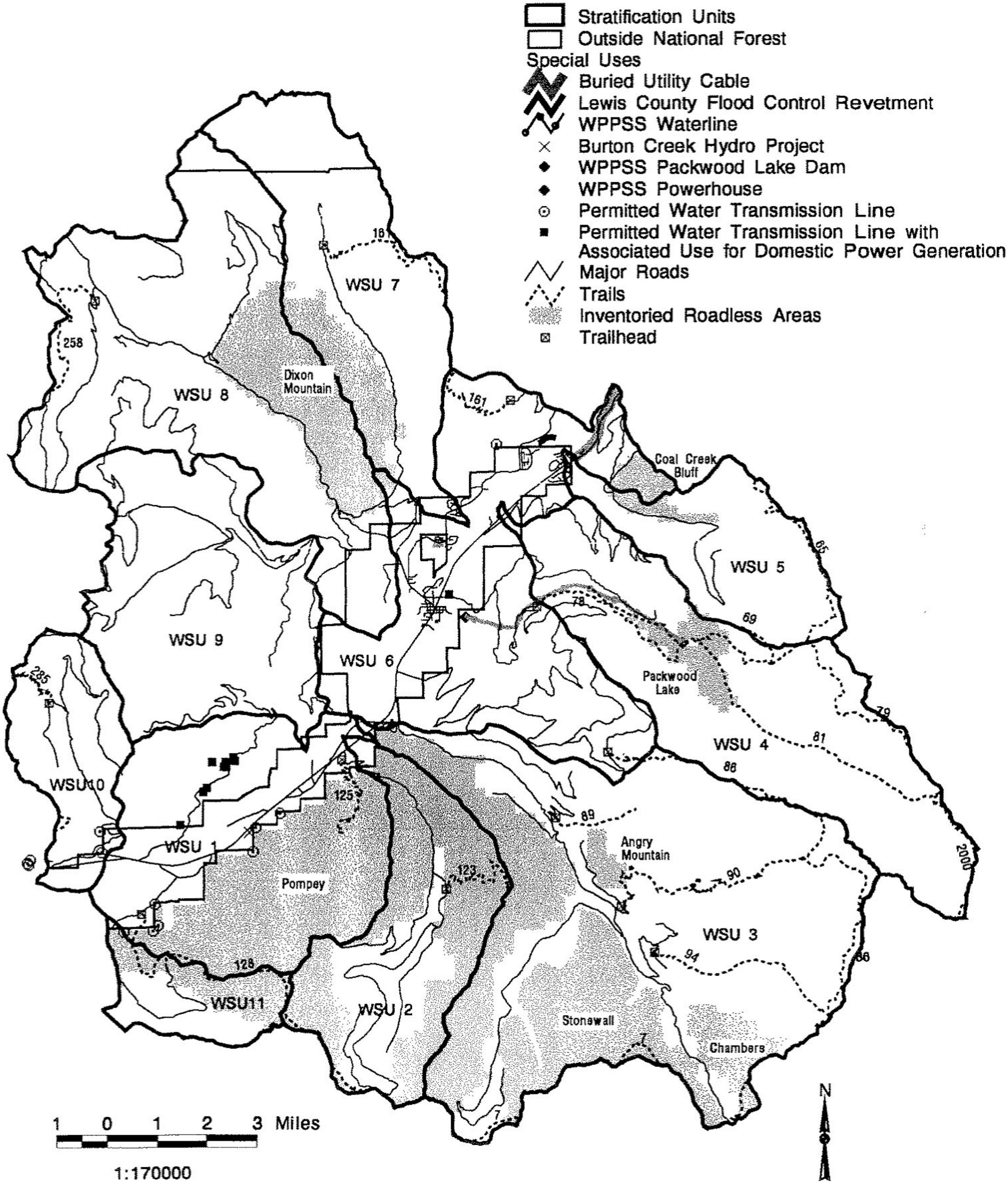
Table 3-4 shows average annual use estimates for each wilderness trail with a trailhead and/or registration box within the upper Cowlitz watershed. These estimates are based on permit registration information collected from 1992 through 1996 with adjustments for permit compliance. Moderate to heavy use has been documented on Packwood Lake Trail #78, Upper Lake Creek Trail #81 and Lily Basin Trail #86. Tatoosh Trail #161 has two trailheads, both of which are within the watershed. 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, Glacier Lake Trail #89, Angry Mountain Trail #90 and Jordan Creek Trail #94.

The WILDMON database includes an inventory of all known sites within wilderness and the associated physical impacts for each site. Information such as distance to the nearest trail and

Map 6

UPPER COWLITZ WATERSHED ANALYSIS
Recreation and Special Uses



distance to the nearest water source are included along with eight site specific indicators that are used to develop a site condition rating.

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 3-3 summarizes the number of sites (excluding reference sites), average site condition and the percent of sites believed to be located within 300' of water sources by Watershed Stratified Units (WSU).

Table 3-3: Wilderness Campsites - Total Number of Wilderness Sites/Campsites, Average Condition Rating and % within 300' of Water Sources by Watershed Stratified Units

WSU (Wilderness)	# of Sites	Avg. Condition Rating	% Within 300' of Water Sources
3 - (Goat Rocks)	21	2.6	76%
4 - (Goat Rocks)	40	2.8	88%
5 - (Goat Rocks)	17	2.5	76%
7 - (Tatoosh)	18	2.1	17%
Total	**96**	**2.6**	**70%**

Table 3-4: Wilderness Trail Use - Day and Overnight Trail Use for Goat Rocks and Tatoosh Wildernesses within the Upper Cowlitz Watershed from 1992-1996

Goat Rocks Trails	Overnight Backpackers	Overnight Stock Users	Day Hikers	Day Stock Users
Three Peaks #69	56	8	20	4
Packwood Lake #78	112	32	114	34
Upper Lake Crk. #81	224	74	172	43
Lily Basin #86	153	23	156	22
Glacier Lake #89	103	9	316	12

Table 3-4: Wilderness Trail Use - Day and Overnight Trail Use for Goat Rocks and Tatoosh Wildernesses within the Upper Cowlitz Watershed from 1992-1996

Goat Rocks Trails	Overnight Backpackers	Overnight Stock Users	Day Hikers	Day Stock Users
Angry Mountain #90	14	0	24	2
Jordan Creek #94	16	4	26	4
Totals	**678**	**150**	**828**	**121**
Tatoosh Trails	**Overnight Backpackers**	**Overnight Stock Users**	**Day Hikers**	**Day Stock Users**
Tatoosh #161N	176	15	397	16
Tatoosh #161S	37	9	99	13
Totals	**213**	**24**	**496**	**29**

Accommodations

Available hotel/motel accommodations have increased dramatically since 1980. Prior to 1980 there were approximately 50 individual units available in the Packwood area. There are currently over 180 available units.

Two private RV/camping parks are within the watershed. NACO West RV Park, with 700 camp units, was a private RV park until 1990 when they made camp sites available to the public. NACO West estimates they have 11,000 camper nights per year. Packwood RV Park, in the town of Packwood, has 75 camping units.

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 Randle and Packwood Ranger District permit database. Generalized information is known about where harvest is occurring. This information is primarily from knowledge of where products grow, administration of Special Forest Product permits, law enforcement personnel and other forest users.

Assumptions

The number of permits issued and amount of harvest specific to the Upper Cowlitz watershed is not known. Areas where specific products are known to be harvested are noted by WSU.

Reference (Historic) and Current Conditions

Special forest products have been gathered throughout the Randle and Packwood Ranger Districts and the watershed for at least the last 6,000 years. These activities involved mainly the harvest of forest resources for consumption, medicinal and ceremonial uses, building materials, sale or trade.

In the past decade commercial demand for traditional and non traditional special forest products has increased substantially. Plants such as salal and beargrass have increased in popularity as a floral green. A permits is required to remove any product from National Forest lands. 3,831 permits were issued in 1996 on the Packwood and Randle Ranger Districts for the commercial harvest of special forest products including: salal, beargrass, mushrooms, firewood, transplants, and boughs.

Table 3-5 lists Special Forest Products commonly harvested within the Upper Cowlitz watershed. Estimates of amounts of harvest are based on permit sales. The majority of the harvesters buy permits on the day they harvest due to wide demand and price differences within the market.

Table 3-5: Commercial Special Forest Products - Primary Products Harvested on the Packwood and Randle Ranger Districts.

Product	WSUs with Known Harvests	Permits Issued (1996)	Year Permits First Issued	$ Value	Elevation Typically Found
Mushrooms	1, 2, 6-10	137	1991	$5,670	< 3000 ft
Beargrass	4,6,7,8,9,10	518	1989*	$39,700	> 3000 ft
Salal	1-10	664	1989*	$33,200	< 3000 ft
Stewardship/Bough Sales	2,5,6,9,10	29	1989*	$178,919	> 3000 ft
Personal Use Firewood	All	1,061	1989*	$13,460	1000-5000 ft
Christmas Trees	2-10	1,354	1989*	$6,770	1000-5000 ft
Ferns	10	39	1989*	$550	1000-1500 ft
Moss	Unknown	29	1989*	$610	1000-1500 ft

* *First year records were recorded.*

Berries, mushrooms and transplants are three of the most popular Special Forest Products gathered under free use permit. Berries are harvested throughout the watershed primarily in stands above 2,000 feet. Table 3-6 summarizes some of the known information about these products for the Packwood and Randle Ranger Districts.

Table 3-6: Free Use* Special Forest Products - Primary Products Harvested on the Packwood and Randle Ranger Districts.

Product	Known Harvest by WSU	# Permits Issued (1996)	Year Permits First Issued	$ Value
Edible Berries/Mushrooms	All	4,210	1991	$42,100
Small Transplants	Unknown	44	1989**	$391
Cedar/Hardwood Transplants	Unknown	29	1989**	$265

* *Free Use means no charge for the permit*
** *First year records were recorded.*

Markets and weather conditions dictate the demand for permits to harvest these products. Prior to 1991 little was known about Matsutake mushrooms in the Randle and Packwood area. The commercial potential for this product was discovered in 1991 when an abundant crop brought hundreds of harvesters to the area. Areas under 2,500 feet in elevation with salal ground cover provides good habitat for Matsutake and Chantrelle mushrooms.

Forest management activities affect availability and distribution of the products. The effects depend on site treatment. It has been noted that Chantrelle mushrooms often take 20 to 30 years to return in abundance following stand site treatments such as regeneration harvest and burning. Beargrass and salal of commercial value are abundant in stands over 50 years of age.

Road access is a key factor in determining where forest products are harvested. Gathers will walk to harvest products, but will not carry forest products more than a couple of miles to a road. All Terrain Vehicles (ATVs) area also used were roads are not passable to standard passenger vehicles or pickups.

Lands, Minerals, and Special Uses

Data Sources/Data Gaps

The primary data sources for land use adjustments are related files from the Gifford Pinchot National Forest Headquarters and the Packwood and Randle Ranger Districts. The primary data sources concerning the management of the adjacent private lands are the Packwood and Randle Ranger District *Lands and Special Uses* files regarding right-of-way, road cost/share, cooperative maintenance, land exchange and special use permits issued during the last several years.

The primary data source for mining activities is the current (9/96) USDI, Bureau of Land Management, *Geographic Claims Listing* for unpatented mining claims, as recorded by the BLM mining claims office, Portland, OR. Although the listings can be up to 6 months old, the current claim listing is typical of activities within the watershed analysis areas during the last several years. Public records of active claims indicate little, if any, mining activities. While the Forest Service does deal with owners of claims not filed with the BLM, few reports of such claims have been received by either the Packwood or Randle Ranger Districts.

All private uses of National Forest lands, (excluding common recreational activities), timber harvests, grazing and mining require prior authorization through a special use permit. The primary data sources for special use authorization within the watershed analysis area are the Packwood and Randle Ranger District special use files.

Assumptions

Given the extensive shared boundary between National Forest, private, and lands managed by other agencies, land use adjustment activities are expected to be continual and ongoing.

Reference (Historic) and Current Conditions

Management of Adjacent Lands

Large Land Holdings

In the past, corporate and state land holdings within and adjacent to the watershed analysis area were managed for the maximization of income from timber harvests. Investments were subsequently made in replanting and pre-commercial thinnings, in anticipation of future commercial harvests. Investments in construction and maintenance of transportation facilities were commensurate with management of these lands for current and future timber production.

In the past ten to fifteen years, these same lands have been cut over and replanted, consolidated via land exchanges, and are now subject to more restrictions on harvest activities. Timber management activities, from planting through harvest, have become concentrated on lands still reasonably remote from the residential interface. Large corporate land holdings adjacent to the residential interface could be (and have been) sold to residential developers or individual home owners.

Small Land Holdings

Small land holdings in the watershed analysis area vary from large farms to small lots for private homes. As income from farming and logging diminishes, there will be increased pressure on small landowners to log and/or subdivide their lands. Some investors purchase small timbered parcels of lands, harvest the timber and then resell to developers or prospective home builders. A number of such properties are located adjacent to the National Forest boundary within the watershed analysis area.

Mineral Activities

The Packwood and Randle Ranger Districts, including the watershed analysis area, have been open to mineral explorations for more than a century. In areas of commercially viable mineral deposits, the interests of mineral prospectors have continued unabated to the present. However, based upon district and BLM records, the upper Cowlitz watershed is not an area where there has been, nor is there likely to be, extensive interest in mineral prospecting and development. We might expect an occasional mining claim at the pick, shovel, panning, and possibly suction dredging levels.

New mining claims for locatable minerals cannot be established within wilderness areas. Mining activities are permitted if valid rights were obtained prior to the establishment of the wilderness area. There are no records of such rights within the Goat Rocks or Tatoosh Wilderness areas.

Special Uses

A review of district files indicate three general categories of special use authorizations relevant to watershed analysis. These categories include authorizations of water transmission lines, underground utilities, and private use of National Forest roads. There are also some special activities permitted on a case-by-case basis. See Map 6, Recreation and Special Uses.

Water Transmission Lines

A special use permit for a water transmission line authorizes the placement of a pipeline, on National Forest land, to transport water from a diversion point (usually a catch basin or a small cement or rock diversion dam) to the National Forest boundary. This differs from the right, or authorization, to actually draw water from a stream, which must be obtained from the State of Washington. In the watershed analysis area, all such pipelines continue past the National Forest boundary onto private residences. Transported water is used for domestic purposes and/or to power small generators to produce electricity. There are currently 19 permits authorizing water transmission lines, located in WSU's 1, 6, and 10. These lines have been in place for varying periods of time. The most recent was authorized in 1994. The majority date from 1962 to 1989. The oldest dates from 1931. There are likely other water transmission lines in existence that the Forest Service is not aware of.

Utility Lines

Short segments of buried utility lines are found on National Forest land, within WSU 5. These lines, less than 3 miles in length, are located along Highway 12 and Cannon roads. They provide phone and electrical service to La Wis Wis campground, privately owned lands within the town of Packwood, and National Park facilities at Ohanapacosh. The useful life of new underground utility lines is currently about 30 years. It is expected that existing utility lines will be replaced periodically. Ground disturbance during installation of new buried lines varies with terrain and soil types. In deep soils, special equipment can be used to easily plow new lines into roadside areas with little soil disturbance. Special equipment can also push lines beneath streams and riparian areas with minimal disturbance. Where soils are rocky, backhoe trenching may be necessary.

Private Uses of National Forest Roads

Existing National Forest roads within the watershed analysis area provide owner access to private lands within or adjacent to the National Forest. These lands range from the small holdings of timber companies along the Highway 12 corridor to small residential lots. By various federal laws, the Forest Service must grant access to private landowners when the most reasonable route is across the National Forest or along National Forest roads. Access authorizations are usually granted through a permit or, more rarely, by easement. The majority of these authorizations within the watershed analysis area have involved the use of existing, functional Forest Service roads. In rare instances, the Forest Service may issue permits that authorize minor reconstruction of existing National Forest Roads to facilitate access. The Packwood Ranger District does receive occasional inquiries from telecommunications companies concerning the building or use of existing National Forest roads for accessing potential communication sites located in remote, high-elevation areas.

Forest Road 52, (Skate Creek road) is a favored route for various commercial and recreational traffic between Packwood and Ashford. Authorizations for commercial activities are usually by permits. In recent years, fees generated by permits issued by the Packwood and Randle Ranger Districts have provided additional funding for the maintenance of Forest Service roads. Approximately 18 miles of Road 52 remain under the jurisdiction of the Forest Service as a forest development road. Both ends of the road have been improved during recent years to the point where Lewis County has taken over day-to-day management and maintenance. The Forest Service has continued, by various means, to upgrade the road to meet the standards at which the county would assume management responsibilities.

U.S. Highway 12 is governed by a Forest Service / Washington State Department of Transportation (DOT) MOU for forest highways over National Forest lands. The Washington State DOT manages and maintains Highway 12 within the watershed analysis area. Maintenance and small reconstruction projects are ongoing activities in which the Forest Service's degree of involvement varies with the intent of the DOT project. For example, the Forest Service may supply rock materials or permit the use of National Forest sites for materials storage. Activities range from surfacing and bridge replacement to the construction of truck run-away ramps.

Private Commercial Hydroelectric Generating Facilities

Private power generating facilities operating under FERC licenses include WPPSS Packwood Lake facilities (FERC Licence No. 2244) and the Burton Creek Hydro.

The Packwood lake facilities include a dam, diversion, and intake structures at Packwood Lake, pipelines, a surge tank, penstocks, a power generating plant, and trailrace channel. All of the facilities, except for most of the trailrace channel, are located on National Forest land. Special Use Permits have been issued to WPPSS for minor support facilities, such as a service road and a boathouse at the dam.

The current license will expire Oct. 28, 2028. Relicensing is contingent upon the applicant's mitigating past and present impacts on the adjoining National Forest lands.

The Burton Creek Hydro is a small facility, located primarily on privately owned land. It is currently not operating. A Special Use Permit has been issued for a pipeline on National Forest lands, used to draw water from Burton Creek for domestic purposes.

Other miscellaneous special, road, and minerals uses include the repair of roads, and the building or rebuilding of flood control facilities. Area flooding, due to heavy winter and spring precipitation events in the last few years, has resulted in more multi-agency flood control and repair activities. Such activities include road repair and the installation or repair of Lewis County Cowlitz River flood control revetments for the protection of High Valley subdivisions outside of

Packwood. To facilitate these and other projects, the Forest Service has authorized the use and construction of temporary roads and bridges, the extraction of rip-rap from established quarries, and the partial placement of revetment facilities on National Forest lands (pursuant to the issue of a Special Use Permit).

Holders of Special Use Permits for outfitter/guide services and apiary (bee keeping) activities also make use of various roads in the watershed analysis area for access to trailheads and the placement of bee hives.

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. These recruitment periods may range from 50-75+ years at higher elevations and harsher environments. Fire history must also 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 upper Cowlitz watershed is based on stand age analysis. Stand age was determined by use of the GIS vegetation layer (IVEG), based on stand exam information, professional judgement, personal on-the-ground knowledge, and aerial photo interpretation. Due to the lack of stand data on private and national park land, fire history analysis is confined to the National Forest portion of this watershed analysis area.

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, 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 their effects is quite large and should be made only for the entire Cowlitz watershed area. No assumptions, interpretations, or recommendations can or should be made about historic fire disturbance at the WSU 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 the most significant disturbance mechanism in the 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 potential natural wildfire effects for 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.

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 upper Cowlitz 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, three large fires have burned in the upper Cowlitz watershed analysis area. See Map 7, Fire History. Between 1800 and 1850, an 8000 acre fire burned from upper Smith Creek, through much of Deception Creek, across upper Johnson Creek, Jordan Creek and beyond the timberline east of Jordan Creek. The largest fire burned approximately 27,000 acres. The fire burned much of the area just north of the Cowlitz River from Hopkins Creek to the Muddy Fork of the Cowlitz, up Skate Creek beyond Bear Prairie and across Dixon Mountain to Butter Creek and, at the least, to the top of the Tatoosh Range. A historical report, from a party of mountain climbers on their way to Mt. Rainier, described the entire Bear Prairie area as blackened and full of snags in 1870. The fire, therefore, must have occurred in the late 1860's. The third fire burned south of the Cowlitz River from near Kilborn Creek to Johnson Creek. Historical records suggest that this area burned over twice; once in 1895 and again in 1906. These fires burned approximately 6,800 acres. Numerous small fires, of 1,500 acres or less, have burned in the analysis area between 1800 and 1910.

Based on stand age analysis, approximately 50% of the upper Cowlitz watershed was burned by stand replacing fires during the 110-year period from 1800 to 1910. Approximately 48% of the stands originated between 1610 and 1800. The remaining 2% of the stands originated before 1600 or after 1910.

The watershed is currently outside the natural condition for fire "effects". Past harvest activity in the watershed has been extensive, resulting in the loss of certain structural elements, such as snags, large down coarse woody debris, and possibly duff layers. Moreover, only 2% of the analysis area has experienced a stand-replacing fire event in the 86 years since 1910. This is far below the average for the previous 110 years. Some high elevation meadows have been lost due to the encroachment from adjacent timber stands.

Fire Ecology Groups

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

***Western Hemlock/Pacific Silver Fir-Fire Group 8*:**

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

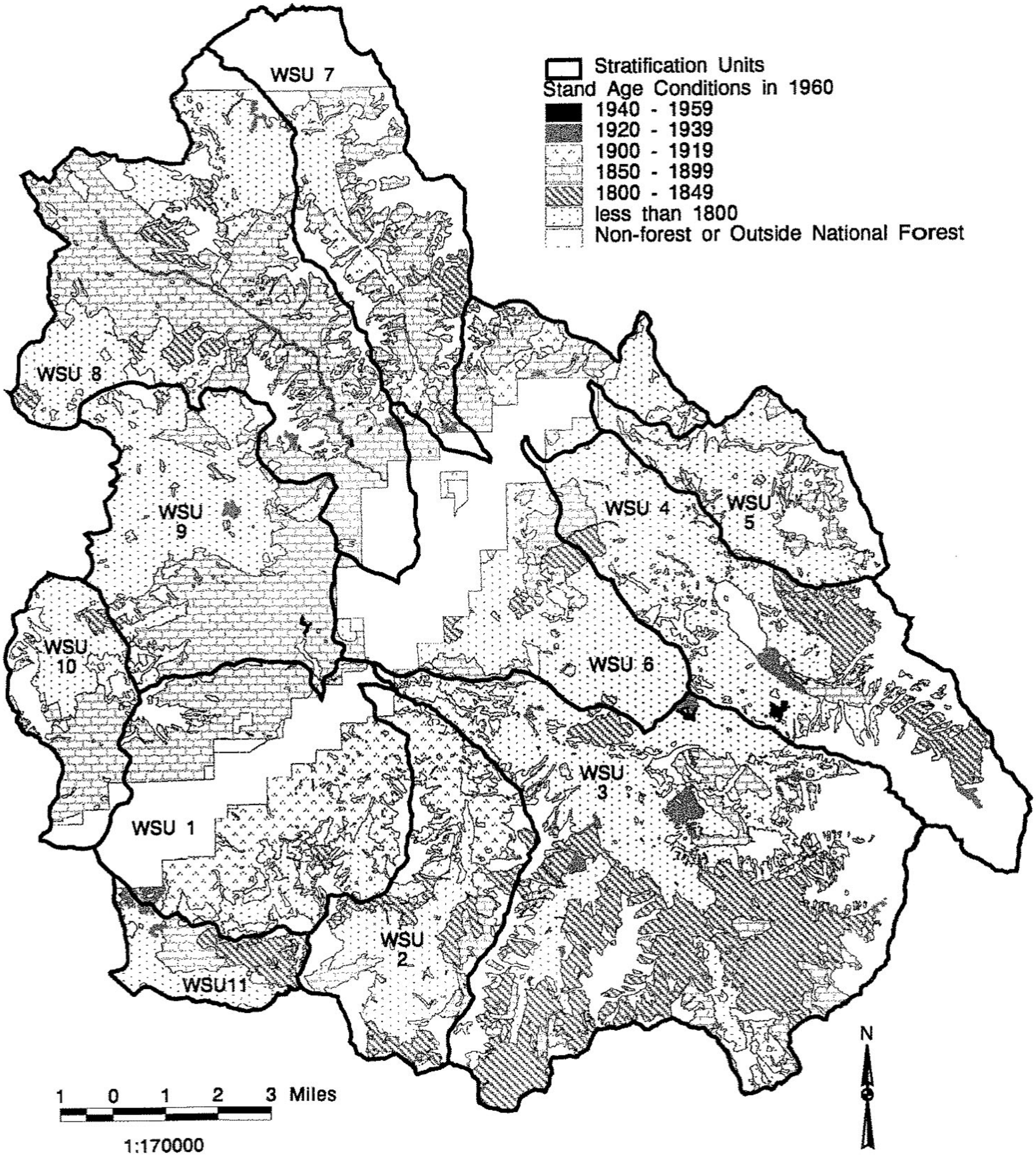
Three conifer species: Douglas-fir, western hemlock, and western red cedar, tend to dominate the overstory in the western hemlock zone. The pacific silver fir zone includes a wider variety of overstory species, including noble fir, western white pine, and mountain hemlock.

This group generally lacks fine fuels through most of the 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.

Both western hemlock and Pacific silver fir are extremely fire sensitive due to thin bark, shallow roots, and highly flammable foliage. 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.

Map 7

UPPER COWLITZ WATERSHED ANALYSIS
Fire History



Dry Western Hemlock and Douglas-Fir-Fire Group 9:

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 red cedar, and big leaf maple. Western red cedar grows primarily in draws and other locations with deeper soils that hold more moisture. Shrubs, rather then forbs, tend to dominate the most common fire group nine plant associations.

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.

Douglas-fir is more fire resistant than many of its associates and can survive moderately intense fires. Moderately severe underburns 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 red cedar 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 dominate until the next stand-replacement fire occurs.

Upper Subalpine and Timberline Forests - Group 10:

All stands within this group lie above the range of Douglas-fir habitat. Mountain hemlock is the most common tree species in all of the associations. 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. Stand replacing crown fires can develop at intervals of 200-300 years or longer. Such fires develop under prolonged drought conditions and high winds.

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 1974 data. Survey maps done since 1974 are not available for every year from 1974 to 1996.

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, state, or national park lands in the watershed.

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/state/national park lands is similar to those found on National Forest system land, with the exception of balsam woolley adelgid (an insect associated with tree species not found on the lower elevation private/state lands) and white pine blister rust (a disease associated with a tree species not likely to be found on lower elevation private/state lands).

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 present here hundreds 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 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).

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 20 years are the balsam woolley adelgid (in Pacific silver fir) and the Douglas-fir beetle (in Douglas-fir). There are other insects at work in this watershed, but the level of their presence and activity is relatively small and 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 low 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 Butter Creek, Coal Creek, Davis Creek, Deception Creek, Dry Creek, Jordan Creek, Lake Creek, Mission Creek, and Smith Creek drainages, as well as on Dixon Mountain, Skate Mountain, South Point Ridge, and the Tatoosh Range.

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 the 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. Resistance of the host tree 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 Burton Creek, Butter Creek, Davis Creek, Dry Creek, Glacier Creek, Hager Creek, Johnson Creek, Karr Creek, Skate Creek, Smith Creek, and Willame Creek drainages, and are often associated with laminated root rot infections in those drainages.

The majority of the documented occurrences can be characterized as having caused light mortality, with an occasional level of moderate mortality. A notable exception occurred in 1974 in this watershed, resulting in a high amount of fairly concentrated mortality. There is one known or recorded instance of a relatively large outbreak of this insect that occurred in the mid-1970's and was noted on the 1974 aerial survey map. The outbreak was located in the lower North Fork Willame Creek, Skyo Mountain, lower South Fork Willame Creek, Karr Creek, lower Davis Creek/Hopkins Creek area (an area just north-northwest of the Cowlitz River between Hopkins Creek and the town of Packwood). The outbreak occurred in several large patches containing anywhere from an estimated 200 to 1500 dead trees per patch. This outbreak resulted in a large sanitation/salvage operation (clearcuts) that began in 1975. Much of this Douglas-fir bark beetle outbreak was directly linked to serious laminated root rot infections.

Generally, the patches of Douglas-fir beetle mortality range anywhere 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.

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

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 potential for greatly reducing 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 upper Cowlitz River watershed is not well known, with the exception of a number of areas that have been surveyed and mapped in this watershed (USDA Forest Service, 1984-1987). The Pest Management Subsystem currently documents its existence in young managed stands (previous clearcuts), as well as in the 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 portion of the watershed (lower Davis Creek, lower Karr Creek, middle and lower Willame Creek, middle and lower Skate Creek, middle and lower Butter Creek, lower Dry Creek, lower Smith Creek, Hinkle Tinkle Creek, lower Coal Creek, lower Lake Creek, Snyder Creek, lower Hager Creek, and middle and lower Johnson Creek). Although there is no data on disease occurrence on private/state lands in the watershed, it is highly likely that the infection level of this disease is comparable on the private/state lands in the Cowlitz River valley. The Pest Management Subsystem records laminated root rot in 82 young managed stands in the watershed. In addition, it records 234 infection centers in older natural stands. Most of those infection centers are less than 0.5 acres in size, but a fair number are 1 to 5 acres in size, with a few 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 TRI subsystem. The level of infection of the disease in these areas of documented infection varies from very low to severe, with approximately 33 percent being very low to moderate, and approximately 67 percent being high to severe. It is very possible that the level of laminated root rot infection in this watershed exceeds the estimate of 5 to 10 percent of the forested area mentioned previously.

Windthrow

Data Sources/Data Gaps

The primary data source for information on windthrow is aerial photo sets from 1959, 1973, 1985, 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 1959 aerial photos are the earliest data available for this watershed. There is no reliable information at all (photographic or otherwise) concerning windthrow in the watershed prior to 1959.

Assumptions

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

The storm events that have caused windthrow in the watershed are the same or very similar to those that have caused windthrow in the middle and upper Cispus watershed (see the Middle and Upper Cispus Watershed Analysis, 1995).

Reference (Historic) and Current Conditions

We have no knowledge or data about historic windthrow events in this watershed prior to the mid-1950's. The only thing we can say with any certainty is that windthrow events have 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 over the past 40 years in the watershed. Windthrow patch size was less than 10 acres most of the time, with a few being 10 to 20 acres in size, and a few greater than 20 acres in size (with one of those being approximately 90 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. Windthrow occurrence was distributed over much of the watershed, but from a quick review it appears that most of the windthrow events have occurred in the upper Willame Creek drainage, the upper Hager Creek drainage, and the Lost Creek drainage.

Windthrow Events (weather and timing)

Storms associated with windthrow events in this watershed probably involve 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 range 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 the 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. It is likely that most of the windthrow events are linked to strong storms that blow in from the south or southwest.

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 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 (approximately 80%) was directly related to the edges of clearcuts. Only about 20% of the windthrow events were "natural" events that occurred away from clearcut edges. There was no obvious windthrow identified (via aerial photo interpretation) as being associated with shelterwoods or commercial thinnings, although it is known to have occurred to some degree.

Forest Vegetation

Forest Zones

Data Sources/Data Gaps

For National Forest system land, the data sources for production of the forest zones map were the Gifford Pinchot National Forest ecology plot data and the IVEG database. For forest zones coverage of the private/state/national park lands the data sources included 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/state/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, with the exception of non-forest acreage. On the private/state lands there are areas that were forested before the Euro-American settlers arrived that have since been converted to permanent non-forest acres (e.g., agricultural fields/pastures, towns, and home sites).

Reference (Historic) and Current Conditions

Terrestrial ecosystems develop and are affected by the influence 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 upper 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 3-7 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 3-7: Forest Zones by Forest and Non-Forest Acres

Zone	**Forest**		**Non-Forest**	
	Acres	(%)	Acres	(%)
Western Hemlock	43,451	28	5,265	3
Pacific Silver Fir	61,223	39	12,241	8
Mountain Hemlock	14,685	10	8,732	5
Subalpine Fir	1,387	1	7,483	5
Alpine	0	0	989	1
Totals	**120,746**	**78**	**34,710**	**22**

Western Hemlock Zone

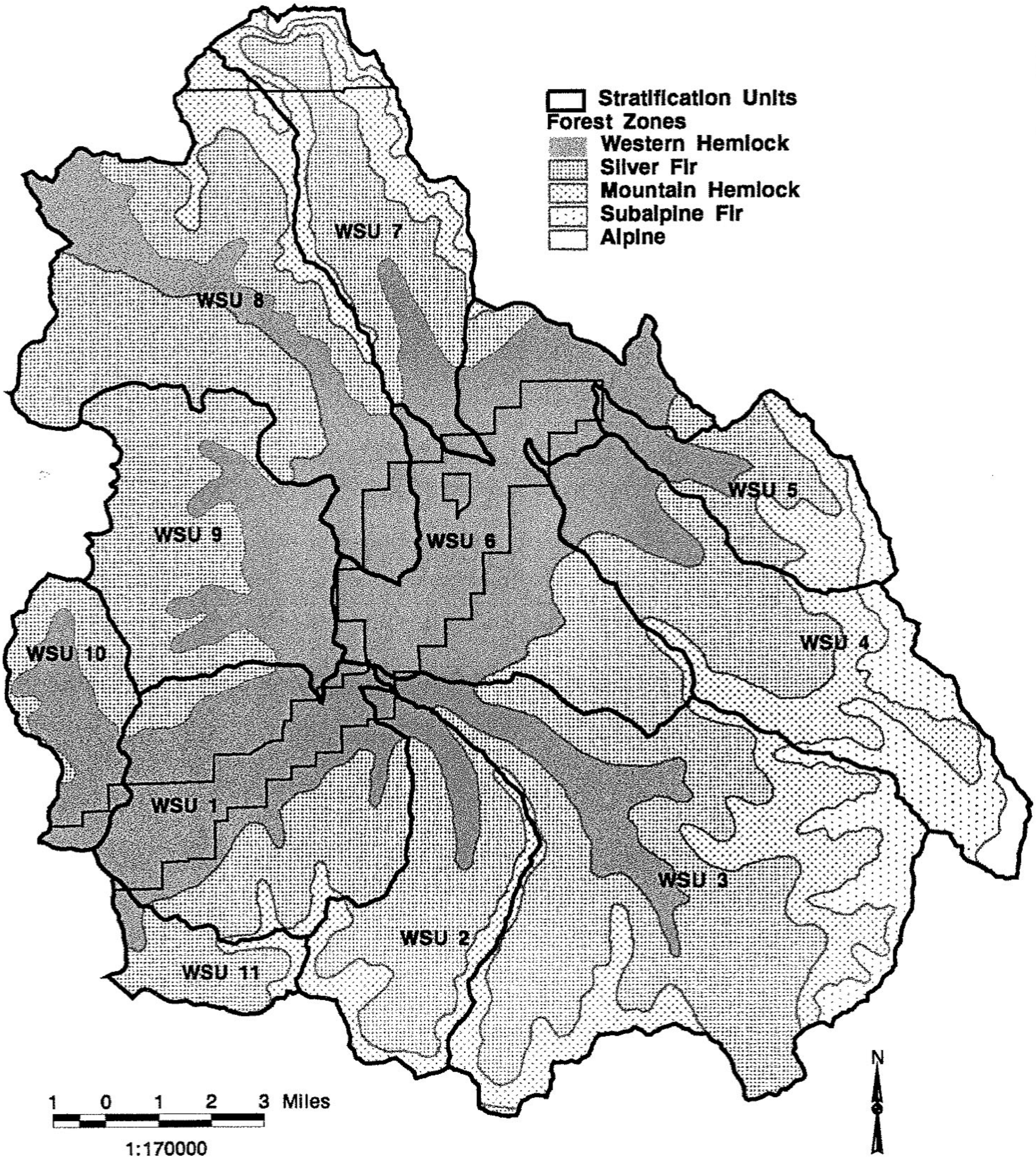
This forest zone includes the lower elevation, warm and moist forests. It is the most environmentally moderate zone of the four forested zones found in this watershed. Its upper elevation occurs at about 3000 feet where it begins to transition into the Pacific Silver Fir Zone. This zone covers the second largest portion of the watershed. It is located primarily in the central portion of the watershed on both sides of the Cowlitz River, with narrow arms extending a ways up Johnson Creek, Smith Creek, Lake Creek, Coal Creek, Butter Creek, Skate Creek, Willame Creek, and Davis Creek. It covers 48,716 acres (31%) of the watershed, with 43,451 of those acres being productive forest land, and 5,265 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. This zone covers the largest portion of the watershed. It is located primarily in the northwestern one-third and the southeastern one-third of the watershed. It covers

Map 8

UPPER COWLITZ WATERSHED ANALYSIS
Forest Zones



73,464 acres (47%) of the watershed, with 61,223 of those acres being productive forest land, and 12,241 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 4500 to 5600 feet where it begins to transition into the Subalpine Fir Zone. This zone covers a small portion of the watershed. It is located primarily in narrow bands near the northern, eastern, and southern edges of the watershed: in the Goat Rocks Wilderness, Tatoosh Wilderness, Mt. Rainier National Park, and in the areas of Dixon Mountain, Mission Mountain, Stonewall Ridge, South Point Ridge, Castle Butte, and Pompey Peak. It covers 23,417 acres (15%) of the watershed, with 14,685 of those acres being productive forest land, and 8,732 acres being non-forest land.

Subalpine Fir Zone

This forest zone includes the upper elevation forests in very cold environments. It occupies sites at the very high elevations from about 5600 feet upward to the tree line. This zone occurs over a very small portion of the watershed. It is located primarily in narrow bands in the Goat Rocks Wilderness, Tatoosh Wilderness, and Mt. Rainier National Park on the eastern and northern edges of the watershed. It covers 8,870 acres (6%) of the watershed, with 1,387 of those acres being productive forest land, and 7,483 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 989 acres (1%). The alpine communities are generally located in two areas; one on the south flanks of the Tatoosh Range in Mt. Rainier National Park, and another along the southeast edge of the watershed 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 Forest Zones Technical Report in the analysis file.

Vegetation Structural Stages

Data Sources/Data Gaps

The primary source for current vegetation descriptions on Forest Service land is the Gifford Pinchot National Forest IVEG (Interim Vegetation) database. The IVEG database was initially installed in 1993-94 and is updated annually. The IVEG 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 IVEG 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/state/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 1959 aerial photos, written historic accounts, 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 IVEG 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 1997 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, 1959 aerial photos, and on-the-ground knowledge of Forest Service personnel (see the Historic Vegetation Technical Report in the analysis file). The year 1880 serves as a "picture" 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/state/national park lands. The definitions for both situations are described below.

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

> Grass/pole forest -- It includes 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 -- It includes one- or two-storied forest stands of 9.0" dbh up to 18.0" dbh (for the Pacific Silver Fir and Mountain Hemlock Zones) or 20.9" dbh (for the Western Hemlock Zone).
>
> Large tree forest -- It includes 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 -- It includes rock, water, avalanche chutes, administrative sites with little or no vegetation, meadows, grasslands, forblands, and shrublands.

Private/State/National Park Lands -- The four structural stage categories for forest vegetation on private/state/national park lands are defined as follows:

> Grass/pole forest -- It includes 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 -- It includes 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 -- It includes 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 -- It includes 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 3-8 below. In 1880 the acres of forest land in this watershed were fairly evenly distributed across the three forested structural stages.

Table 3-8: Historic (1880) Vegetation by Structural Stage and Ownership
(USFS and Private/State/National Park)

Structural Stage	USFS Acres (%)	Private/State Acres (%)	National Park Acres (%)	Total Acres (%)
Grass/Pole	36,102 (26)	6,781 (53)	1,487 (52)	44,370 (29)
Small Tree	41,347 (29)	166 (1)	302 (11)	41,815 (27)
Large Tree	31,843 (23)	5,681 (44)	82 (3)	37,606 (24)
Non-Forest	30,495 (22)	201 (2)	969 (34)	31,665 (20)
Totals	139,787 (100)	12,829 (100)	2,840 (100)	155,456 (100)

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 3-9 below. See Map 9 for a visual display of the historic vegetation structure.

Table 3-9: Historic (1880) Vegetation by Structural Stage and Forest Zone (USFS and Private/State/National Park)

Forest Zone	Grass/Pole Acres (%)	Small Tree Acres (%)	Large Tree Acres (%)	Total Acres (%)
W. Hem. (US)	18,110 (41)	5,748 (14)	10,010 (27)	
(PS)	6,781 (15)	166 (<1)	5,681 (15)	
(NP)	0 (0)	0 (0)	0 (0)	46,496 (38)

Table 3-9: Historic (1880) Vegetation by Structural Stage and Forest Zone (USFS and Private/State/National Park)

Forest Zone	Grass/Pole Acres (%)	Small Tree Acres (%)	Large Tree Acres (%)	Total Acres (%)
P. Silv. Fir (US)	14,781 (33)	25,727 (61)	20,031 (53)	
(PS)	0 (0)	0 (0)	0 (0)	
(NP)	583 (1)	20 (<1)	81 (<1)	61,223 (49)
Mt. Hem (US)	2,852 (6)	9,159 (22)	1,703 (5)	
(PS)	0 (0)	0 (0)	0 (0)	
(NP)	702 (2)	269 (1)	0 (0)	14,685 (12)
Subalp Fir (US)	336 (1)	717 (2)	100 (<1)	
(PS)	0 (0)	0 (0)	0 (0)	
(NP)	225 (1)	9 (<1)	0 (0)	1,387 (1)
Totals	**44,370 (100)**	**41,815 (100)**	**37,606 (100)**	**123,791* (100)**

* This represents the number of productive forest land acres in the watershed.
Total watershed acres = 155,456 Non-forest watershed acres = 31,655
(US) = USFS land (PS) = Private/State land (NP) = National Park land

Large Tree

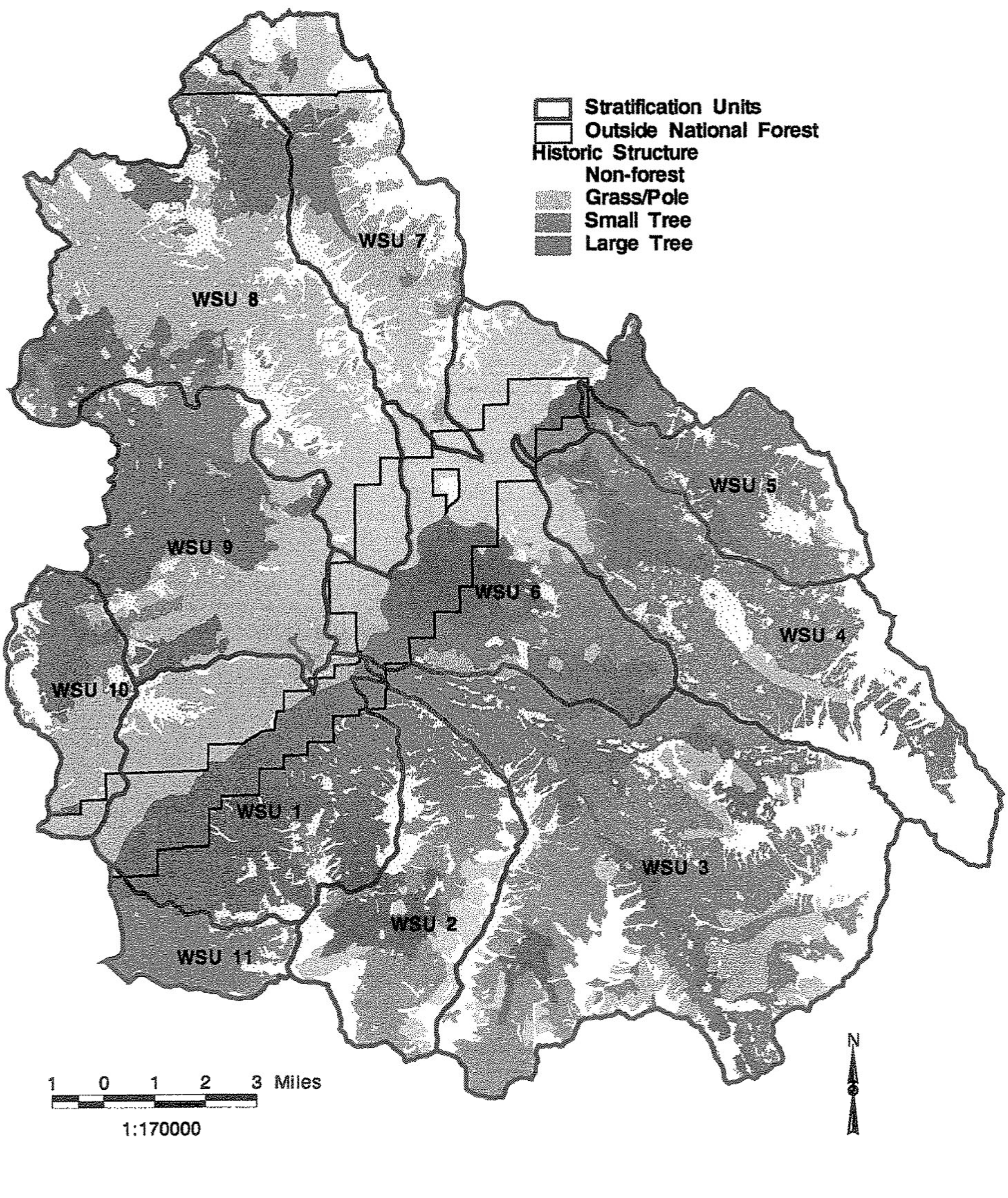
At 37,606 acres, the large tree forest had the smallest number of acres of the three forested structural stages (30% of the watershed's productive forest land). The large tree forest in 1880 was made up of several small to large, well-distributed, mostly unfragmented patches, one being very large (approximately 15,000 acres and located in WSU's 1 and 6 along the southeast side of the Cowlitz River valley from lower Kilborn Creek to Snyder Creek), and another being about half that size at approximately 7,000 acres (located in WSU's 9 and 10 in the areas of West Fork Willame Creek and upper Davis Creek). Much of the large tree forest (53% or 20,112 acres) was located in the Pacific Silver Fir Zone, but a substantial portion (42% or 15,691 acres) was also located in the Western Hemlock Zone. Large tree forest occurred in each of the WSU's, but was the most prominent (in terms of acres) in WSU 1 (9,242 acres - Dry Creek, Burton Creek, Garrett Creek), WSU 6 (6,244 acres - Hager Creek, Snyder Creek, Hall Creek), and WSU 9 (6,054 acres - North and West Forks Willame Creek). Large tree forest was the least prominent in WSU 11 (159 acres - Kilborn Creek) and WSU 5 (753 acres - Coal Creek, Lost Creek).

Small Tree

At 41,815 acres, the small tree forest covered 34% of the watershed's productive forest land. The small tree forest in 1880 was principally made up of one very large, fairly contiguous matrix

Map 9

UPPER COWLITZ WATERSHED ANALYSIS
Historic (1880) Vegetation Structure



imbedded with smaller patches of grass/pole forest and large tree forest. Small tree forest covered much of the watershed southeast of the Cowlitz River valley. Much of the small tree forest (61% or 25,747 acres) was located in the Pacific Silver Fir Zone, with a fair amount (22% or 9,159 acres) also located in the Mountain Hemlock Zone. Small tree forest occurred in each of the WSU's, but was the most prominent (in terms of acres) in WSU 3 (13,924 acres - Johnson Creek, Deception Creek, Middle Fork Johnson Creek), WSU 4 (8,005 acres - Lake Creek), WSU 2 (4,806 acres - Smith Creek), and WSU 5 (4,166 acres - Coal Creek, Lost Creek). Small tree forest was the least prominent in WSU 1 (368 acres - Dry Creek, Burton Creek) and WSU 10 (538 acres - Davis Creek).

Grass/Pole

At 44,370 acres, the grass/pole forest had the largest number of acres (but only slightly larger than small tree) of the three structural stages (36% of the watershed's productive forest land). The grass/pole forest in 1880 principally consisted of one extremely large (approximately 34,000 acres and basically contiguous) patch northwest of the Cowlitz River. This gigantic patch of grass/pole forest was the result of a wildfire in the 1860's (Schullery, 1987). Much of the grass/pole forest (56% or 24,891 acres) was located in the Western Hemlock Zone, but a substantial portion (34% or 15,364 acres) was also located in the Pacific Silver Fir Zone. Grass/pole forest occurred in each of the WSU's, but was the most prominent (in terms of acres) in WSU 8 (12,026 acres - Skate Creek, lower "Little" Johnson Creek), WSU 6 (7,705 acres - Hinkle Tinkle Creek, Cowlitz River), WSU 7 (6,467 acres - Butter Creek), and WSU 9 (5,080 acres - Willame Creek, South Fork Willame Creek). Grass/pole forest was the least prominent in WSU 11 (23 acres - Kilborn Creek), WSU 5 (174 acres - Coal Creek, Lost Creek), WSU 4 (1,008 acres - Lake Creek), and WSU 2 (1,356 acres - Smith 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 the landscape was dominated by large blocks of unfragmented forest. The grass/pole and small tree structural stages were the most dominant forest vegetation across the watershed, although the large tree structural stage and the non-forest areas were not insignificant.

Most of the grass/pole forest was contained in one extremely large, well defined patch (approximately 34,000 acres in size) in the northwest half of the watershed, largely unfragmented, but occasionally being broken up by some relatively large areas of non-forest land (principally along ridgetops between sub-basins). The remainder of the grass/pole forest was located in relatively small patches (less than 1,200 acres in size) scattered through the southeast half of the watershed.

Most of the small tree forest was contained in approximately five large patches (of several thousand acres each) whose shapes were not well defined by clear distinctive boundaries (i.e. amorphous) -- being fairly contiguous as one extremely large patch, narrowly broken by small patches of large tree forest, grass/pole forest, or non-forest areas (again, principally along ridgetops). The remainder of the small tree forest was located in relatively small patches (less than 1,200 acres in size) scattered though the northwest half of the watershed.

Most of the large tree forest was contained in roughly four large to very large, unfragmented patches (over 2,000 acres to 15,000 acres in size) and a number of smaller patches (less than 1,600 acres in size) scattered throughout the watershed.

The patches of forest vegetation in 1880 were largely unfragmented (with the exception of some areas of natural fragmentation by non-forest areas). They were generally large with irregular shapes and irregular, sinuous edges. They tended to be wide (but not in all cases) and well connected in most cases. The larger patches range in size from about 2,000 acres to ten's of thousands of acres. The smaller patches range in size from about 10 acres to 1,600 acres.

The large tree forest patches in the southeast half of the watershed were well-connected by small tree forest, but in the northwest half of the watershed the large tree forest patches were somewhat isolated by the large expanse of grass/pole forest. The 1880 landscape was a relatively stable, coarse-grained landscape with much less edge and contrast than the current landscape.

In 1880, the southeastern half of the watershed was the most diverse in terms of forest patch size, structural stages (mix of grass/pole, small tree, large tree, and non-forest), and patch shape (especially in WSU's 2, 3, and 6). While the northwest half of the watershed had much less diversity of patch size, structural stages, and patch shape; being dominated by an extremely large patch of grass/pole forest.

Current Vegetation: Amount, Distribution, and Location

The amount of current (1997) grass/pole, small tree, and large tree forest vegetation (and areas of non-forest) in the watershed is shown by ownership in Table 3-10 below. Currently, the acres of forest land in this watershed are fairly evenly distributed across the three forested structural stages.

Table 3-10: Current (1997) Vegetation by Structural Stage and Ownership (USFS and Private/State/National Park)

Structural Stage	USFS Acres (%)	Private/State Acres (%)	National Park Acres (%)	Total Acres (%)
Grass/Pole	24,612 (18)	6,882 (54)	1,203 (42)	32,697 (21)
Small Tree	43,702 (31)	763 (6)	0 (0)	44,465 (29)
Large Tree	40,978 (29)	1,938 (15)	668 (24)	43,584 (28)
Non-Forest	30,495 (22)	3,246 (25)	969 (34)	34,710 (22)
Totals	139,787 (100)	12,829 (100)	2,840 (100)	155,456 (100)

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 3-11 below.

Table 3-11: Current (1997) Vegetation by Structural Stage and Forest Zone (USFS and Private/State/National Park)

Forest Zone	Grass/Pole Acres (%)	Small Tree Acres (%)	Large Tree Acres (%)	Total Acres (%)
W. Hem. (US)	8,367 (26)	15,415 (35)	10,086 (23)	
(PS)	6,882 (21)	763 (2)	1,938 (4)	
(NP)	0 (0)	0 (0)	0 (0)	43,451 (36)
P. Silv. Fir (US)	15,041 (46)	22,258 (50)	23,250 (53)	
(PS)	0 (0)	0 (0)	0 (0)	
(NP)	367 (1)	0 (0)	307 (1)	61,223 (51)
Mt. Hem (US)	1,142 (3)	5,330 (12)	7,256 (17)	
(PS)	0 (0)	0 (0)	0 (0)	
(NP)	618 (2)	0 (0)	339 (1)	14,685 (12)
Subalp Fir (US)	60 (<1)	699 (1)	392 (1)	
(PS)	0 (0)	0 (0)	0 (0)	
(NP)	220 (1)	0 (0)	16 (<1)	1,387 (1)
Totals	32,697 (100)	44,465 (100)	43,584 (100)	120,746*(100)

* This represents the number of productive forest land acres in the watershed.
Total watershed acres = 155,456 Non-forest watershed acres = 34,710
(US) = USFS land (PS) = Private/State (NP) = National Park land

Grass/Pole

At 32,697 acres, the grass/pole forest has the smallest number of acres of the three forested structural stages (27% of the watershed's productive forest land). The grass/pole stands are largely the result of regeneration harvest by clearcutting, with only a small number of acres being of wildfire origin. The largest patch of grass/pole forest is found on private/state lands located along both sides of the Cowlitz River (also created by clearcut harvest). This grass/pole block is occasionally fragmented by agricultural fields and urban developments. Most of the grass/pole forest is located in the Pacific Silver Fir Zone (47% or 15,408 acres) and Western Hemlock Zone (47% or 15,249 acres). Grass/pole forest occurs in each of the WSU's, but it is most prominent (in terms of acres) in WSU 6 (7,293 acres - Hager Creek, Hall Creek, private/state lands), WSU 9 (4,953 acres - Willame Creek; North, West, South Forks Willame Creek), WSU 3 (4,541 acres - Johnson Creek, Deception Creek), and WSU 8 (4,052 acres - upper Skate Creek, upper "Little" Johnson Creek). Grass/pole forest is the least prominent in WSU 5 (708 acres - Coal Creek, Lost Creek) and WSU 11 (730 acres - Kilborn Creek).

Large Tree

At 43,584 acres, the large tree (late-successional) forest covers 36% of this fifth-field watershed's productive forest land. The large tree stands are a result of wildfires that occurred prior to 1800. With the exception of the Goat Rocks Wilderness and some unroaded areas, much of the large tree forest has been fragmented as a result of regeneration harvest activities over the past 50 years. Much of the large tree forest (54% or 23,557 acres) is located in the Pacific Silver Fir Zone, with a fair amount (27% or 12,024 acres) also located in the Western Hemlock Zone. The large tree forest is well dispersed across the watershed, with its largest, most unfragmented patches being located in (and adjacent to) the Goat Rocks Wilderness, as well as some unfragmented, larger patches in the unroaded areas around Pompey Peak, upper Burton Creek, and upper Dry Creek. Large tree forest occurs in each of the WSU's, but it is most prominent (in terms of acres) in WSU 3 (9,048 acres - Glacier Creek, Middle Fork Johnson Creek), WSU 4 (7,067 acres - middle Lake Creek), and WSU 8 (6,416 acres - Skate Creek, "Little" Johnson Creek). Large tree forest is least prominent in WSU 11 (1,479 acres - Kilborn Creek), WSU 10 (1522 acres - Davis Creek), and WSU 2 (2,095 acres - Smith Creek).

Small Tree

At 44,465 acres, the small tree forest has the largest number of acres (but only slightly more than the large tree forest) of the three forested structural stages (37% of the watershed's productive forest land). The majority of the small tree forest is a result of wildfires that occurred after 1850, but a small portion is a result of older clearcut harvest activity. In general, small tree stands form the most contiguous, least fragmented patches of forest in the watershed (see Map 10, Current (1997) Vegetation Structure). Much of the small tree forest (50% or 22,258 acres) is located in the Pacific Silver Fir Zone, with a substantial amount (37% or 16,178 acres) also located in the Western Hemlock Zone. Small tree forest occurs in each of the WSU's, but it is the most prominent (in terms of acres) in WSU 3 (9,046 acres - Johnson Creek, Deception Creek, Mission Creek, Jordan Creek), WSU 1 (6,406 acres - lower Dry Creek, lower Burton Creek, lower Garrett Creek, Karr Creek), and WSU 8 (6,157 acres - Skate Creek, "Little" Johnson Creek). Small tree forest is the least prominent in WSU 11 (744 acres - Kilborn Creek), WSU 10 (1,079 acres - Davis Creek), and WSU 5 (1,480 acres - Coal Creek, Lost Creek).

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 (1997) Vegetation Structure.

The current size, shape, spatial arrangement, connectivity, and structural stages of vegetation patches in the watershed have been heavily (and almost exclusively) influenced by fire suppression and timber harvest activities. 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 this watershed in the late 1940's/early 1950's, it became the disturbance agent largely responsible for moving forest stands into the grass/pole (early) structural stage, instead of fire. There have been three major 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. Regeneration harvest on Forest Service land in this watershed totals approximately 24,324 acres since it began in the late 1940's/early 1950's. There has been no timber harvest on national park land. The amount, type, and timing of timber harvest that has occurred on private/state land over the decades is not well known, although it is safe to say (based on looking at aerial photos) that much of the harvest has been clearcut regeneration.

The estimated amount of regeneration harvest on Forest Service land, stratified by decade and WSU, is shown below in Table 3-12. Note: These acres are based on IVEG stand year-of-origin.

Map 10

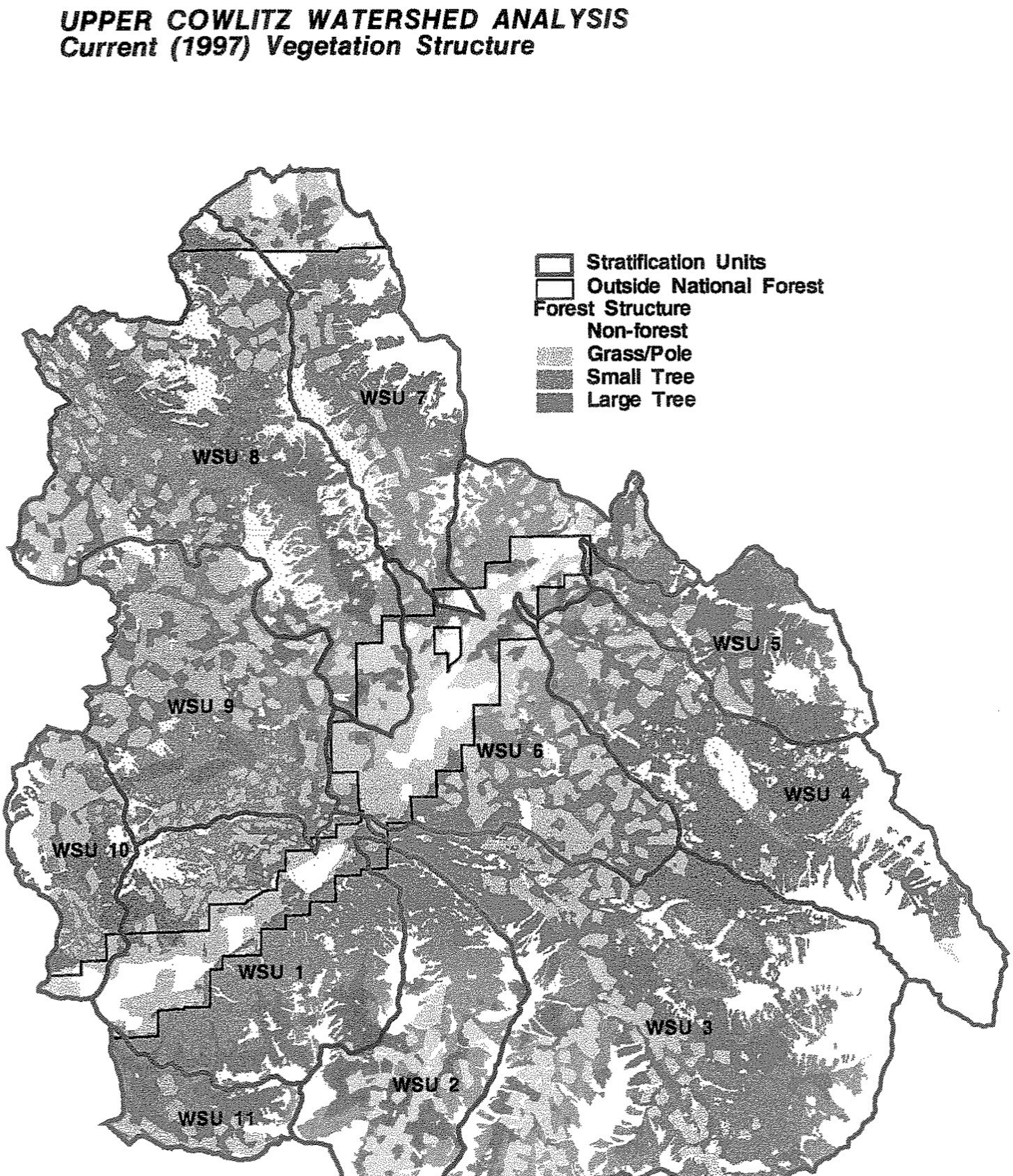

UPPER COWLITZ WATERSHED ANALYSIS
Current (1997) Vegetation Structure
Stratification Units
Outside National Forest
Forest Structure
Non-forest
Grass/Pole
Small Tree
Large Tree
WSU 1
WSU 2
WSU 3
WSU 4
WSU 5
WSU 6
WSU 7
WSU 8
WSU 9
WSU 10
WSU 11
1 0 1 2 3 Miles
1:170000
N

Table 3-12: Regeneration Harvest Acres* by Decade and WSU (National Forest Ownership Only)

WSU	1940	1950	1960	1970	1980	1990	Total Ac.	%
1	0	0	19	527	18	123	687	3
2	70	444	593	502	89	50	1,748	7
3	0	745	1,422	771	821	547	4,306	18
4	0	18	417	435	352	62	1,284	5
5	0	0	67	507	102	62	738	3
6	18	305	1,364	1,461	496	294	3,938	16
7	0	0	267	323	77	228	895	4
8	0	9	842	1,236	772	558	3,417	14
9	0	1,164	1,477	1,079	883	394	4,997	21
10	333	294	172	201	250	309	1,559	6
11	0	0	91	386	63	215	755	3
Totals	**421**	**2,979**	**6,731**	**7,428**	**3,923**	**2,842**	**24,324**	**100**
(%)	**(2)**	**(12)**	**(28)**	**(30)**	**(16)**	**(12)**	**(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 Forest Service land, stratified by decade and WSU is shown below in Table 3-13.

Table 3-13: Commercial Thinning Harvest Acres by Decade and WSU (Forest Service Ownership Only)

WSU	1940	1950	1960	1970	1980	1990	Total Ac.	%
1	0	0	265	0	0	0	265	5
2	0	0	0	0	0	0	0	0

Table 3-13: Commercial Thinning Harvest Acres by Decade and WSU (Forest Service Ownership Only)

3	0	0	0	167	0	0	167	3
4	0	0	90	277	0	0	367	7
5	0	40	0	0	0	0	40	1
6	0	40	387	985	0	0	1,412	27
7	0	0	50	0	0	0	50	1
8	0	40	426	875	686	0	2,027	39
9	0	0	357	539	0	0	896	17
10	0	0	0	0	0	0	0	0
11	0	0	0	0	16	17	33	<1
Totals	**0**	**120**	**1,575**	**2,843**	**702**	**17**	**5,257**	**100**
(%)	**(0)**	**(2)**	**(30)**	**(54)**	**(13)**	**(1)**	**(100)**	

The amount of partial cut salvage harvest that has occurred in the watershed is unknown, but it has been a common practice since the 1950'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 numerous over the years, but 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 (1997), this watershed's forested landscape contains a mix of large patches of unfragmented forest and highly fragmented forest. The small tree and large tree structural stages are the most dominant forest vegetation across the watershed, but the grass/pole and non-forest structural stages are not insignificant.

The grass/pole forest patches tend to be relatively small in size and regular in shape (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, but very few approach the grass/pole patch sizes or configurations found in the watershed in 1880. The larger grass/pole forest patches that currently exist are very often less than 300 acres in size, with the larger ones only approaching 800 to 1000 acres in size. Today's grass/pole forest is structurally homogenous, possessing few (if any) snags or large, live remnant trees, or pieces of large down wood.

The current small tree forest forms the most numerous and largest (many still being several thousand acres in size), most connected, and least fragmented patches in the landscape; several have been fragmented to some degree by regeneration harvest. Much of the small tree forest is contained in several large patches located in WSU 7 (Butter Creek), WSU 8 (Skate Creek), WSU 9 (South Fork Willame Creek, lower Willame Creek), WSU 1 (Burton Creek, Dry Creek), WSU 2 (lower Smith Creek), WSU 3 (Deception Creek, Mission Creek, Jordan Creek, Parnassus Creek).

Most of the current large tree forest located outside wilderness and unroaded areas has been fragmented and disconnected, with patch sizes dramatically reduced, and the shapes of those patches made more regular and angular. Most of the regeneration harvest over the past 50 years came out of the large tree forest, converting it to grass/pole forest in a staggered block pattern. The large tree forest patches that currently exist are very often less than 200 acres in size. They are often long, narrow, gangly strips less than one-half mile wide, many less than one-quarter mile wide. The exceptions to the above are a few larger (800 to 7,000 acres in size) unfragmented patches of large tree forest that remain intact in the Goat Rocks Wilderness, Pompey Roadless Area, and on the northeast side of Skate Creek.

Currently, there are still a few 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: Pompey Roadless Area (portions of WSU's 1, 2, and 11), Goat Rocks Wilderness (portions of WSU's 3, 4, and 5), Tatoosh Wilderness (portions of WSU's 6, 7, and 8), Mt. Rainier National Park (portions of WSU's 7 and 8), and the area north of South Fork Willame Creek (a portion of WSU 9). Outside of these areas above, 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: upper Smith Creek (WSU 2); Johnson Creek, Deception Creek (WSU 3); Hager Creek, Hall Creek, Snyder Creek (WSU 6); lower Lake Creek (WSU 4); lower Coal Creek, lower Lost Creek (WSU 5); upper Butter Creek (WSU 7); upper Skate Creek, upper "Little" Johnson Creek (WSU 8); North Fork Willame Creek, West Fork Willame Creek (WSU 9); upper Davis Creek (WSU 10); and upper Kilborn Creek (WSU 11). The pattern of forest vegetation in the above drainages is the most "unnatural" in terms of patch size, shape, connectivity, and structural diversity.

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 such comprehensive databases exist for survey and manage and noxious weed species, although interim databases have been developed that catalogue some location information on these species groups. Habitat information used in this report comes from maps and data produced and stored in Geographic Information Systems (GIS) and National Wetland Inventory maps.

Assumptions

In most cases, the data stored in the BCD was originally recorded as points on US 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 location and classification of special habitats on the GIS vegetation layer is based heavily on photo interpretation. Small areas of special habitats are easily overlooked on aerial photographs they may not be well represented in GIS. 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 (Historic) and Current Conditions

TES Plant Species

No information on the historic condition of this species group was available for this report. It is assumed that viable populations existed within some areas of 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 north zone of the forest and thus possibly within the analysis area. Those species that have been documented on the north zone (Packwood and Randle Ranger Districts) of the Forest, and those species that may occur there based on their published distributions, are listed in Table 3-14. 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 3-14: TES Plant Species Documented or Suspected on the North Zone

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 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
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

Table 3-14: TES Plant Species Documented or Suspected on the North Zone			
STATUS	**SCIENTIFIC NAME**	**COMMON NAME**	**FS/GS***
Suspected	*Ophioglossum 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 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
#'s refer to standard ranking after The Nature Conservancy

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

Orobanche pinorum
Pleuricospora fimbriolata

Additional sites for these species (and others listed in Table 3-14) 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 GIS database for all ecoclass codes that represent unique plant habitats (i.e. meadows, red alder wetlands, rocky areas, etc.). Acres of each of these habitat types and number of known sites of TES plant species found within the Forest Service lands portion of the analysis area are summarized below by Watershed Stratification Unit (Table 3-15). Because we only have data for Forest Service lands in our GIS layer, certain habitat types will be greatly underestimated for some WSU's. This is particularly true for the category of "Lakes, Ponds, Rivers" because the Cowlitz River flows primarily through non-Forest Service lands within the analysis area.

Table 3-15: Acres of Habitats and Number of Known TES Sites by WSU's (data presented for Forest Service lands only)

WSU	Rocky Areas	Dry Meadows	Wet Meadows	Shrubland	Red Alder Wetlands	Lakes, Ponds, Rivers	# of TES sites
1	1,552	31	27	134	47	22	3
2	1,661	137	71	651	27	1	0
3	7,216	6	210	1,002	23	42	0
4	1,370	0	3,476	512	0	460	5
5	830	0	468	232	0	27	0
6	749	7	104	151	0	2	1
7	2,605	0	502	330	106	0	1
8	2,788	0	447	612	293	22	0
9	544	0	156	174	3	14	0
10	369	0	178	347	73	0	0
11	257	0	4	47	33	0	1
Total	19,941	181	5,643	4,192	605	590	11

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 are different, thus the NWI data is provided here separately from the GIS data shown above. Table 3-16 is a summary of the NWI data. In this case, the data are representative of the entire analysis area, thus the categories of "Riverine" and "Other" shown in Table 3-16 may be a better approximation of total riparian habitat than the "Lakes, Ponds, Rivers" shown in Table 3-15. It is also likely that much of the riverine wetlands identified by NWI and shown in Table 3-16 are vegetated with red alder, and those figures can be compared to those shown in Table 3-15 to get a more adequate description of that habitat type for the entire analysis area.

Table 3-16: Summary of Acres of National Wetland Inventory Wetland Types by WSU's (data presented for entire analysis area)

WSU	Palustrine Emergent	Palustrine Scrub-Shrub	Palustrine Forested	Riverine (Includes Cowlitz River)	Other (includes open water)	Total
1	34	106	50	296	2	488
2	4	58	0	5	1	68

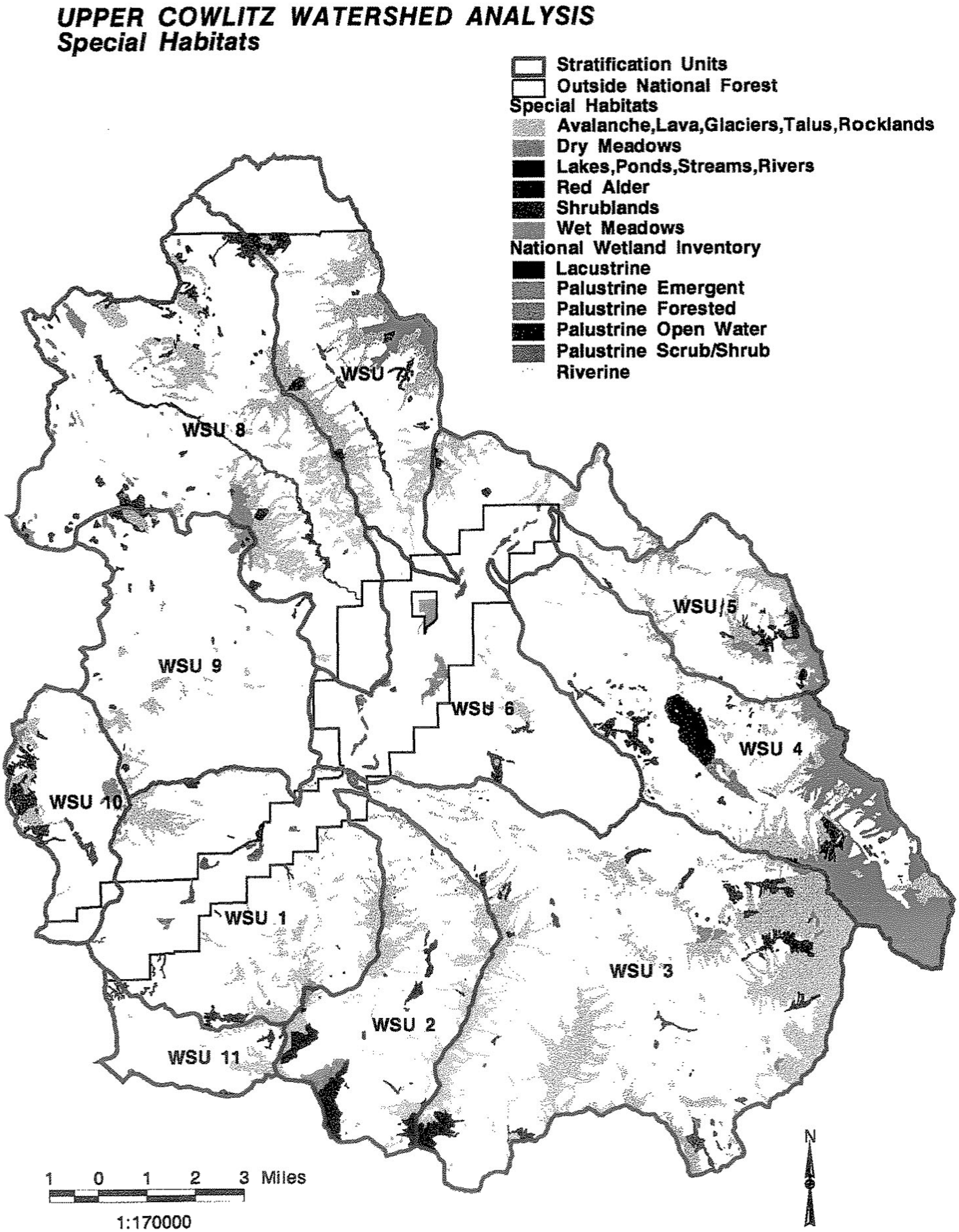
Table 3-16: Summary of Acres of National Wetland Inventory Wetland Types by WSU's (data presented for entire analysis area)

WSU	Palustrine Emergent	Palustrine Scrub-Shrub	Palustrine Forested	Riverine (Includes Cowlitz River)	Other (includes open water)	Total
3	17	30	0	4	42	93
4	9	36	179	7	451	682
5	2	2	0	0	26	30
6	94	207	101	559	18	979
7	0	1	0	8	0	9
8	78	49	31	34	8	200
9	4	13	0	2	11	30
10	3	3	8	0	3	17
11	5	0	0	0	0	5
Total	250	505	369	915	562	2601

The distribution of special habitats within the analysis area is shown in Map 11. This map is a composite of the GIS vegetation layer ecoclasses that were included in Table 3-15 and the NWI wetlands that occur within the private land ownership of the Cowlitz River valley. One additional wetland complex from NWI was included in this map on Forest Service lands in the vicinity of Packwood Lake. This wetland was not represented in the GIS vegetation layer and was included on the map due to its large size. Other NWI wetlands were not included on the map either because they were represented already by a GIS ecoclass, or they were too small to be accurately mapped.

In addition to the habitats shown in Tables 3-15 and 3-16 and in Map 11, the personal knowledge of district personnel indicates that there are some other unique areas that should be highlighted for their contribution to biological diversity within the analysis area. Patches of white oak (*Quercus garryana*) are found in several places within the analysis area and are generally associated with other unique flora. Areas known to contain significant stands of white oak include the south side of Skyo Mountain (T13N R09E parts of Sections 31 and 32), both above and below Forest Road 21 on either side of Brownie Creek (T13N R09E parts of Section 34; T12N R09E portions of Sections 2 and 3), and along Forest Road 20 (T12N R09E part of Section 5). Because these areas are not readily discernable from aerial photos they are not included in the GIS vegetation layer as separate polygons, and thus were not included in the special habitats map.

Map 11


UPPER COWLITZ WATERSHED ANALYSIS
Special Habitats
Stratification Units
Outside National Forest
Special Habitats
Avalanche,Lava,Glaciers,Talus,Rocklands
Dry Meadows
Lakes,Ponds,Streams,Rivers
Red Alder
Shrublands
Wet Meadows
National Wetland Inventory
Lacustrine
Palustrine Emergent
Palustrine Forested
Palustrine Open Water
Palustrine Scrub/Shrub
Riverine
WSU 1
WSU 2
WSU 3
WSU 4
WSU 5
WSU 6
WSU 7
WSU 8
WSU 9
WSU 10
WSU 11
N
1 0 1 2 3 Miles
1:170000

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 President's Northwest Forest Plan. No information on the historic condition of these species groups was available for this report. It is assumed that viable populations existed within some areas of 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 include the vascular plant *Allotropa virgata* (4 known sites within WSU #9 and one known site within WSU #6) and the rare lichen *Tholurna dissimilis* (one known site within WSU #2).

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 President's 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 3-17, 3-18 and 3-19.

Table 3-17: Summary of Acres of Late-Successional Habitat Outside Riparian Reserves by WSU and Potential Vegetation Zone (data presented for Forest Service lands only)

WSU (FS acres)	Western Hemlock	Silver Fir	Mountain Hemlock	Subalpine/ Alpine	Total	% of Forest Service lands
1 (11,270)	298	944	128	0	1,370	12.0%
2 (10,174)	44	1,069	296	0	1,409	14.0%
3 (31,051)	785	3,545	1,619	78	6,027	19.0%

Table 3-17: Summary of Acres of Late-Successional Habitat Outside Riparian Reserves by WSU and Potential Vegetation Zone (data presented for Forest Service lands only)

WSU (FS acres)	Western Hemlock	Silver Fir	Mountain Hemlock	Subalpine/ Alpine	Total	% of Forest Service lands
4 (16,337)	403	917	1,459	113	2,892	18.0%
5 (6,562)	236	882	545	29	1,692	26.0%
6 (12,407)	886	1,269	89	0	2,244	18.0%
7 (9,490)	44	381	189	8	622	7.0%
8 (20,847)	1,059	2,567	657	15	4,298	21.0%
9 (13,417)	715	1,284	0	0	1,999	15.0%
10 (4,994)	342	500	0	0	842	17.0%
11 (3,238)	43	702	107	0	852	26%
Total (139,787)	4,855	14,060	5,089	243	24,247	17.0%

Table 3-18: Summary of Acres of Late-Successional Habitat Inside Riparian Reserves by WSU and Potential Vegetation Zone (data presented for Forest Service lands only)

WSU (FS acres)	Western Hemlock	Silver Fir	Mountain Hemlock	Subalpine/ Alpine	Total	% of Forest Service lands
1 (11,270)	752	631	19	0	1,402	12%
2 (10,174)	23	506	35	0	564	6%
3 (31,051)	788	1,728	489	14	3,019	10%
4 (16,337)	505	2,614	921	87	4,127	25%
5 (6,562)	294	590	243	22	1,149	18%
6 (12,407)	401	237	10	0	648	5%
7 (9,490)	29	278	59	0	366	4%
8 (20,847)	1,178	1,296	335	25	2,834	14%
9 (13,417)	653	611	0	0	1,264	9%
10 (4,994)	438	211	0	0	649	13%
11 (3,238)	120	457	46	0	623	19%
Total (139,787)	5,181	9,159	2,157	61	16,558	12%

Table 3-19: Summary of Acres of Late-Successional Habitat on FS Lands Within the Analysis Area

Total FS Lands in Analysis Area	Western Hemlock	Silver Fir	Mountain Hemlock	Subalpine Alpine	Total	% of Area in Late Successional
139,787	10,036	23,219	7,246	304	40,805	29%

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 north end of the Gifford Pinchot National Forest and likely to occur within the analysis area are shown in Table 3-20.

Table 3-20: Noxious Weeds Likely to be Found in Large Populations Within the Analysis Area

Scientific Name	Common Name
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 Highway 12 and other main thoroughfares within the analysis area currently support extensive populations of many of the above listed noxious weed species.

Wildlife

The upper Cowlitz watershed area provides habitat for a wide variety of wildlife species, including some listed as threatened, endangered, sensitive, and several species of concern. The analysis area also contains designated critical habitat for the northern spotted owl and the marbled murrelet. Wildlife issues important to this watershed include: mountain goat habitat, recovery habitat for threatened and endangered species, riparian connectivity, and how to manage prescribed or natural fire to maintain or increase habitat suitability for selected species.

Data Sources/Data Gaps

This report was compiled from the personal knowledge of district biologists, GIS produced maps, aerial photo interpretation, historic wildlife sighting databases, and literature reviews. No field reconnaissance was conducted for this report. The following data was neither presently available nor collected for this analysis:

- Density, size distribution, and tonnage information on down logs and snags.
- Current and historical information about occurrence, distribution, and density of wildlife species on private lands.
- Current and historical information about occurrence, distribution, and density for most species on federal lands.

Assumptions

Habitat conditions determine wildlife distribution and abundance. Therefore, in the absence of a sighting record, a species is assumed to be present in the watershed if its habitat occurs in sufficient patch size. For very large home range species, such as the grizzly bear and wolverine, species may also depend on the presence of suitable habitats in adjoining watersheds.

The upper Cowlitz watershed has 268 wildlife species potentially present as compared to 264 species listed in the Middle and Upper Cispus River Pilot Watershed Analysis (USDA Forest Service, 1995g). The four new species include the western gray squirrel, Lewis woodpecker, blue jay and the western kingbird. The three birds are somewhat unique in that they are normally east-side Cascade species but have been documented in this watershed. Three introduced species have been confirmed, including the starling, bullfrog, and Norway rat. It is assumed that introduced species were not present in large numbers prior to 1940.

Indigenous people's utilization of wildlife did not limit wildlife populations.

Interior and late-successional habitat-oriented species were more abundant historically than at the present.

Snag and coarse woody debris-oriented species were more abundant historically than at present.

Opening and edge-oriented species are more common at present than they were prior to 1940 due to the amount of timber harvest openings that have provided edge habitat.

Large predators such as the grizzly bear, gray wolf, and wolverine were more abundant prior to 1940 than at the present.

Fire disturbances, timber harvest, and roading accessing habitats have had the greatest influence on wildlife distribution. 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 (Historic) and Current Conditions

Current habitat conditions within the watershed have been influenced by natural ecological succession, such as forest fires, volcanic eruptions and flooding events. As settlers began to inhabit the valley and clear the land, landscape level changes became more permanent. Fires, both natural and human-caused, have also changed the landscape character of this watershed. In the last 40 to 50 years, changes in the vegetative condition of lands under national forest control have occurred primarily as a result of timber harvest. On private lands, timber harvesting and land clearing for housing developments are the primary influences which have changed the vegetative character.

General Wildlife and Habitats

268 wildlife species are potentially present in the upper Cowlitz watershed. Wildlife "guilds" (groups of species with similar habitat requirements) were defined for the Middle and Upper Cispus River Watershed Analysis. A total of 17 terrestrial and 14 riparian habitat guilds were used in that analysis and also apply to the Upper Cowlitz watershed. There are also 13 species that do not fit into guilds due to their dependence on special or unique habitats. Not included in the total number of species are a number of mollusks which are assumed to occur within the watershed.

WSU's: ALL

Special or Unique Habitats

Special and unique habitats include rock outcrops, cliffs, talus slopes, sub-alpine and alpine habitat, wet meadows, shrublands, avalanche chutes, lakes and ponds. Map 11 displays the distribution of special habitats within the upper Cowlitz watershed analysis area. Some of the wildlife species associated with sub-alpine, alpine, rock outcrops and talus include: mountain goats, marmots, and ptarmigan, all of which are present in the Goat Rocks Wilderness. Larch Mountain salamanders, which show an affinity for talus slopes, are found in two locations in the watershed. Cliff habitat is also present which may provide suitable nesting ledges for peregrine falcons (although none have been documented at this time).

A habitat improvement project has been designed and implemented within the Bear Prairie wetland/meadow complex, a special habitat area. Water holes have been created that now maintain a permanent, year-round water source. This benefits migratory birds including waterfowl and other neotropical species. The wetland complex is also used by elk during the calving season.

Mixed conifer/Oregon oak stands are also present in several small locations in the watershed. These unique areas may provide habitat for the western gray squirrel, a very uncommon species in southwest Washington. The acorn crop produced from these trees are especially sought out by deer and Douglas squirrels.

Table 3-15 shows the acreage of special habitats by WSU

WSU'S: 1,2,3

Listed Threatened, Endangered and Sensitive Wildlife Species (TES)

Table 3-21 below lists all threatened, endangered, sensitive, candidate, and wildlife species of concern that are known or suspected to occur within the Upper Cowlitz watershed.

Table 3-21: Threatened, Endangered, Sensitive, Candidate, and Species of Concern. Documented (D) or Potential (P) Occurrence in the Upper Cowlitz Watershed

Species/Occurrence	Endangered	Threatened	Sensitive	Candidate	Species of Concern
Gray wolf (D)	X				
Peregrine falcon (P)	X				
Spotted owl (D)		X			
Marbled Murrelet (P)		X			

Table 3-21: Threatened, Endangered, Sensitive, Candidate, and Species of Concern. Documented (D) or Potential (P) Occurrence in the Upper Cowlitz Watershed

Species/Occurrence	Endangered	Threatened	Sensitive	Candidate	Species of Concern
Bald Eagle (D)		X			
Grizzly bear (P)		X			
North American lynx (P)			X		
California wolverine (D)			X		
Larch Mountain salamander (D)			X		
Townsend's big-eared bat (D)			X		
Western Pond Turtle (P)			X		
Common loon (D)			X		
Spotted frog (P)				X	
Northern goshawk (D)					X
Olive-sided flycatcher (D)					X
Pacific fisher (D)					X
Long-legged myotis (P)					X
Long-eared myotis (P)					X
Fringed myotis (P)					X
Tailed frog (D)					X
Cascade frog (D)					X

There are no records to indicate any wildlife species have been extirpated from the upper Cowlitz watershed. Several species, including the peregrine falcon and grizzly bear, may never have been very common even prior to European settlement of the valley. However, they are assumed to have been more common at present.

Northern Spotted Owl (NSO)

No estimates of the historical acreage of suitable habitat were calculated. However, a review of historic vegetation patterns indicates suitable owl habitat was normally found in large, consolidated blocks. Fire disturbances have had the greatest influence on the distribution of owl habitat, including the size and shape of habitat patches.

Nesting, Roosting, Foraging Habitat: Mapping of current habitat conditions indicates approximately 32,945 acres of NSO suitable habitat are located in the upper Cowlitz watershed. The vast majority is considered quality nesting, roosting, and foraging (NRF) habitat. Less than one thousand acres is considered suitable foraging habitat, but lacks sufficient large diameter trees to be defined as nesting habitat.

The majority of the quality NRF habitat is located east of US Highway 12, particularly in the Coal Creek, Lake Creek, and Johnson Creek drainages, and also extending southeast into the Goat Rocks Wilderness (WSU's 3,4,5). This habitat consists of large, generally well-connected, blocks. Quality NRF habitat is also present near Pompey Peak in WSU 11.

West of US Highway 12, NRF habitat is more fragmented, particularly in the Davis Creek and Willame Creek drainages (WSU's 8,9,10). Quality NRF habitat is also present in the upper Butter Creek area and extending into Mt. Rainier National Park. (WSU 7).

Dispersal Habitat: There are approximately 48,700 acres of forest that currently meet the definition of dispersal habitat (11 inches average dbh with at least 40 percent canopy closure). Combined with the 32,845 acres of suitable habitat, about 58 percent of the of lands under National Forest ownership within the watershed acts in some capacity to support the northern spotted owl. The remaining national forest acreage consists of alpine and sub-alpine areas, bodies of water, and forested stands that have not reached an average 11 inch dbh.

Several areas have been identified as dispersal habitat concerns for the spotted owl. The West Fork of Willame Creek (WSU 9) and upper Davis Creek riparian zones have been heavily harvested and primarily consist of grass/pole stands. Both stream drainages are within matrix allocations, and subject to future scheduled timber harvests which would reduce the availability of suitable dispersal habitat in upland stands of that allocation. These streams connect matrix lands to the Nisqually LSR. The Deception Creek and Johnson Creek drainages (WSU 3) also have dispersal concerns because of poor riparian connectivity, particularly where both streams merge. Deception Creek and Johnson Creek link the Cispus AMA to the Packwood LSR.

Private Lands: Privately owned timberlands or Department of Natural Resources lands are expected to have a rotation schedule of approximately 60-70 years. Quality NRF habitat would not develop, although some foraging capability may be achieved depending on habitat characteristics and the final rotation age. It is estimated these lands would also function in a dispersal capacity for approximately 25-30 years or until subject to regeneration harvest.

Less than 250 acres of private land could be currently classified as NRF habitat. These acres are within WSU 6. Depending on the desire of the landowner, these acres could be harvested and/or sold for housing lots. It is expected that this NRF habitat would not substantially contribute in the maintenance of owl habitat for the long-term.

***Critical Habitat Units*:** All or portions of two northern spotted owl designated critical habitat units (CHU) are present in the watershed. Critical habitat unit WA-36 is located in the northwestern portion of the watershed and CHU-37 is found in the southeastern portion of the watershed as displayed on Map 12. Critical habitat unit WA-37, located on the east side of U.S. Highway 12, includes most of the national forest lands in the watershed that are outside of the Goat Rocks Wilderness, except for the lower reaches of Dry Creek and Smith Creek.

Each CHU partially overlaps a late-successional reserve (LSR) allocation, from the Northwest Forest Plan (NFP). Approximately 55 percent of CHU WA-36 within the watershed also falls within the Nisqually LSR. The remaining acreage is allocated to matrix. Approximately 50 percent of CHU WA-37 within the watershed overlaps the Packwood LSR. The remaining acreage falls within the Cispus AMA and matrix allocations. Where CHU and LSR lands overlap, late structural habitat is the desired future condition which would benefit dependent species including the spotted owl. Matrix lands within the current CHU boundary are not expected to contribute suitable habitat for spotted owl recovery in the long-term.

***Owl Discussion*:** Available survey data indicate there are 27 pairs and 5 territorial single owls with activity centers within the watershed. The amount of suitable owl habitat for each pair or single has been calculated as the home range radius of 1.82 miles. The threshold for "incidental take" status is determined by the U.S. Fish and Wildlife Service to be less than 500 acres within a 0.7 mile radius or less than 2,663 acres of suitable habitat within a 1.82 mile radius from the activity center. Table 3-22 displays the number of owl activity centers by ROD allocation and the pairs or singles in an "incidental take" situation.

Table 3-22: Northern Spotted Owl Pairs or Singles By Land Allocation Within The Upper Cowlitz River Watershed

	AMA	LSR	Wilderness	Matrix	Total
Pairs or Singles	6	11	5	10	32
Incidental Take	5	4	1	2	12

Consistent with ROD direction, 100 acre LSR's have been established for 16 owl pairs or singles within Matrix or AMA allocations known prior to January 1, 1994. 12 pairs of spotted owls occur outside the watershed boundary with 1.82 mile home ranges that extend into the upper Cowlitz watershed.

Trends: Within the LSR's, suitable habitat acreage will gradually increase as forested stands mature and develop the structural characteristics that define suitable habitat. Within matrix allocated lands, scheduled timber harvests will continue to reduce and further fragment remaining suitable habitat. It is expected that few owls would survive over the long-term within matrix lands. How the Cispus AMA would contribute to listed species survival is still questionable. The selection of a final AMA landscape design has not been chosen as of this writing, but is tentatively scheduled for July 1997. The wilderness areas may continue to provide suitable habitat and support spotted owls, depending on the severity and frequency of natural disturbances and their impact on suitable habitat. Fire in old-growth stands would be a primary concern.

Marbled Murrelet

Approximately 46,650 acres of the northern and northwestern portion of the watershed fall near the outer limits of Zone 2 of marbled murrelet range. This is defined as lands within 35 to 55 miles of saltwater, in this case, southern Puget Sound. Within Zone 2, designated critical habitat for the murrelet coincides with the Nisqually LSR. There are also approximately 20,000 acres within Zone 2 of the watershed not designated as critical habitat, located in the Davis and Willame Creek drainages (see Map 12). These acres are allocated as matrix under the Northwest Forest Plan and managed for timber production.

Suitable nesting habitat is present in the upper Cowlitz watershed, primarily in the Skate Creek and Butter Creek drainages. Limited, smaller, and more fragmented nesting habitat is also present in the Davis and Willame Creek drainages. To date, there have been no detections of marbled murrelets within the watershed. However, only limited timber sale related surveys have been conducted in the Davis and Hopkins Creek drainages.

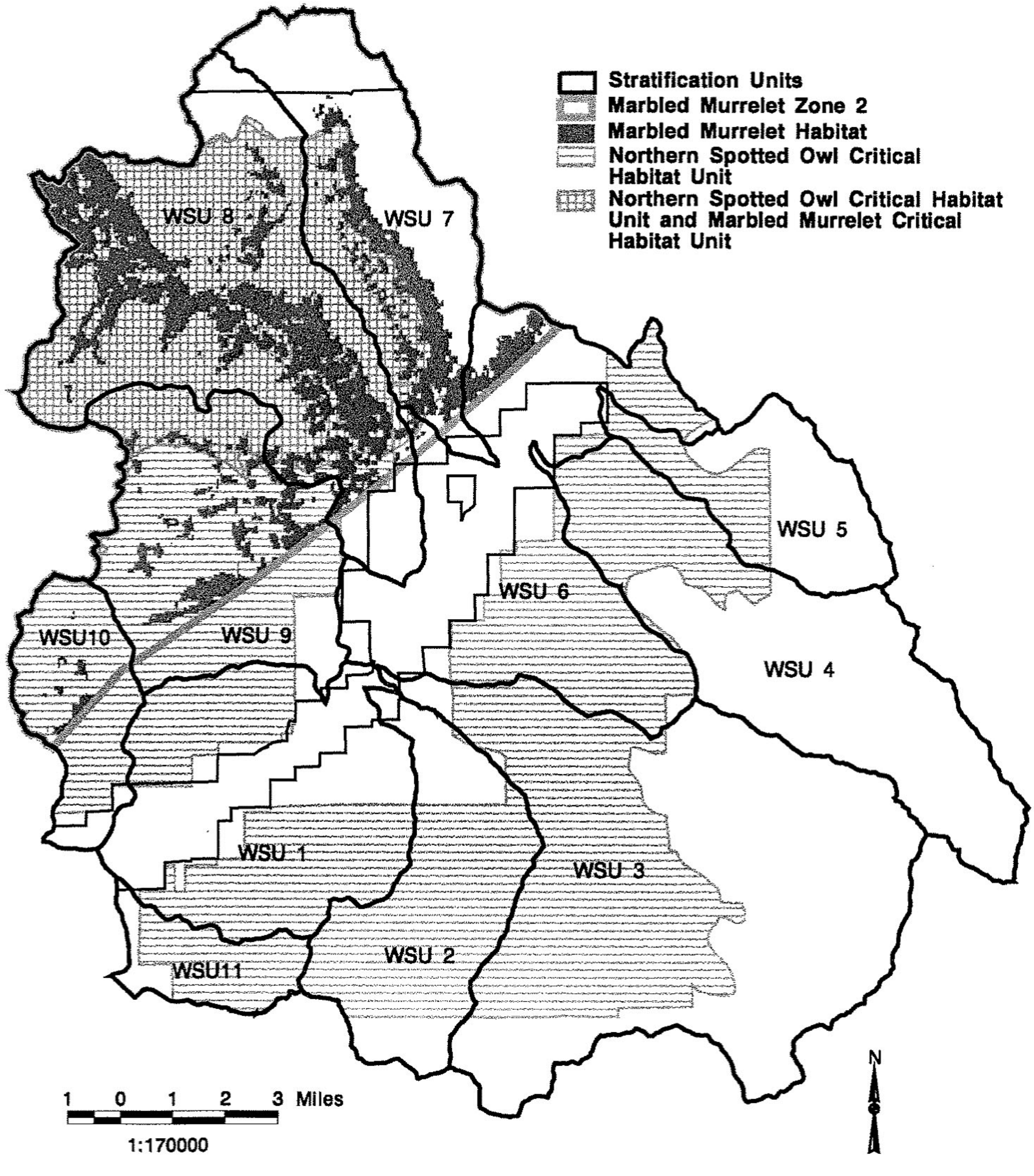
Any projects within the 55 mile murrelet range that may alter or modify suitable habitat or that could potentially disturb murrelets during the nesting season, require surveys to determine their presence. The confirmation of occupied habitat requires that a 0.5 mile radius protective buffer be placed around that habitat before project implementation could occur.

Trends: In the long-term, forested lands within the Nisqually LSR not currently classified as nesting habitat would gradually mature and develop the structural characteristics of large diameter trees with large limbs which function as suitable habitat. This would create large, consolidated blocks of suitable nesting habitat and decrease the risk of nest predation, noted in fragmented stands. While matrix lands within Zone 2 are available for timber harvest, a two-year survey effort to established protocol would be required prior to signing any timber sale decision notice. If occupied nesting behavior is established from the survey, habitat protection buffers would be required to meet ROD direction.

WSU's within zone 2 of murrelet range : 6, 7, 8, 9, 10

Map 12

UPPER COWLITZ WATERSHED ANALYSIS
Marbled Murrelet Zone / Northern Spotted Owl Critical Habitat



Peregrine Falcon

The wildlife sighting database reports one peregrine falcon sighting in the Goat Rocks Wilderness just outside the watershed boundary. This bird may have been en route to coastal wintering grounds. Re-introduction of peregrine falcons has been conducted on the Wind River and Randle Ranger Districts of the Gifford Pinchot National forest. Releases occurred in 1989 and 1990 in Wind River, and from 1991 to 1993 on the Randle Ranger District. Two breeding pairs have been confirmed on the Gifford Pinchot National Forest, although neither was within this watershed. An initial assessment of potential nesting habitat in the watershed was conducted in 1996 by T. Kogut and J. Pagel (pers. communication, 1996). Suitable nesting ledges were present on several cliff sites. Cooperative funding approaches between state and federal agencies may provide the necessary funding resources to conduct adequate falcon occupancy surveys.

WSU's: 1, 5, 7, 8

Gray Wolves

Gray wolves were thought to be eliminated as a breeding resident in Washington by 1930 (Young 1944). However, Laufer and Jenkins (1989) suggest wolves may be re-colonizing former ranges based on numerous reported sightings. This is consistent with the increasing number of wolf sightings reported on the Packwood Ranger District since 1991. Individuals and, on several occasions, multiple animals (suggesting a wolf pack) have been sighted. The evidence suggests wolves are re-establishing themselves. However, it is unknown if the animals are pure wolves or hybrids. Wolf denning activity has not been confirmed on either district.

WSU's: 4, 5, 7, 8

Grizzly Bear

Grizzlies have never been very common in Washington state. Small remnant populations exist in the North Cascades and in the Selkirk Mountains in northeastern Washington. There have been no confirmed sightings on the Gifford Pinchot National Forest, although suitable habitat is available. The nearest confirmed sighting occurred just west of Mt. Rainier during the summer of 1993. The most suitable habitat in the watershed can be found within the Goat Rocks and Tatoosh Wilderness areas. Human recreational use in both wilderness areas is considered high during the summer months and the fall hunting seasons. Since most human use is closely associated with the network of hiking trails, vast acreages with little disturbance may provide quality habitat on a seasonal basis.

Northern Bald Eagle

Eagles are commonly seen during the late fall through early spring (November through March) along the Cowlitz River. An annual winter survey along the Cowlitz and Cispus River is conducted by district wildlife personnel every January. These census counts typically record 8 to 15 bald eagles every year. Ungulate, salmon, and steelhead carcasses provide the main sources of nutrition during these months. Food resources for wintering eagles is expected to rise as a result of the current re-introduction of steelhead and salmon to the Cowlitz and Cispus River systems. The first adult returns are expected in 1998. As part of mitigation efforts, surplus adult salmon and steelhead have been released into the Cowlitz near Packwood and at Jody's bridge over the last several years. These fish are intended to provide a fishing opportunity for local sportsmen. As these fish spawn and die, eagles can be seen feeding on the carcasses.

There are no known communal night roosts in the watershed despite intensive surveys. Research on the Lewis River in southwest Washington has indicated communal roosts are typically located on north facing slopes, within older multiple canopy stands (Anderson, *et al* 1986). These stands are selected because of the protection they afford from the prevailing southwesterly winter storms and winds. Potential communal roosts on the upper Cowlitz watershed may occur in any of the tributary drainages on the south side of the Cowlitz River where old growth stands are present. Surveys at dusk are necessary to confirm communal roosting.

An occasional bald eagle is seen during the summer months, although no nesting pairs have been documented. The nearest known eagle nests are located on the reservoirs of the Cowlitz River near the towns of Glenoma, Randle and Mossyrock.

WSU's: 1, 2, 3, 4, 5, 6

Wolverine

Several wolverine sightings have been reported in the Goat Rocks and Tatoosh Wilderness areas as recently as 1995. This is consistent with suitable habitat being described as mountainous, forested areas. Wolverines likely utilize the ridge system connecting Mt. Rainier National Park and the adjacent Tatoosh Wilderness.

North American Lynx

There are no documented lynx sightings and suitable habitat is considered limited based on habscapes modeling. Denning habitat is potentially present in late-successional or old-growth stands within the Goats Rocks wilderness. Foraging habitat is described as younger aged, high elevation forests (above 4500 feet) with high populations of snowshoe hares. Modeling shows few stands of this nature.

Fisher

Several fisher sightings have been reported in the Skate Creek corridor, linking the upper Cowlitz and the Nisqually River watersheds. Another sighting occurred of an animal crossing U.S. Highway 12 east of Packwood. Research by Aubrey and Houston (1992) shows fishers to be a relatively low elevation species in the west-side of the Cascade Mountains. They are closely associated with forested riparian corridors which are used as foraging, resting and travel habitat. This is consistent with habitats in which the sightings were recorded.

In 1996 the Gifford Pinchot National Forest entered into an agreement with the Washington State Department of Fish and Wildlife to conduct surveys of forest carnivores. A camera is used to record activity near a bait (usually a deer or elk quarter) attached or suspended from a tree.

To date, there have been no detections of lynx, fisher or wolverine, although marten, bobcats, weasels, spotted skunks, and red-tailed hawks have been photographed on the bait. Despite the lack of detections, the three main target species are still assumed to be present within the watershed. Populations may be so low that several years worth of surveys are required to photograph or document the species. Surveys have been conducted in several drainages of the upper Cowlitz including Glacier Creek, Muddy Fork of the Cowlitz, and upper Johnson Creek. Funding sources will need to be secured in order to continue surveys beyond the winter of 1997.

Common Loon

Although this species has been documented on Packwood Lake as a migrant, no nesting activity has been confirmed.

Harlequin Duck

This species of duck winters along the Pacific coastline but migrates inland to nest. This is the only duck species in the northern hemisphere known to breed almost exclusively along a select few, swiftly flowing, mountain streams. Productivity seems to be primarily influenced by stream runoff (Genter, *et al.* 1993) and food availability (Gardarsson, *et al.* 1991). Although historical information is incomplete, both breeding and wintering Pacific populations appear to be declining (Cassirer 1993).

Numerous harlequin sightings have been reported along Skate Creek and the Cowlitz River, including multiple pairs in the last four or five years. Unfortunately, the lack of records of reproductive pairs may indicate a stream runoff or food source problem. The Skate Creek corridor is also subject to heavy recreational use by camping and fishing enthusiasts. Research is needed to determine if high human use along the stream may also be contributing to the lack of nesting activity.

The Washington State Department of Fish and Wildlife has been color leg banding harlequins while the birds are on wintering grounds in Puget Sound. Anyone seeing the banded birds on any stream is requested to report the sighting to them or Forest Service biologists. The intent of the study is to further define which streams the birds may be selecting for nesting.

Amphibians and Mollusks

Little is currently known on the presence of amphibian and mollusk species within the watershed. A few terrestrial and aquatic amphibian surveys have been conducted. No data exists for mollusks. Table 3-23 displays the amphibian species listed as ROD "survey and manage" or federal species of concern known to occur within specific WSU's.

Table 3-23: Known "Survey and Manage" and Federal Amphibian Species of Concern by WSU

Species	Name	Status	01	02	03	04	05	06	07	08	09	10	11
Tailed frog	*Ascaphus truei*	SOC			X		X						
Cascade frog	*Rana cascadae*	SOC		X	X								
Larch Mountain salamander	*Plethodon larselli*	SM			X								

SOC - federal species of concern SM - survey and manage

Other listed or survey and manage amphibian species that may occur within the watershed include Van Dyke's salamander (*Plethodon vandykei*) and the spotted frog (*Rana pretiosa*). Since 1997, surveys for Larch Mountain and Van Dyke's salamanders have been required for ground disturbing projects. Many other amphibians species, neither federally listed, candidates nor survey and manage species, are documented to occur in the Upper Cowlitz watershed. These include: Pacific giant salamander (*Dicamptodon tenebrosus)*, Cope's giant salamander (*D. copei*), Northwestern salamander (*Ambystoma gracile*), long-toed salamander (*A. macrodactylum*), western red-back salamander (*Plethodon vehiculum*), ensatina (*Ensatina eschscholtzii)* and the rough-skin newt (*Taricha granulosa*).

Potential "survey and manage" mollusk species which may occur in the watershed include:

- Puget Oregonian *Cryptomastix devia*
- Evening Fieldslug *Deroseras hesperium*
- Keeled jumping slug *Hemphillia burringtoni*

- Warty jumping slug — *Hemphillia glanulosa*
- Panther jumping slug — *Hemphillia pantherina*
- Oregon megomphix — *Megomphix hemphilli*
- Bluegray taildropper slug — *Prophysaon coeruleum*
- Pappillose taildropper slug — *Prophysaon dubium*

Surveys to determine the presence of these species will be required for all ground disturbing projects implemented in FY 99.

ROD Protection Buffer Species

The ROD afforded extra protection for a selected group of wildlife species that were considered rare or locally endemic. Several species from this group have been documented or are suspected to occur based on the availability of suitable habitat. The lynx was discussed under the threatened and endangered species section. Guidelines for the black-backed woodpecker require sufficient snag habitat be left to maintain 100 percent potential population density. Guidelines for Van Dyke's and Larch Mountain salamander habitat require three survey visits under appropriate weather conditions to determine presence or absence. The discovery of either species requires the establishment of buffer zones to protect the species and associated habitat at that location.

The great gray owl is also a buffer species. Habscapes modeling indicates that little suitable habitat is present in the watershed. What suitable habitat exists is primarily located in two areas: one, within the upper Lake Creek basin of the Goat Rocks Wilderness (WSU 04), and the other a small area near Davis Mountain (WSU 10). This species has not been documented to occur in the watershed, although no surveys have been conducted.

The ROD lists five species of bats requiring special attention (fringed myotis, silver-haired, long-eared myotis, long-legged myotis, and the pallid bat). 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.

Big Game Habitat

Deer and Elk Biological Winter Range

Historically, wildfires were the major land disturbance most likely to affect the density and distribution of deer and elk populations in the Cowlitz River valley. An analysis of fire history maps show several large events in the watershed have occurred since 1800, some as large as tens of thousands of acres in size. Smaller blazes have also occurred, from several hundred acres to less than one acre lightning strikes. Big game populations were influenced primarily by these disturbances. Hunting pressure by Native Americans probably had little impact on animal populations.

The landscape character in the wintering grounds began to change with the arrival of white settlers to the valley and the start of land clearing operations. Fire suppression became a major Forest Service policy beginning in the 1920's and 1930's. The lack of natural fires and the intensive timber harvest management that began in the 1950's determined the location of deer and elk populations within the watershed. Even today, timber management has the greatest influence on big game distribution.

The following analysis of big game winter range was conducted for the National Forest lands using the IVEG database. Generally, biological winter range is defined as lands below 2200 to 2400 feet in elevation. Within the upper Cowlitz watershed, there are approximately 32,680 acres of biological winter range. 19,880 acres (61 percent) are on national forest lands and approximately 12,800 acres (39 percent) are in private ownership. Map 13 displays deer and elk biological winter range within the watershed and includes national forest and private lands.

Private lands

Privately owned lands include small farms, woodlots, the town of Packwood, housing developments, and holdings of other land management agencies such as the Washington State Department of Natural Resources. No analysis of vegetation was conducted for privately owned land within winter range. Most commercial timberlands are commercially thinned at about 25-30 years of age and regeneration harvested at 60-70 years. Lands currently in fields or pastures will likely remain in that condition and continue to provide deer and elk winter forage. Large numbers of elk are commonly seen feeding in the pastures. There are approximately several hundred acres of privately owned land in optimal cover condition (WSU 6). These lands may be harvested to meet the landowner's needs. Overall, privately owned lands within biological winter range consist of a mosaic of open forage areas, hiding and thermal cover stands with little optimal cover acreage.

National Forest Winter Range

Biological winter range occurs in AMA, Matrix, and Late-Successional Reserve allocations of the Northwest Forest Plan. The following table displays the current cover/forage condition of the winter range within national forest boundaries.

Map 13

UPPER COWLITZ WATERSHED ANALYSIS
Deer and Elk Winter Range

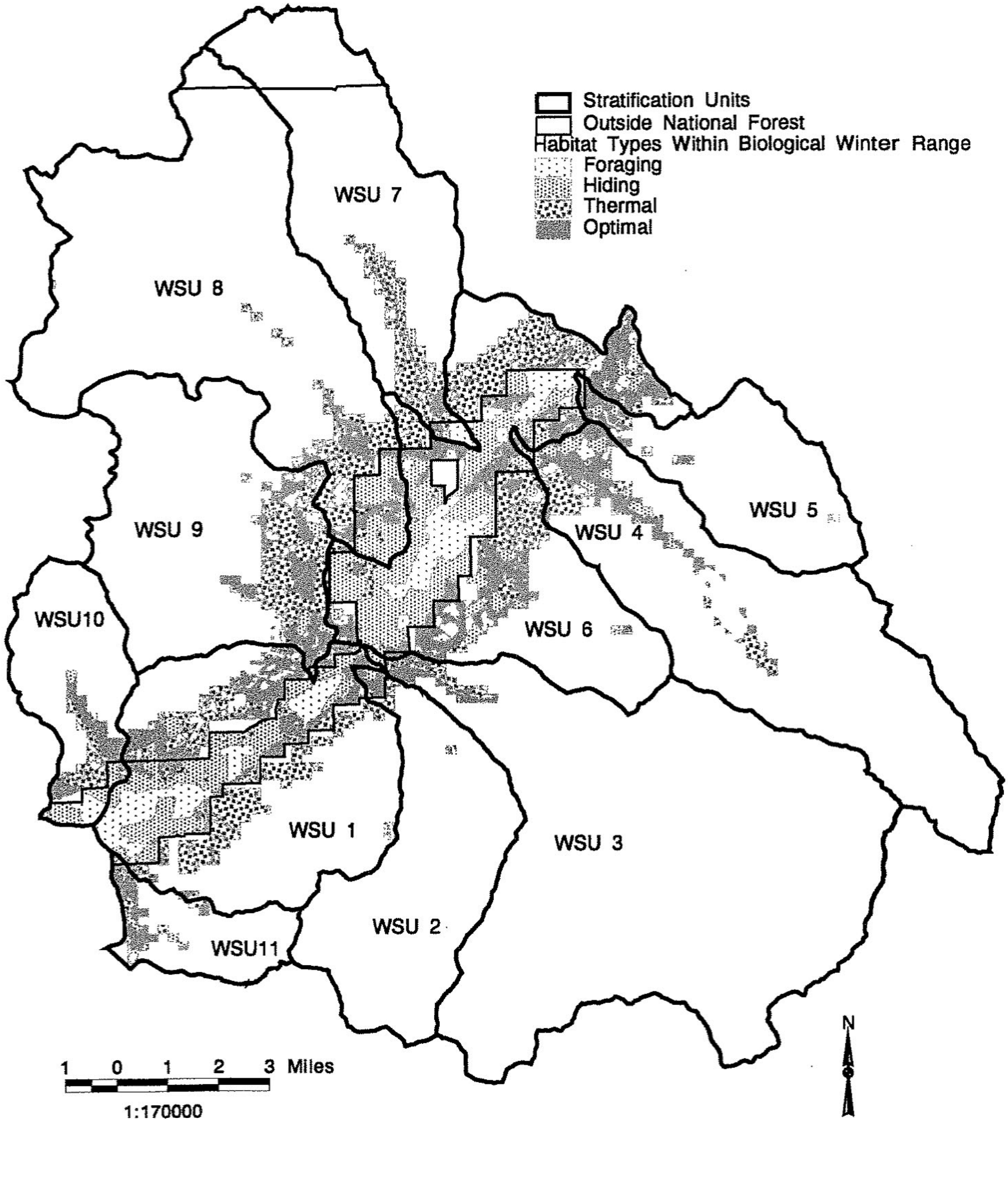


Table 3-24: National Forest Biological Winter Range Acres and Percent by Cover Condition for the Upper Cowlitz Watershed					
	Optimal Cover	Thermal Cover	Hiding Cover	Open Forage	Total
Acres	6,277*	9,264	1,919	2,427	19,887
Percentage	32%	47%	10%	12%	100

** These acres were developed from a vegetation database and have not been field verified. Actual acres that meet an optimal cover condition class may differ and may be less than are stated in the table.*

Optimal cover is defined as forested stands with an average dbh greater than 21 inches, 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 includes both natural openings (meadows, shrublands etc.) and regeneration harvest openings up until about age 20. Occasionally, heavy commercial thinnings can also be considered as forage openings if the canopy closure is sufficiently low.

The GPLRMP Amendment 11 standards and guidelines specify that 44 percent of biological winter range acreage should be in optimal cover, preferably well distributed across the watershed in 60-acre cover blocks. As the previous table shows, there is currently a deficiency in optimal cover. Optimal cover is generally well distributed across the watershed, with the exception of the following four areas: WSU 1 (Garrett Creek, Burton Creek, Dry Creek), WSU 2 (Smith Creek), WSU 6 (Hinkle Tinkle Creek), and WSU 7 (Butter Creek). Thermal cover stands are present in these areas, however, and partially mitigate the lack of optimal cover. Open forage areas are well distributed across the entire winter range and are at the prescribed levels of approximately 12 percent over a two decade period. Forage openings across the entire winter range, including private lands, is not a limiting factor in big game populations at this time.

It may be possible to accelerate the development of optimal cover from thermal cover conditions using silvicultural practices on winter ranges within national forest lands. Treatments may include commercial thinning and/or understory planting of shade-tolerant species such as western red cedar and western hemlock.

Open road density on deer and elk winter range on the Packwood Ranger District is 1.6 miles/square mile of land (T. Kogut, *pers. com.* 1997). This is within the 1.7 miles/square mile limit specified under the GPLRMP. Road density on the private land has not been calculated but would be described as very high. High road densities contribute to poaching and an increased risk of animal/vehicular collisions.

Trends

Private lands: Over the long-term, there will be a general reduction in the amount of disturbance-free habitat available to animals wintering on private lands. Open forage distribution will not likely be a concern, but animals will be subjected to increased levels of harassment from people, roaming dogs, and poaching.

National Forest lands: In the short-term there will be little change in habitat conditions. Over the long-term, as the LSR's in WSU's 3,4,5, and 7 develop large tree structure, open forage will decrease to that present in older aged stands, natural openings or temporarily created through thinning prescriptions. The loss of larger openings, normally created in regeneration harvests, will force more animals onto private lands. This may lead to more animal/human interactions with increased animal mortality during the winter period. Within other NFP allocations, small-scale forage openings may still be created in winter range areas, keeping some wintering populations on the forest and off private lands.

WSU's containing biological winter range: 1, 2, 3, 5, 6, 7, 8, 9, 10, 11

Mountain Goat Habitat

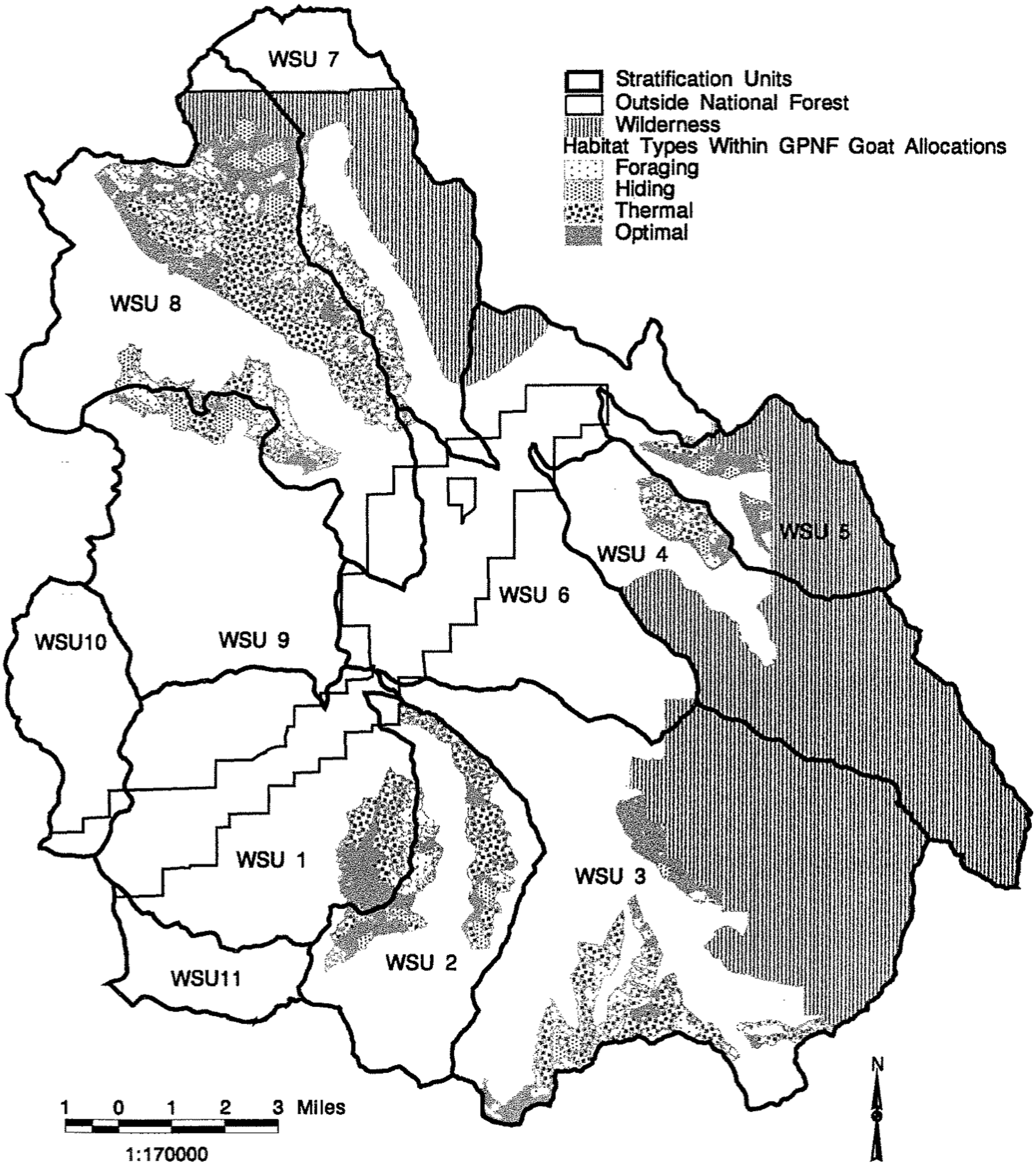
Mountain goats are considered a relatively common species in the Upper Cowlitz watershed. Populations can be found either year-round or seasonally in the Goat Rocks Wilderness, Tatoosh Wilderness, Coal Creek Bluffs, Johnson Peak, Southpoint Ridge, Stonewall Ridge, Goat Dike, Angry Mountain, Mission Mountain, and Cold Springs Butte. Map 14, displays the GPLRMP mountain goat allocations and wilderness areas where mountain goats are known to occur.

Historically, native populations of mountain goats ranged as far south as the current boundary of the Goat Rocks Wilderness. However, there is no information available on the number or distribution of mountain goats in the watershed prior to 1920. From 1920 to 1960, populations were thought to be stable (USDA, 1995x). After 1960, timber harvest intensified in the watershed, including higher elevation optimal cover stands within known mountain goat range. Increased road access from timber harvest, combined with legal and illegal hunting, contributed to a drastic population decline, particularly in the Smith and Dry Creek drainages.

In response to decreasing populations, the Washington State Department of Game eliminated mountain goat hunting permits in the Smith Creek area in the mid 1980's. The Packwood Ranger District also began an intensive road closure program aimed at restricting access into goat range. During this same time period, mountain goats were relocated from the Olympic National Park to

Map 14

UPPER COWLITZ WATERSHED ANALYSIS
Mountain Goat Habitat



the Jackpot Lake area in 1985 (12 animals) and again in 1987 (8 animals). Collectively, these measures have given a boost to the goat population in the Smith Creek area. The Washington State Department of Fish and Wildlife is carefully regulating goat harvest in the Smith Creek and Stonewall Ridge areas by issuing very few hunting permits. Another positive response to the population increase is the migration of goats into suitable habitats to the south and west of the release area within the Cispus AMA and other peaks of the Randle Ranger District.

The Gifford Pinchot National Forest and the Washington State Department of Fish and Wildlife have entered into a challenge cost-share agreement to conduct four helicopter surveys to estimate goat populations. The data will be used to improve management of the Cispus AMA for mountain goats and other species. Two flights have been conducted to date. A total 51 goats were recorded during an October 3, 1996 survey and 19 goats were recorded during a March 25, 1997 survey. The majority of the animals were seen on Southpoint Ridge and Stonewall Ridge during both flights. Recent data suggests no distinction between mountain goat summer and winter range in the Cispus AMA area. Most of the animals were seen at elevations above 4500 feet on both flights. The fewer animals noted on the second flight may be the result of animals hidden in optimal cover stands or having moved to other wintering areas. Two remaining flights are tentatively scheduled for July and September 1997. The next Forest Plan revision should take into account the habitat data collected from these flights to help define goat range in the watershed and the Cispus AMA.

The quality of goat habitat across the watershed varies substantially. The Goat Rocks Wilderness contains the highest quality habitat in the watershed, based on the amount of natural meadows (foraging habitat) and cliff habitat (escape terrain). In comparison, goat habitat on the other peaks or ridge systems is usually restricted to the uppermost elevations where rock cliffs or outcrops are found. These peaks can only support small groups or bands of goats. Human disturbances have the greatest negative impact on goats where trails, for example, traverse rocky outcrops where goats are found. The goats are left with nowhere to go to avoid people, in contrast to the Goat Rocks Wilderness which has many thousands of acres of goat habitat.

There is some concern as to whether people accessing the Tatoosh Lakes are negatively impacting goats and forcing them into the adjacent Mt. Rainier National Park. Similar concerns may exist for the Castle Butte/Twin Sisters area along the Klickitat Trail. The development of the Cispus AMA plan may provide research opportunities to study mountain goat habitat selection, home range, travel and migration routes, food selection and response to human disturbances. Partnerships with universities, private groups, and other state and federal agencies could provide necessary funding sources and personnel to conduct research.

Areas designated as mountain goat allocations under the GPLRMP include only some of all the ranges inhabited by goats in the watershed. Standards and guidelines in the forest plan detail what activities are permitted and the amount of optimal cover percentage that must be retained on a permanent basis. Ten separate mountain goat allocations (winter or summer) have been designated in the watershed. The following tables display the current forage and cover conditions for summer/winter ranges identified in the forest plan. Several of the mountain goat allocations have been summarized collectively since they may fall within multiple WSU's.

Table 3-25: Smith Ridge and Southpoint Ridge Allocated Mountain Goat Range Forage and Cover Conditions (WSU'S 1 and 2)

	Optimal Cover Acres (%)	Thermal Cover Acres (%)	Hiding Cover Acres (%)	Forage Openings (%)	Total Acres
Winter Range	493 - 17%	1,539 - 54%	315 - 11%	498 - 17%	2,829
Summer Range	706 - 39%	463 - 26%	55 - 3%	580 - 32%	1,804
Totals	1,199 - 26%	2,002 - 43%	370 - 8%	1,078 - 23%	4,633

Table 3-26: Stonewall Ridge Allocated Mountain Goat Range Forage and Cover Conditions (WSU 3)

	Optimal Cover Acres (%)	Thermal Cover Acres (%)	Hiding Cover Acres (%)	Forage Openings (%)	Total Acres
Summer Range	434 - 13%	1,520 - 47%	117 - 4%	1,192 - 37%	3,263

Table 3-27: Angry Mountain/Chambers Lake Allocated Mountain Goat Range Forage and Cover Conditions (WSU 3)

	Optimal Cover Acres (%)	Thermal Cover Acres (%)	Hiding Cover Acres (%)	Forage Openings (%)	Total Acres
Winter Range	628 - 63%	235 - 24%	42 - 4%	90 - 9%	995

Table 3-28: Coal Creek Bluffs Allocated Mountain Goat Range Forage and Cover Conditions (WSU's 4 and 5)

	Optimal Cover Acres (%)	Thermal Cover Acres (%)	Hiding Cover Acres (%)	Forage Openings (%)	Total Acres
Winter Range	677 - 38%	443 - 24%	381- 21%	297 - 17%	1,798

Table 3-29: Dixon/Skate Allocated Mountain Goat Range Forage and Cover Conditions (WSU'S 7, 8 and 9)					
	Optimal Cover Acres (%)	Thermal Cover Acres (%)	Hiding Cover Acres (%)	Forage Openings (%)	Total Acres
Winter Range	681- 18%	1,935 - 50%	0	1,217 - 32%	3,833
Summer Range	1,090 -14%	2,267- 29%	1,047- 14%	3,335 - 43%	7,739
Totals	1,771 - 15%	4,202 - 36%	1,047 - 9%	4,552 - 39%	11,572

The above tables illustrate that optimal cover acreage is most abundant in the Angry Mountain goat range (WSU 3) and least abundant on Stonewall Ridge (WSU 3) and on Dixon and Skate Mountains of WSU's 7,8, and 9.

Stands of optimal cover are important to mountain goats for several reasons. During the summers, the dense canopy condition blocks much of the solar radiation and provides cooler bedding areas for the animals. In the winter, optimal cover stands hold greater amounts of snow in the tree canopies as compared to thermal cover stands. This allows the animals to move more freely, expending less energy during foraging periods. Optimal cover also moderates extreme cold weather and blocks strong, gusty winds common in winter storms. Lichens are a major food source for goats, particularly during the winter months, and are most abundant in large tree or old growth stands classified as optimal cover.

A substantial amount of thermal cover is found in each WSU's. Thermal cover can modify extremes in weather but not as well as optimal cover. Commercial thinning of thermal cover stands may shorten the time frame for development into optimal cover. Lower elevation stands of western hemlock within goat range may respond best to a commercial thinning entry. A more cautious silvicultural prescription should be developed for thinning within the silver fir zone. Any proposed timber harvests in goat range should be designed to benefit goats and their habitat.

A preliminary analysis of natural meadow succession in the Smith Creek area of the watershed has been completed by Tom Kogut, Packwood District Wildlife Biologist. The results show that some meadows are being impacted by conifer encroachment that has occurred over the last 40 years. Without treatment of some kind, the end result will be a continuing loss of foraging habitat. There is no evidence at this time that mountain goats are utilizing clear-cut harvest openings as a forage base. This makes natural meadow enhancement even more important to helping maintain the goat population. Further discussion of this topic is presented in Chapter 4 of this document, titled "**Areas of Concern**".

WSU's containing allocated mountain goat habitat: 1,2,3,4,5,7,8,9

Roads

Road densities range from 0.75 miles/square mile in WSU's 4 and 7 to 3.75 miles/square mile in WSU 06. There are 441.7 miles of road and 242.9 square miles of land, for an average road density of 1.82 miles/square mile across the entire watershed. Road densities in the deer and elk winter range and the mountain goat range are within desired levels and are not thought to be impacting populations of either species at this time.

High road densities (near or exceeding 2.0 miles/square mile) in WSU's 6, the northern half of 8, 9, 10, and 11, have resulted in a low habitat capability for grizzly bear, gray wolf and wolverine. The most suitable habitat available for this group of species is located in WSU's 1, 2, 3, 4, 5, 7, and the southern half of 8, particularly roadless and wilderness areas.

Habitat Connectivity

Connectivity can be defined as a 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 a function of 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 has been influenced primarily by fires, volcanic events, and floods. Fire events ranged from less than one acre burns to those involving tens of thousands of acres, drastically altering the connectivity between patch types. All three types of natural disturbances have occurred to some degree since 1980.

Riparian Connectivity

At a landscape scale, three riparian areas (Cowlitz River, Skate Creek, and Johnson Creek) are readily apparent as contributing to species flows. The Cowlitz River (WSU 6) is an obvious connectivity zone and functions as a major neotropical bird flyway on the north end of the national forest. At one time, it likely served as a movement area for carnivores and big game species migrating between summer and winter ranges in other watersheds. This capacity has been diminished by the development of private lands within the valley.

The Skate Creek zone (WSU 8) ties the Niqually watershed to the Cowlitz River. Small tree to large tree structural stands are still relatively well-connected in this zone. Wildlife sightings indicate this zone is used by carnivores such as bobcats, martens and fishers.

The Johnson Creek zone (WSU 3) ties the Cowlitz River to the upper Cispus River watershed. The Johnson Creek drainage has been impacted by riparian regeneration harvests, particularly in the southern reaches near the watershed boundary and upstream from the confluence of Deception Creek. The Johnson Creek riparian zone acts as a funnel for migrating big game, carnivore species, and neotropical birds.

Clearly, other riparian zones are important for many wildlife species. Under the ROD, riparian reserves were intended to act as dispersal corridors, particularly for species with large home ranges such as the spotted owl. The riparian reserves connect other land allocations to large areas of suitable habitat within the LSR's. A review of the condition of forested riparian drainages leading to the Nisqually LSR indicate riparian connectivity concerns in two areas. The West Fork Willame Creek (WSU 9) riparian zone is primarily in a grass/pole condition, withscattered patches of large tree structural habitat. Similar problems exist in the upper Davis Creek (WSU 10) riparian reserves.

Large tree riparian connectivity is also a concern in two drainages linking the Cispus AMA to the Packwood LSR. Deception Creek (WSU 3) has major grass/pole breaks with scattered large-tree structural habitat over most of its stream length. Improvement is shown, however, south of its confluence with Johnson Creek. Johnson Creek (WSU 3) was described earlier with connection concerns.

Terrestrial Connectivity

Ridgetops provide travel corridors for species associated with higher elevations, including mountain goats, lynx, and wolverine. Two high elevation connectivity areas are important for this species group. A ridge system (WSU 7) ties the Tatoosh Wilderness to Mt. Rainier National Park, facilitating species movements between areas. A major ridge system (WSU's 11,2,3) partially separates the middle Cispus watershed from the upper Cowlitz. Mountain goats are known to use this ridge system (also known as the Klickitat Trail) when traveling between natural meadows and cliff habitats. Wolverine and marten are also expected to use the ridge. It is not known what impact, if any, human use of the trail system is having on wildlife species. The AMA plan has proposed learning opportunities that may increase our knowledge of mountain goat habitat selection, reaction to disturbance, and travel and migration in this area. Other ridgetop connectivity zones can be found on Dixon Mountain (WSU's 7,8), Smith Ridge (WSU's 1,2), and Southpoint Ridge (WSU's 2,3).

Habitat Fragmentation

Fragmentation is the process of reducing size and connectivity of stands that compose a forest (FEMAT, FSEIS). An analysis of interior habitat was conducted for the watershed. Interior forested habitat is defined as stands greater than 40 feet tall, with at least 70 percent canopy closure, located at least 150 feet from a road and/or greater than 450 feet from an opening greater than two acres in size. A report of interior forested habitat was generated and is displayed in the following table.

Table 3-30: Acres and Percent of Interior Forested Habitat on National Forest Lands by WSU

WSU	Interior Acres	Total Acres	Percent
1	3,979	11,270	35
2	1,857	10,174	18
3	7,052	31,051	23
4	3,710	16,337	23
5	1,990	6,562	30
6	1,998	12,407	16
7	1,538	9,490	16
8	3,780	20,847	18
9	2,192	13,417	16
10	601	4,994	12
11	909	3,238	28

The above table compares interior acres to the entire acreage within each WSU, but does not take into account the acres of rock, sub-alpine and alpine lands not capable of becoming interior forested habitat. This report also does not account for interior habitat present on private lands, although vegetation mapping for private lands shows very little interior forest habitat. Acreage and percentage estimates for WSU's 7 and 8 are slightly underestimated, since interior forested habitat is present on the adjacent Mt. Rainier National Park. Caution should be used in trying to interpret or make judgements of these acres. An interior habitat map is present in the analysis files.

Interior forested habitat is present within each WSU. The largest and most contiguous blocks are located in the lower elevations of the Goat Rocks Wilderness (WSU's 3,4,5). Outside of wilderness areas, large blocks are present in WSU 1 in the Garrett Creek, Burton Creek, and Dry Creek drainages, which also fall within the AMA portion of the watershed. Another large block is located in the South Fork of Willame Creek drainage (WSU 9) within the Matrix allocation. Several blocks are present in WSU 8 of the Nisqually LSR. The remaining WSU's (2, 6, 7, 10 and 11) all have some interior habitat, but blocks are generally less than several hundred acres in size and irregularly shaped.

Isolated late-successional patches, (as small as several acres) surrounded by early or mid-successional habitat, can be very important refugia for small home range species such as amphibians, mollusks, and northern flying squirrels. These stands function as a "genetic center", where species may persist until adjacent stands mature and species re-colonization could occur. Fragmentation may be a concern in the matrix and Cispus AMA allocations of WSU's 2, 3, 6, 9, 10, and 11. Regeneration harvests are permitted within these allocations and a review of isolated late-successional patches, if present, should occur during project planning.

Pileated Woodpecker and American Marten Network

Six American marten and five pileated woodpecker allocations were placed in the upper Cowlitz watershed under the Gifford Pinchot National Forest Plan. The ROD (1994) amended individual forest plans to eliminate these allocations. However, these allocations could be retained if management objectives for these two species are not being met through the ROD's land allocation.

An analysis was conducted of the network sites and whether retention of any or all sites is justified. It was determined eight of the network sites would be protected through LSR designation. Two additional sites would be protected through riparian reserve and deer and elk winter range allocations. One marten allocation immediately south and adjacent to Willame Lake should be maintained to provide connectivity over Dixon Mountain. More detailed analysis of the assumptions and rationale used can be found in the analysis files.

Aquatic Elements

Disturbance Regimes

Data Sources/Data Gaps

Information regarding volcanic and 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.

Due to time limitations, the mass wasting part of this report 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.

A major flood event occurred during 11/30/95 that initiated mass wasting events and stream channel changes; another major flood event occurred during 2/8/96 that caused severe mass wasting events and changes to stream channel conditions. Damage occurred along the 20, 21, 47, 52, 63 road systems, descriptions of which are included in this report.

Locations for mass wasting events were produced using a GIS coverage called "GeoHaz" (see Map 15 - Mass Wasting Inventory). GeoHaz is generally accurate, meaning that most landslides out on the ground have been identified by GeoHaz (prior to November, 1995), and most of the slides shown by GeoHaz will be found on the ground . 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. Time did not allow for a review of the entire watershed, or actual input of corrections onto the GIS coverages. The bullet statements listed below reflect corrections of known errors where applicable.

Air photos taken in 1939 exist for portions of this study area, but only a few photos were available for this analysis. Air photos taken in 1959, 1972, 1979, 1989/90, and 1993 are available for use in determining the *timing* and *cause* of mass wasting events. Time limitations did not allow for air photo sequencing in order to compare the rate of "naturally occurring" mass wasting events to "human-caused" mass wasting events. However, air photo reviews for previous timber sale projects in this study area has allowed the writer to make qualitative determinations regarding the rate of human-related mass failures compared to naturally occurring mass failures throughout the rest of the watershed during the same time span. This time span, referred to below as Historic Conditions, usually refers to the 1973-1990 period of air photo coverage, and sometimes extends back to the 1959 air photos when noted. This brief time span is entirely too short to use for determining a *Range of Natural Variability* for mass wasting, so the term Historic Conditions has been used instead. When discussing the comparison of management-related mass wasting events to historic conditions, the following qualitative descriptions were used:

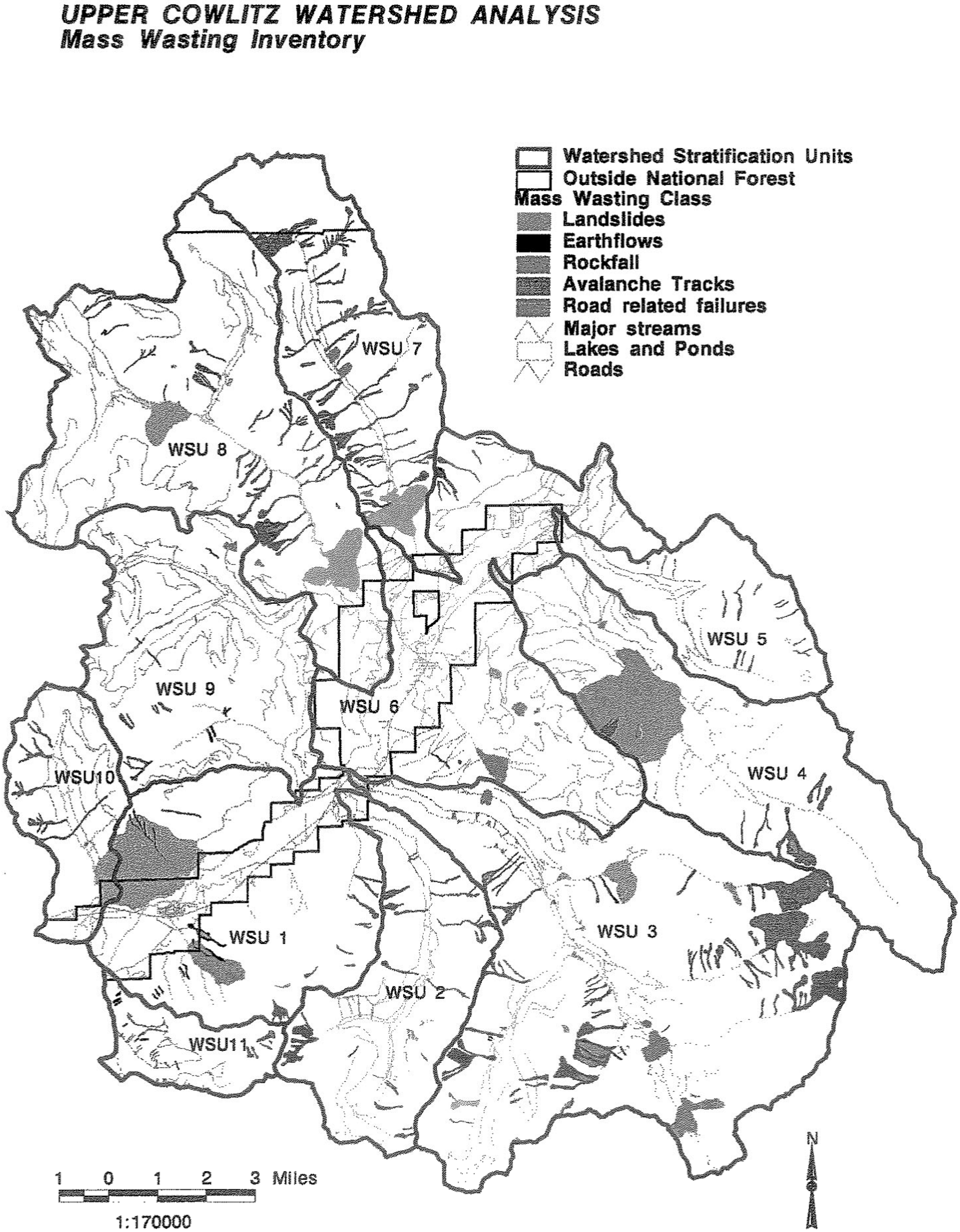
Slight: a few small road and harvest-related failures have occurred, separated in both time and space

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.

Map 15


UPPER COWLITZ WATERSHED ANALYSIS
Mass Wasting Inventory
Watershed Stratification Units
Outside National Forest
Mass Wasting Class
Landslides
Earthflows
Rockfall
Avalanche Tracks
Road related failures
Major streams
Lakes and Ponds
Roads
WSU 7
WSU 8
WSU 5
WSU 9
WSU 6
WSU 4
WSU10
WSU 1
WSU 3
WSU 2
WSU11
N
1 0 1 2 3 Miles
1:170000

Information for hillslope erosion was taken from the forest Soil Resource Inventory (SRI) map, stored as another GIS coverage. 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 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 (Access and Travel Management, Phase II) Surveys were conducted prior to this watershed analysis, during the summer of 1996. Another source of information used regarding road conditions is the Flood Damage assessment forms on file in Randle District Engineering. A summary of these reports lists flood damage sites from high water events in 1994-96, and estimated costs to repair these sites to a similar standard as before the flood events.

Reference (Historic) and Current Conditions

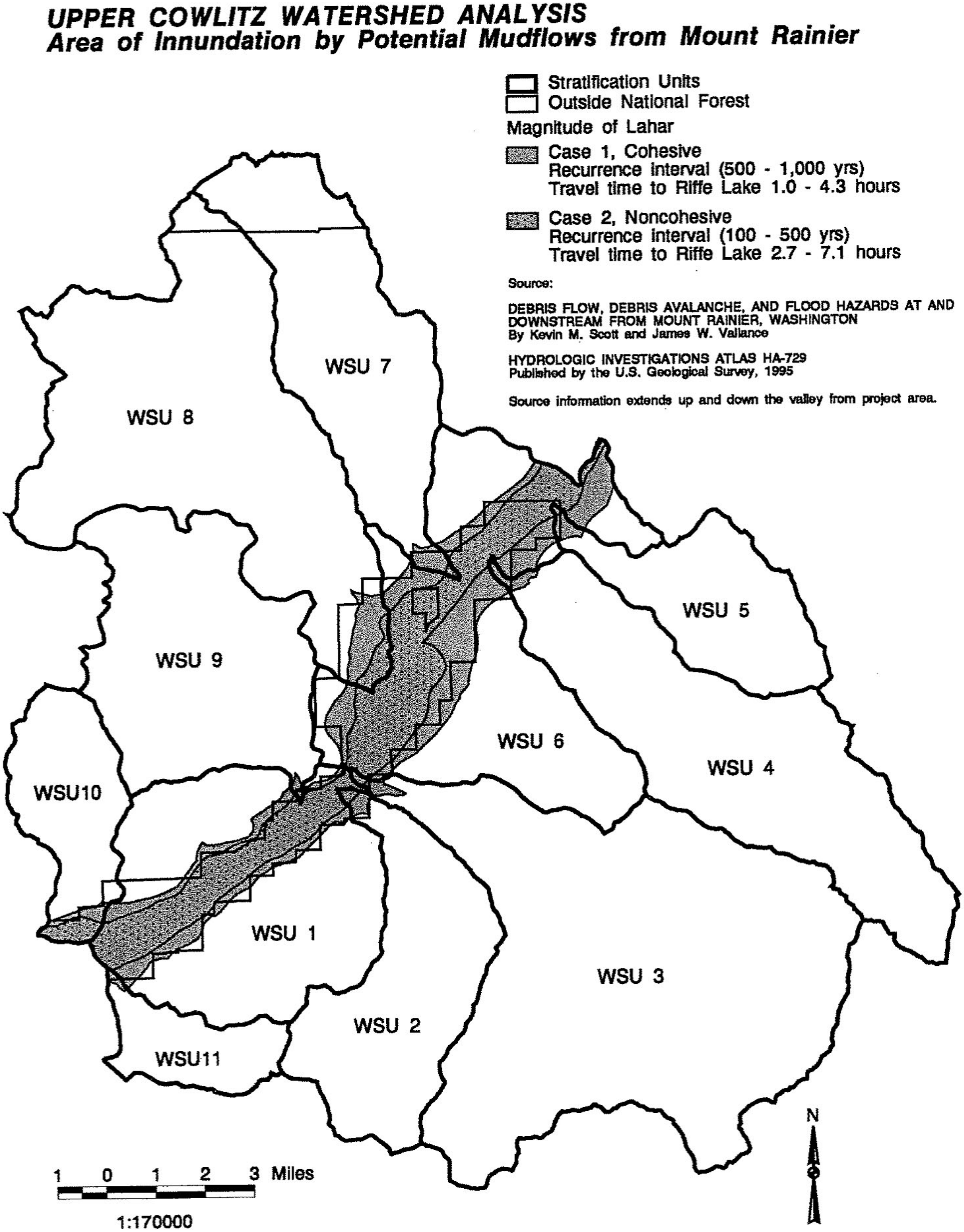
Geologic Processes

Volcanic Eruption and Seismic Activity

Mount St. Helens has deposited ash and pumice across the upper Cowlitz 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 Spring/Summer, 1980. The eruption of about 3,500 years ago (Mullineaux, *et.al*, 1975) does not appear to have left measurable deposits in this watershed, though deposits of the Yn layer are recognizable to the east. Fine pumice and ash covered most of this study area to a depth of less than 1 inch (Pfeifer and others, personal communication, 1997); the 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 *et al.* 1978).

Mt. Rainier is an active stratovolcano located due north of the study area, and about 15 river miles away via the Muddy Fork Cowlitz River. "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 post-glacial time." (Scott, *et al.* 1995b). According to recent hazard maps published for the area (Scott *et al.* 1995a), most of the Cowlitz River valley (floodplain) in this study area could be inundated by a mudflow to a depth up to 60-200 feet, with or *without* an associated volcanic eruption (see Map 16).

Map 16


UPPER COWLITZ WATERSHED ANALYSIS
Area of Innundation by Potential Mudflows from Mount Rainier
Stratification Units
Outside National Forest
Magnitude of Lahar
Case 1, Cohesive
Recurrence interval (500 - 1,000 yrs)
Travel time to Riffe Lake 1.0 - 4.3 hours
Case 2, Noncohesive
Recurrence interval (100 - 500 yrs)
Travel time to Riffe Lake 2.7 - 7.1 hours
Source:
DEBRIS FLOW, DEBRIS AVALANCHE, AND FLOOD HAZARDS AT AND DOWNSTREAM FROM MOUNT RAINIER, WASHINGTON
By Kevin M. Scott and James W. Vallance
HYDROLOGIC INVESTIGATIONS ATLAS HA-729
Published by the U.S. Geological Survey, 1995
Source information extends up and down the valley from project area.
WSU 7
WSU 8
WSU 9
WSU 5
WSU 6
WSU 4
WSU10
WSU 1
WSU 3
WSU 2
WSU11
N
1 0 1 2 3 Miles
1:170000

Seismic activity in the form of small earthquakes (most less than 2.0 magnitude) occurs on the average of approximately 6-20 per decade underneath the planning area, with occasional larger earthquakes of magnitude 4 to 5. According to electronic records kept at the PNSN database at the University of Washington Geophysics Department, small quakes are common on the north side of the Cowlitz River, and quakes under this study area may represent a southern extension of the Western Mt. Rainier Seismic Zone. 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 (Alper, 1993). It is possible that some of the large, deep-seated landslides in this study area were caused or reactivated during these large seismic events. 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 (Schuster, 1989).

Mass Wasting

WSU 1 - Two large, deep-seated landslides occur in this watershed; both are ancient and considered to be past active, though some smaller areas along the margins may still be actively unstable. The Davis Mtn. slide is extremely large (about 2 ½ square miles); the Garrett Creek slide is smaller (about 2/3 sq. miles) and based on its relatively unweathered morphology, may be a younger (though still prehistoric) landslide. Several small debris flows and avalanche chutes can be found on steeper slopes across the watershed.

Few management related slides are known from this watershed; mass failures related to management activities occur at a *slight* rate above the Reference Conditions in this watershed.

WSU 2 - Numerous avalanche tracks are present throughout this watershed, though the rate at which avalanches occur has not yet been determined. Several debris flows originating as road sidecast failures have occurred in this watershed since the 1970's, particularly on the upper sections of the 2010 and 2020 roads. The sections of these roads most often contributing to debris flows were decommissioned in the early 1990's; it is too soon to tell how effective these efforts have been.

Mass failures related to management activities occur at a *High* rate above the Reference Conditions in this watershed.

WSU 3 - Types and amounts of mass wasting vary widely across this large and complex WSU. Avalanche tracks are common along Southpoint and Stonewall Ridges, and particularly so in the headwaters of Glacier, Middlefork, and Jordan Creek basins (in the Goat Rocks proper, where avalanche tracks and talus slopes start to become indistinguishable). Several large, deep-seated landslides occur, particularly in the headwaters of Johnson Creek. The landslide that formed Glacier Lake probably occurred about 660 years ago, based on a radiocarbon date of wood taken from a drowned, standing tree in the lake (Schuster, 1989). There have been numerous debris flows along the Johnson Creek drainage; most have been road-related failures associated with the 21 Road system. Also, there have been many instances of roads being effected by debris flows that originated upslope in natural, forested conditions.

Mass failures related to management activities occur at a *Moderate* rate above the Reference Conditions in this watershed.

WSU 4 - Numerous avalanche tracks, and actual glaciers, are present in the headwaters of Lake Creek, capped by Old Snowy Mountain of the ancient Goat Rocks volcano. Further downstream, an extremely large landslide is located on the NE side of Snyder Mountain. This landslide dammed Lake Creek, forming Packwood Lake. Based on radiocarbon dates obtained from drowned, standing snags in Packwood Lake, this landslide occurred about 1,100 years ago (Schuster, 1989). This time frame roughly approximates dates obtained from other landslide formed lakes in the Olympic and North Cascade Mountains, as well as Puget Sound, and may indicate that a major seismic event (a "Great Earthquake", greater than magnitude 8.0) shook all of western Washington (Alper, 1993). Several small debris flows have either originated from or effected roads in the lower part of the watershed.

Mass failures related to management activities occur at a *Slight* rate above the Reference Conditions in this watershed.

WSU 5 - Several small avalanche chutes and debris flows occur in the headwaters of Coal and Lost Creeks. Roads in this watershed are more often the recipient of debris flows than the cause.

Mass failures related to management activities occur at a *Slight* rate above the Reference Conditions in this watershed.

WSU 6 - A few avalanche chutes are located on Butter Butte in the northern portion of this WSU. A moderate sized, active landslide is effecting the channel of Hager Creek just below Hager Lake (this slide formed Hager Lake).

Few management-related slides are known from this watershed; mass failures related to management activities occur at a *slight* rate above the Reference Conditions in this watershed.

WSU 7 - There are numerous large avalanche chutes all along both sides of the Butter Creek drainage. Also, three moderate sized, deep-seated landslides occur on both sides of Butter Creek where the drainage opens up to the Cowlitz River valley. It is not yet clear if these landslides were formed by 1) glacial downcutting of the valley, which undermined the hillslopes above, 2) activity along a suspected but unproven NE/SW fault north of Packwood, or 3) a great earthquake as described for Packwood Lake.

Mass failures related to management activities occur at a *Slight* rate above the Reference Conditions in this watershed.

WSU 8 - One moderate sized, deep-seated landslide exists in the upper part of this watershed; two more are located on both sides of Skate Creek where the drainage opens up to the Cowlitz River valley (similar to Butter Creek to the northeast). Numerous avalanche tracks are present over a four mile stretch of Skate Creek where it has become deeply incised between Dixon and Skate Mountains. There are also a number of road-related failures in this four mile stretch, often associated with cut-bank failures in deep glacial till. Often, however, the 52 road is the recipient of material moving down from natural slopes above.

Mass failures related to management activities occur at a *Moderate* rate above the Reference Conditions in this watershed.

WSU 9 - A few small avalanche tracks are located in the headwaters of South Fork Willame Creek. Several debris flows are found throughout the drainage that are related to either roads or timber harvest.

Mass failures related to management activities occur at a *High* rate above the Reference Conditions in this watershed.

WSU 10 - Several avalanche tracks are located on the west side of the drainage below Purcell and Prairie Mountains. Several road-related failures have occurred within this watershed.

Mass failures related to management activities occur at a *Moderate* rate above the Reference Conditions in this watershed.

WSU 11 - Several small avalanche tracks are located in cirque headwaters of Kilborn Creek. Numerous small, naturally-occurring debris flows are located on steep side slopes along the lower half of Kilborn Creek. Because of the decomposed volcaniclastic bedrock and the resulting soils, this watershed is considered more prone than most to mass wasting processes. Several small debris flows, related to both roads and harvest, have occurred in this watershed.

Mass failures related to management activities occur at a *Moderate* rate above the Reference Conditions in this watershed.

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, or when flowing water is routed onto hillsides where water does not ordinarily flow. Based on the SRI, map units for this area were rated with a "Low" or "Moderate" surface erosion potential.

Road Conditions

Erosion and mass wasting associated with roads have been identified as a primary contributor of both coarse and fine sediments above the natural (background) rate to streams in this watershed. Note that 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.

There are 85 flood damage sites along the existing road system on Federal land in the Upper Cowlitz watershed. These sites are listed by WSU in Chapter 6 - Management Recommendations.

Table 3-31: Road Conditions and Flood Damage

WSU	Size (acres)	Size (sq. mi)	Road Length (mi)	Rd. Density (mi./mi²)	Red Flags on Roads	Flood Damage # sites/est. $
WSU 1	15,781	24.66	37.22	1.51	0	0 / 0
WSU 2	10,347	16.17	23.54	1.46	34	5 / $38,280
WSU 3	31,103	48.60	59.81	1.23	9+	22 / $272,680
WSU 4	16,409	25.64	19.61	0.76	56	2 / $26,020
WSU 5	6,613	10.33	11.39	1.10	8	1 / $18,760
WSU 6	18,407	28.76	107.79	3.75	90	3 / $12,060
WSU 7	12,104	18.91	14.21	0.75	31	5 / $86,150
WSU 8	22,475	35.12	71.79	2.04	71	28 / $333,220
WSU 9	13,435	20.99	63.33	3.02	13	13 / $263,950
WSU 10	5,520	8.63	23.27	2.70	7	6 / $61,080
WSU 11	3,262	5.10	9.75	1.91	0	0 / 0
total	**155,456**	**242.90**	**441.71**	**1.82**	**319**	**85/ $1,112,200**

Hydrology

The mainstem upper Cowlitz River has been extensively modified. Starting in the late 1800's timber harvest and other land-clearing, and agricultural activities in the flood plain, led to draining of riparian wetlands, ditching of tributaries, clearing of riverside vegetation, and diking of the river channel. The lower portion of the upper Cowlitz River from river mile (RM) 114 (Davis Creek confluence) to RM 133.5 (just north-east of the Muddy Fork confluence) flows in a relatively low gradient (0.5-1.5 percent) stream channel. In the summer the waters are relatively warm, though opaque with gray, fine grained volcanic-origin sediments, while in the winter its waters are often cloudy with high concentrations of brown suspended sediment routed from natural hillslope instabilities, which have been aggravated by ground-disturbing activities.

The hydrologic analysis area consists of one fifth field watershed: the upper Cowlitz River, located in the upper drainage basin of the Cowlitz River. The analysis area is approximately 155,456 acres with 28 subwatersheds ranging in size from 2,506 acres (the West Fork Willame subwatershed) to 12,104 acres (the Butter Creek subwatershed). Map 3 shows the Upper Cowlitz analysis area and the existing 6th field subwatersheds within each WSU. Map 17 shows class 1 through 4 streams present in the analysis area. The northern portion of the analysis area originates from the southern slopes of Mt. Rainier in the Mt. Rainier National Park (14,410' elevation) while the most dominating point in the southern portion of the analysis area consists of the western slopes of Johnson Peak (7,487' elevation) in the Goat Rocks Wilderness. From the headwaters in the upper stream channel reaches (RM 133.5), the main Cowlitz River flows in a southwesterly direction, passing through the town of Packwood at RM 126. From that point, the Cowlitz River continues in a southwesterly direction towards RM 89.8 located west of Randle, where the Cispus confluences with the mainstem Cowlitz River.

Data Sources/Data Gaps

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

Assumptions

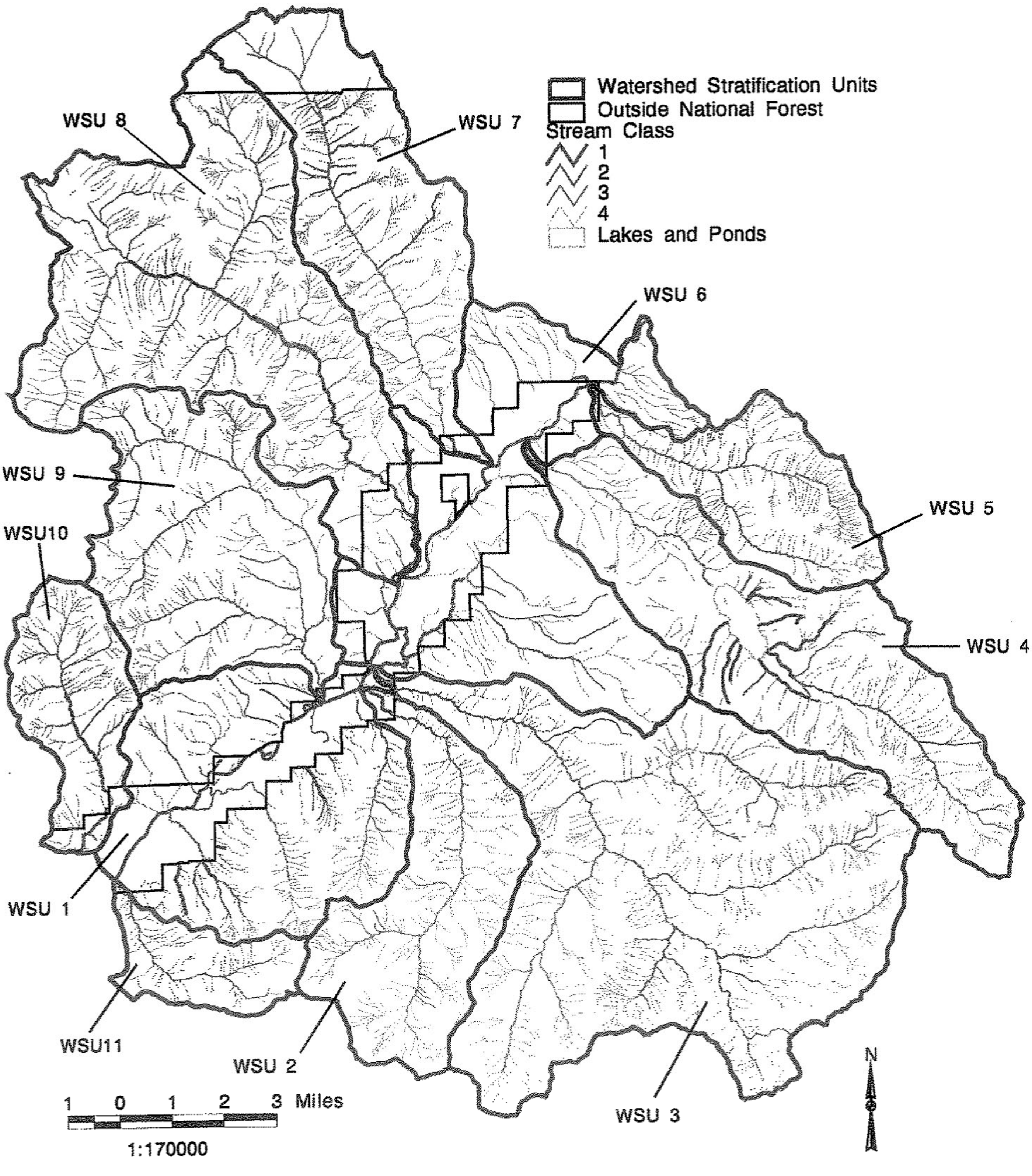
The best available data sources were used regarding historic precipitation events and to determine how it is impacting the watershed. Past stream flow studies, which have displayed the alterations in stream channel flows at different elevations, have given the USFS a firm understanding of the areas where 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

Four precipitation zones occur within the analysis area: rain-dominated, rain-on-snow, snow dominated, and highland. These zones vary in the amounts of precipitation per year, the rate of snow melt-off, and site specific geographic and climatic influences.

Map 17

UPPER COWLITZ WATERSHED ANALYSIS
Stream Class



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 in large amounts or last very long. This zone accounts for a total of 21,914 acres (14%) within the analysis area and is primarily located in the lower basin areas of WSU 1 and 6 (Dry and Hall Creeks, respectively).

Rain-on-snow zone: Geographic zone located in the middle elevations between 1,500 and 3,500 feet elevation where shallow snowpacks are common in winter with greater snow accumulation in clearings than in forested areas (Brunengo *et al* 1992). Large scale snow accumulation occurs during heavy snow events (a 24-48 hour time frame) as a result of warm jet stream paths moving quickly into the basin. Heavy rains associated with the stream paths result in rapid snowmelt and surface run-offs exceeding the soil moisture infiltrations and/or storage capacity parameters. Such conditions result in enhanced "hydrologic flush" particularly in soil regimes where the foliage and root density is lacking (Harr 1981). This zone accounts for a total of 16,791 acres (11%) within the analysis area and is primarily centralized in WSU 6 and 9 (Hall and Willame Creeks, respectively).

Snow-dominated zone: Geographic zone where normal winter precipitation is snow and deep snowpack accumulations occur. Consolidation of the snowpack is a result of warm winter storms (USDA Forest Service, 1995h). This zone accounts for 53,884 acres (39%) 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 lag time of percolation through the existing snowpack (Brunengo *et al.* 1992). This zone is most prevalent in WSU 2, 8, 9, and 11 (Smith, Skate, Willame, Kilborn basins).

Highland zone: Geographic zone consisting of higher elevations where deep snowpacks accumulate. Winter rain is rare and normally will not contribute to rain-on-snow runoff rates. This zone has little likelihood of significantly affecting moisture percolation into the ground during storm events due to freezing. Effects of harvest on moisture run-off rates are minimal (Brunengo *et al.* 1992). This zone accounts for 36% (56,867 acres) within the analysis area and is most prevalent in WSU 2, 3, 4, 5 and 7 (Smith, Johnson, Lake, Coal, and Butter Creek basins).

Table 3-32: Precipitation Zone per WSU Within the Analysis Area

WSU Name	WSU #	Acreage	% Rain dominated	% Rain-on-Snow	% Snow dominated	% Highland
Dry	1	15,781	39%	19%	15%	27%
Smith	2	10,347	3%	7%	46%	44%
Johnson	3	31,103	2%	8%	59%	31%
Lake	4	16,409	1%	11%	52%	36%

Table 3-32: Precipitation Zone per WSU Within the Analysis Area

WSU Name	WSU #	Acreage	% Rain dominated	% Rain-on-Snow	% Snow dominated	% Highland
Coal	5	6,613	2%	11%	57%	31%
Hall	6	18,407	48%	22%	11%	18%
Butter	7	12,104	3%	11%	54%	31%
Skate	8	22,475	7%	14%	34%	45%
Willame	9	13,435	1%	28%	24%	47%
Davis	10	5,520	15%	17%	29%	39%
Kilborn	11	3,262	3%	13%	33%	51%

Flow Regime (WAR and ARP)

Data Sources/Data Gaps

Flow data was collected by Packwood Ranger District, (U.S. Forest Service) and USGS (Geological Survey). ARP and WAR peak flow models were developed by the Forest Service and the State of Washington. Data values were calculated in March, 1996.

Assumptions

Two methods for predicting peakflow sensitivity, determining expected changes in flow release, and identifying areas of concern were used for this analysis: WAR and ARP. WAR (Water Available for Run-off), as detailed in the Washington State Watershed Analysis Handbook, is an estimate of the predicted increase in stream flow due to changes in vegetative cover based on rainfall, tree size, temperature, antecedent snow accumulation and elevation. For non-forested areas, including rock outcrops and meadows, this model assumes rapid runoff and greater snow accumulation and melt. WAR values on National Forest lands were calculated from current vegetation data and digital elevation models. WAR on private and state lands was calculated using current vegetation data supplied by the Washington State Department of Natural Resources.

In calculating WAR values, the following broad assumptions were made about the elevations of each precipitation zone: the average elevation of the rain dominated zone is 1000 feet, rain on snow zone is 2400 feet, snow dominated zone is 3500 feet, and highland zone is 4100 feet. It has been observed that the transient snow zone is more accurately 1500 to 3500 feet for this area. WAR values are likely to be low.

ARP is detailed in the Gifford Pinchot Cumulative Assessment Process Final Report. This method calculates a predicted hydrologic recovery for a basin, based upon stand year of origin, species composition and site class. A stand is considered 100% hydrologically recovered once it reaches an average dbh of 8 inches. This method does not rely on rainfall, temperature or antecedent snow accumulation. Non-forested National Forest lands are considered 100% hydrologic recovered. The ARP calculated for private and state lands assumes a high productivity class for the rain dominated zone, consisting primarily of a western hemlock (CH) ecoclass. Productivity for the rain-on-snow zone is moderate and also consists of ecoclass CH. Productivity for the snow dominated zone is moderate, with the ecoclass consisting of Pacific silver fir (CF). For the highland zone, the productivity class is low and ecoclass is CF. Estimated ages of the various stand types are assigned as follows: non-forest vegetation type is assumed to be agricultural, 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 model accounts 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 are noted below.

- Rain-on-snow - 0-10% equating to good conditions, 10-20% equating to moderate concerns, and >20% equating to potential concern zones.
- WAR - 10% or greater - possible downstream flood damage and scour to fish spawning and rearing areas and stream channel degradation.
- ARP - 70% or less - for seeing adverse effects including water quality and stream channel degradation.

Regional flood frequency regression equations, including explicit confidence estimates, provide a reasonable framework for evaluating the effects of forest harvest on peakflows over basin scale areas. For the purpose of this analysis, it is assumed that the regression equations predict flows under predominately hydrologically mature (pre-disturbed) conditions. 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 cannot be evaluated.

It is assumed that the snow regression equation is derived from the measurements representing hydrologically mature conditions. Snow measurements recorded by Cooperative Snow Survey and the National Weather Service, are made under a variety of forest stands, although the climatic and topographic conditions of most stations are unknown. The US Army

Corp of Engineers snow melt equation is considered appropriate for estimation of melt under rain-on-snow conditions.

Peakflow and Flooding

Table 3-33: WSU Peakflow Ratings by Transient Snow Zone, WAR, and ARP

WSU	% of WSU in Transient Rain-on-snow zone	WAR - % Increase in Peakflow during a 2 yr. Unusual Event	% ARP	Peakflow Rating
1 (Dry)	19%	12.6%	82% *	Moderate
2 (Smith)	7%	5.8%	89%	Low
3 (Johnson)	8%	3.6%	91%	Low
4 (Lake)	11%	3.7%	95%	Low
5 (Coal)	11%	4.3%	91%	Low
6 (Hall)	22%	17.6%	68% *	High
7 (Butter)	11%	7.9%	86%	Moderate
8 (Skate)	14%	6.1%	84% *	Moderate
9 (Willame)	28%	7.7%	80%	High
10 (Davis)	17%	11.7%	81% *	High
11 (Kilborn)	13%	11.2%	79%	High

** Private or non-Forest Service areas considered not recovered due to human influences such as road placement. ARP value age class assigned as 0.*

Water Diversions

Davis, Garrett, Burton, Dry, Lake, and Hinkle Tinkle Creeks have some type of water diversion facility.

Table 3-34: Historical Flow Measurements within the Analysis Area

WSU	Historical Flows (late 1930's)	Historical Flows (late 1940's)	Historical Flows (1950's-1960's)
1	No data is available	Garrett Creek: 10 CFS (Bryant 1949) Burton Creek: 22 CFS (Bryant 1949)	Burton Creek: 15 CFS (Birtchet 1963)
2	Smith Creek : 69 CFS (Roth 1938)	No data is available	No data is available

Table 3-34: Historical Flow Measurements within the Analysis Area			
WSU	**Historical Flows (late 1930's)**	**Historical Flows (late 1940's)**	**Historical Flows (1950's-1960's)**
3	Johnson:168 CFS (Roth 1938) Recorded: 132 CFS (Source unknown)	Johnson: 65 CFS at Hwy 12 crossing: (Bryant 1949)	Johnson: 22 CFS (WA Dept. of Fisheries 1962)
4	Lake Creek: 235 CFS (Roth 1938)	Lower 1.9 miles of Lake Creek: 150 CFS (Bryant 1949)	Lake Creek: 65 CFS (Meekin 1962)
5	Coal Creek: 54 CFS (Roth 1938)	No data is available	No data is available
6	No data is available	No data is available	Hall Creek: 15 CFS (Meekin 1962)
7	Butter Creek: 336 CFS (Roth 1938)	Butter Creek: 80 CFS (Bryant 1949)	Lower mile of Butter Creek: 75 CFS (Meekin 1962)
8	Skate Creek: 360 CFS (Roth 1938)	Skate Creek: 36 CFS (Bryant 1949)	Lower mile of Skate Creek on lower flood plain: 50 CFS (Meekin 1962)
9	No data is available	Willame Creek: 15-18 CFS (Bryant 1949)	No data is available
10	No data is available	Davis Creek: 4 CFS (Bryant 1949)	Lower RM of Davis near Cowlitz River 20 CFS (Birtchet 1963)
11	No data is available	Kilborn Creek: 15 CFS (Bryant 1949)	No data is available

Water Quality

Assumptions

The best available data was used from Packwood and Randle Ranger District stream surveys. No new data was collected for this analysis. 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.

Data collected for stream temperatures within this report vary from continuous gauges and max- min thermometers 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 past stream and lake temperature measurements is summarized by WSU in the Appendix.

Riparian Areas and Stream Channels

Data Source/Data Gaps

Both historic and present source materials for riparian conditions are limited in scope. The information contained in this document has been gathered from watershed assessments conducted on National Forest and private timber company lands, Forest Service stream surveys, and from Forest Service SMART, Aquarun, and IVEG databases.

An inventory of current stand age and tree species composition was completed for riparian areas within WSU's 1-11. Refer to Map 18 for a display of riparian vegetative conditions within the analysis area.

Connectivity and Fragmentation

The stream fauna, flora, organic matter, nutrients, and the 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, *et al.* 1991). A critical function of intact riparian habitat areas is to maintain the spatial and temporal connectivity within and between watershed areas, such as the lateral, longitudinal, and drainage network connections between wetlands, upslope areas, headwater tributaries, and intact refugia. Aquatic Conservation Strategy objectives (USDA Forest Service and USDI BLM, 1994b) state "these 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 those related to timber harvest, result in fragmentation and an alteration of the riparian vegetation conditions (both existing species as well as densities). Past salvage logging activities have been reported to reduce the number of standing large trees and in-stream logs, thereby reducing the potential for large woody recruitment (Bryant *et al.* 1984, Bisson *et al.* 1987). Such woody debris removals have resulted in reducing the amount of cover for rearing salmonids (Gurtz *et al.* 1980; Bilby 1989). Secondly, removal of such trees from the stream channel system can further affect aquatic organisms through the loss of shade and increased water temperatures. Within the analysis area there are approximately 84 miles of road inside the existing riparian corridors. Such roads restrict the ability of streams to interact with the floodplain during periods of high flows and reduces the amount of wood available to the stream.

Information presented in Table 3-35 is based upon a GIS products analysis and a review of available stream survey data of areas with fragmentation/connectivity concerns. Note that this section discusses a different approach to the function of the riparian area than discussed in the Large Woody Debris section that follows. More specific reaches are provided within the subwatershed areas.

Map 18

UPPER COWLITZ WATERSHED ANALYSIS
1997 Vegetation Structure Within Riparian Reserves

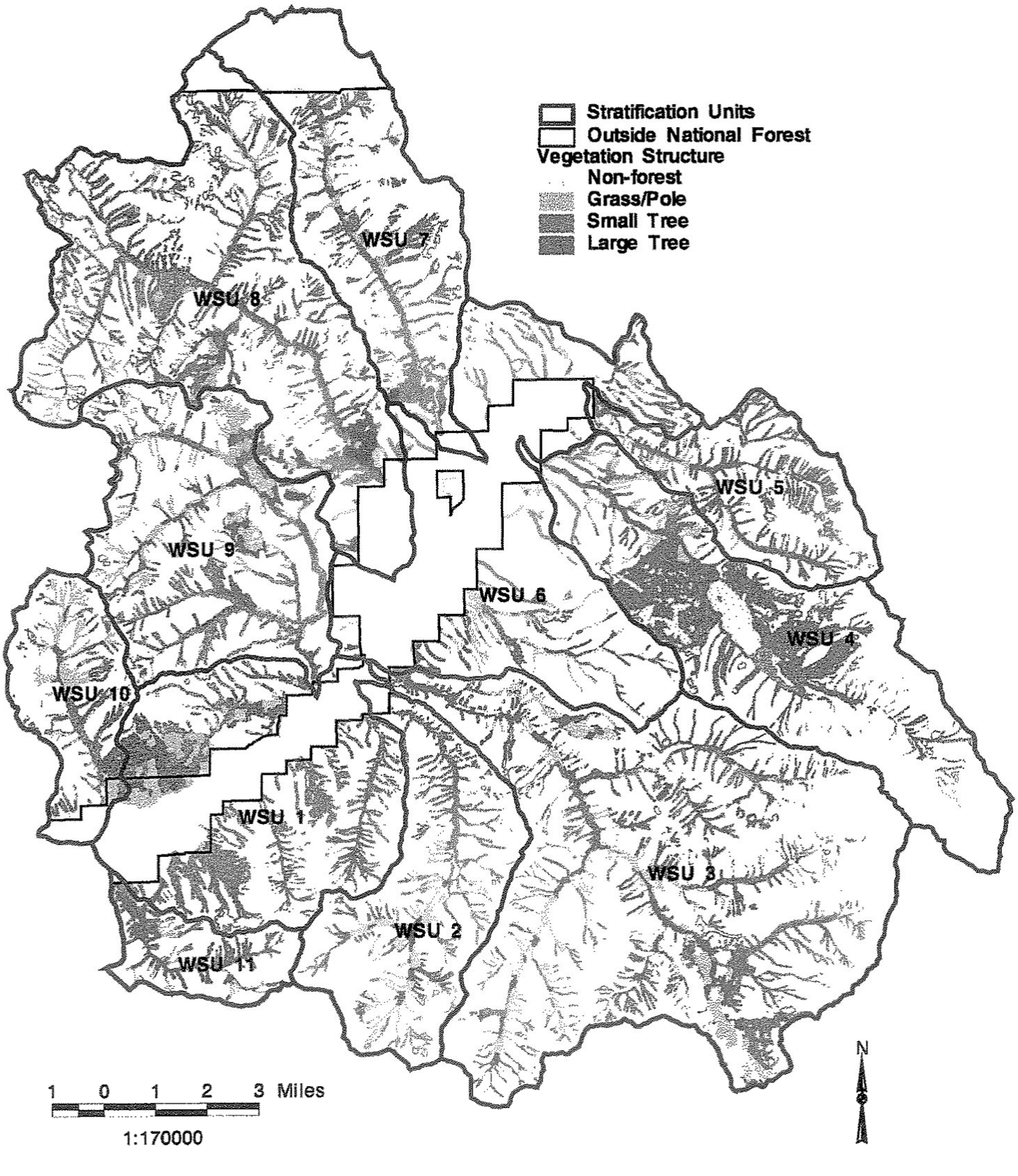


Table 3-35: Subwatersheds in the Analysis Area Having A High Amount Of Riparian Habitat Fragmentation and Poor Stream Channel Connectivity.

WSU	Subwatershed Name	Problem Areas
1	Dry, Pothole	Lower Cowlitz floodplain area
1	Burton Creek	Lower Burton Creek, RM 0-1.5
1	Garrett Creek	Lower Garrett Creek, RM 0-1.3
2	Smith	Lower Smith Creek, RM 0-0.8 Upper Smith Creek, RM 3.5-6.0
3	Lower Johnson	Lower Johnson Creek, RM 0-0.8
3	Lower Johnson	Jennings Creek, RM 0-1.2
4	Lake	Lower Lake Creek, RM 0-0.7
5	Coal	Lower Coal Creek
6	Hager, Snyder, Hinkle Tinkle	Upper Cowlitz River Area
6	Hall	Hall Creek
6	Hager Creek	Lower Hager Creek, RM 0-0.3 Middle Hager Creek, RM 0.3-1.0
6	Snyder Creek	Lower Snyder Creek, RM 0-0.1
6	Hinkle Tinkle Creek	Lower Hinkle Tinkle Creek, RM 0-1.0
7	Butter	Lower Butter Creek, RM 0-1.2
8	Skate	Lower Skate Creek, RM 0-8.0 Upper Skate Creek, RM 11.0-12.0
9	Willame	North Fork Willame Creek, RM 0.5-4.0 West Fork Willame Creek, RM 0.5-3.0 Mainstem Willame Creek
10	Davis	Lower Davis Creek, RM 0-1.0

Inner Gorge

Inner gorge is defined in the Final Supplement (USDA Forest Service and USDI BLM, 1994a) as a "stream reach bounded by steep valley walls that terminate upslope into a more gentle topography - common in areas of rapid stream downcutting or uplift". This definition differs slightly from what the Gifford Pinchot has adopted. Inner gorge areas are delineated as those areas consisting of narrow steep valleys located along the riparian corridor which are smaller than the canyon and more steep-sided than a ravine. Slopes along the restricted steep-walled part of the canyon are greater than 55 percent.

Due to time constraints, the watershed analysis team was unable to use aerial photos to define the inner gorge locations at the watershed analysis scale. Areas consisting of past inner gorge concerns will be determined by a review of data collected during stream surveys, pre-sale and road placements. Areas considered were unstable sideslopes, side channels on steep slopes, and frequent stream channel shifts as identified within the study area. Additional inner gorge concern areas were determined by including avalanche tracks, such as those located in the upper stream channel areas of the Class 4 channels. A review of 1959 data showed that a large percentage of 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 type section).

Table 3-36: Subwatersheds in the Analysis Area Having Inner Gorge Areas.

WSU	Subwatershed Names	Inner Gorge Area Locations
1	Dry Creek	Dry Creek, RM 1.0-2.0
2	Smith Creek	Smith Creek, RM 1.0-3.0
3	Lower Johnson Creek	Lower Johnson Creek, RM 0.8-5.0
3	Deception Creek	Deception Creek, RM 0.1-0.6
4	Lower Lake Creek	Lower Lake Creek, RM 1.0-3.5
5	Coal Creek	Lower Coal Creek, RM 0.5-2.5
6	Hinkle Tinkle	Main Upper Cowlitz River, RM 131.5-132.5
7	Butter Creek	Lower Butter Creek, RM 1.2-2.2
9	Main Willame Creek	Lower Willame Creek, RM 0.4-1.2
10	Davis Creek	Davis Creek, RM 1.0-3.5
11	Kilborn Creek	Kilborn Creek, RM 0.5-3.0

Further work is needed to define the specific inner gorge confinements. Upon completion of aerial photo interpretation, a field review will be necessary to determine the possible extent of both aquatics and wildlife habitat concerns in inner gorge concern areas.

Flood Plain

Pre-1880 Conditions

Valley floors were frequently subject to flooding, effectively disturbing the existing riparian corridors. New landforms were created as a result of fluvial sediment deposits. Over time, new channels and flood plain configurations developed during flood events at or above bankfull discharge (Brinson 1990). New landforms developed in response to understory succession and stand development, subject to controls such as light exposure, physical topography, and further disturbance (Menges *et al*, 1983; Hupp 1988). WSU's displaying evidence of historical flood plain activities include Dry Creek (WSU 1) and Hall Creek (WSU 6), watershed areas which account for the mainstem of the upper Cowlitz River area, and several of the major tributary basins such as the Skate Creek (WSU 8) and Willame Creek (WSU 9) basins. Such areas have naturally been conducive to flood plain activities due to lack of channel confinement, compared to main tributary streams such as Smith Creek (WSU 2), Johnson Creek (WSU 3), Lake Creek (WSU 4), Coal Creek (WSU 5), Butter Creek (WSU 7), and Davis Creek (WSU 10) basins.

Current Conditions

The ability to cope with natural disturbance regimes most likely changed with the advent of timber harvest, road construction, and farming activities. Human-caused disturbances in the upper Cowlitz basin began to exacerbate the damage caused by historical high flow events. 1959, 1973, 1989, 1990, 1993, and 1996 basin-wide aerial photos were used to compare pre-human disturbance characteristics to present conditions. 1959 aerial photos were used to determine pre-1880 equivalent flood plain parameters, since the upper Cowlitz basin had not yet received significant human disturbance. The influence of stream channel bank and bed stability, compared to present conditions, is considered partially a result of management activities. During the 60+ year time period (1880 to approximately 1940's), a lack of upslope vegetative disturbance resulted in the development of old-growth timber stands in the Dry, Skate, and Willame Creek basins. These stands were less conducive to highly disturbing peak flow events, which have recently occurred within the area .

A comparison of the 1989/1990 and post-1996 aerial photos indicates the riparian zone had been highly impacted by the 1996 flood event. Aerial photos show evidence of significant channel downcutting in stream reaches throughout the lower reaches of the upper Cowlitz basin. These changes are attributed, in part, to the large-scale timber removal from the surrounding sideslopes, as well as numerous road construction projects over a relatively short time period. Such timber removal is associated with accelerated increases in peakflow releases during heavy precipitation events and spring melt-off (USDA Forest Service, 1995x). A review of the main Upper Cowlitz watershed basin, RM 114-132.5, shows an active flood plain and high sediment input from the surrounding high peak areas.

Analysis of channel shape, using aerial photos, may be of interest to management since the existing the 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 one of these factors will result in alterations of the stream channels flow regimes and channel configuration based on sediment transport abilities by the system (Heede 1980).

Stream Shading

Pre-1880 Conditions

While no specific information is available on stream shading for 1880, the reconstruction of vegetation structural stages shows that the vegetative stands located south and southeast of the Cowlitz River consisted mainly of large-tree stands. A large portion of WSU 7-10 (Butter, Skate, Willame, and Davis Creek basins) consisted primarily of poles due to the fires in the 1860's. It is assumed that there was no disturbance in the riparian forests except, windthrow, fire, disease, and flooding. The streams were generally well-shaded, where permitted, by the flood plain configuration.

Below are the assumed size-class compositions within riparian zones in the upper Cowlitz watershed, for pre-1880 conditions. These figures are based mostly on professional judgement, fire history and existing data.

Forest Zone	Large Tree	Small Tree	Grass/Pole
Western hemlock	80%	10%	10%
Pacific silver fir	60%	20%	20%

Current Conditions

Riparian structural class 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 comparative ratio between sub-watersheds of forest structural class currently existing in riparian reserves. Riparian condition for each sub-watershed was evaluated and summarized below. The four structural classes are grass/pole, small tree, mature tree, and non-forest. Since the last stand replacement fire occurred in the mid 1800's, grass/pole stands in the watershed are s a result of timber harvest, mass wasting, conversion to pasture, or residential development. See the following maps: Vegetation Structure within Riparian Reserves and Forest Zones.

Table 3-37: Percent of Structural Stage in Riparian Reserves *

WSU	Miles of Stream	Acres of Riparian Reserve	Grass / Pole	Small Tree	Large Tree	Non-Forest
1 - Dry	125	5,374	7%	50%	29%	14%
2 - Smith	93	3,009	21%	36%	19%	24%
3 - Johnson	285	10,463	17%	26%	29%	28%
4 - Lake	134	7,506	7%	10%	55%	28%
5 - Coal	78	2,564	7%	21%	45%	27%
6 - Hall	101	2,921	27%	32%	23%	18%
7 - Butter	98	3,578	8%	46%	10%	36%
8 - Skate	197	8,086	14%	30%	35%	21%
9 - Willame	97	4,596	33%	31%	28%	8%
10 - Davis	53	2,055	28%	17%	33%	20%
11 -Kilborn	28	1,062	9%	56%	33%	2%

** Note that Acres of Riparian Reserve accounts only for National Forest lands, while data collected for Stream Miles and Structure Class was collected for the entire analysis area.*

Based on 1989 riparian aerial photo surveys and historical stream survey data, the above structural classes appear to be 95 percent accurate. Structural class can be used to evaluate the stream shading potential. The large-tree class is assumed to meet the minimum shade criteria.

In the Upper Cowlitz analysis area, all but Lake (WSU 4) and Coal (WSU 5) Creeks have less than 40% of the riparian area in the large-tree structural class (Refer to Map 18). The high amount of small tree or non-forest types is characteristic of open, alpine vegetation in steep, high-elevation mountain subwatersheds. Many of the channels here are debris chutes and pass large quantities of sediment from snow and mud slides and high intensity rain storms.

Project maps show substantial wetland areas in the Skate (WSU 8), Davis (WSU 10), and to a lesser degree Smith (WSU 2), Johnson (WSU 3), and Kilborn (WSU 11) Creeks. Significant portions of these areas have been exposed as a result of past timber harvest. Conditions in these wetlands are expected to be considerably different from reference conditions due to a lack of shade.

Shade conditions in the analysis area have changed significantly due to residential development along the mainstem and timber harvest without riparian buffers. However, due to the width of the main Cowlitz River, this has had a lesser effect than changes within the side tributary channels. The greatest impacts of reduced shade have been on tributary streams as a result of past timber stand harvest, associated roads, and, to a lesser extent, recreational project construction along the main tributary stream channels. Temperatures in excess of current standards in Lake Creek below the Packwood Lake dam area (WSU 4), Skate Creek (WSU 8), North Fork Willame Creek and the main Willame Creek (WSU 9) may be due to the cumulative effect of increased light exposure and increased sediment loading (see Sediment Transport and Storage).

Large Woody Debris

Large woody debris is important in many Western Cascade streams 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 sources of large woody material are old trees growing near a channel, that either die and fall into the channel or are blown over, and 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. One exception is in debris avalanche channels, where large wood is carried downslope during catastrophic events. In large streams, the wood may be transported long distances downstream during storm events.

Pre-1880 Conditions

No detailed study of large woody debris (LWD) has been conducted in the upper Cowlitz 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 trees in riparian areas falling into the channel. Historical riparian vegetation conditions and 1959 aerial photos indicate that LWD recruitment potential was historically good throughout the analysis area. This is based on the presence of small-tree and large-tree vegetation. Some very old forest stands distributed throughout the area actively contributed dying large trees. Natural disturbance by disease, fire and windthrow also contributed LWD over time.

Current Conditions

The structural class of riparian vegetation (see Map 18) is useful in evaluating the potential for LWD recruitment. The large-tree structure class represents old, large trees considered a valuable source of woody debris in streams for the control of hydraulic energy and the creation of quality aquatic habitat. These areas may provide LWD through dying trees or have the potential to supply large wood through catastrophic events (windthrow, fire, debris slides). The small-tree structural class may supply large woody material over the next 10 to 120 years, depending on the vegetation zone and its current size. Areas currently in the grass/pole structural stage will not provide large woody debris until they develop into small-tree or large-tree stands.

Forest structural stage, based on the IVEG database, was used to evaluate Large Woody Debris (LWD) recruitment potential. The identification of riparian forests is quite rough in this database. For the most part, riparian areas were not delineated from adjacent upland forests. Riparian tree growth rates were based on professional judgement.

Recruitment potential is based on the following assumptions:

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

Map 19, Large Woody Debris Concentrations, is based on a study of the LWD ratings from stream surveys completed in the last 15 years. LWD is divided into 3 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:

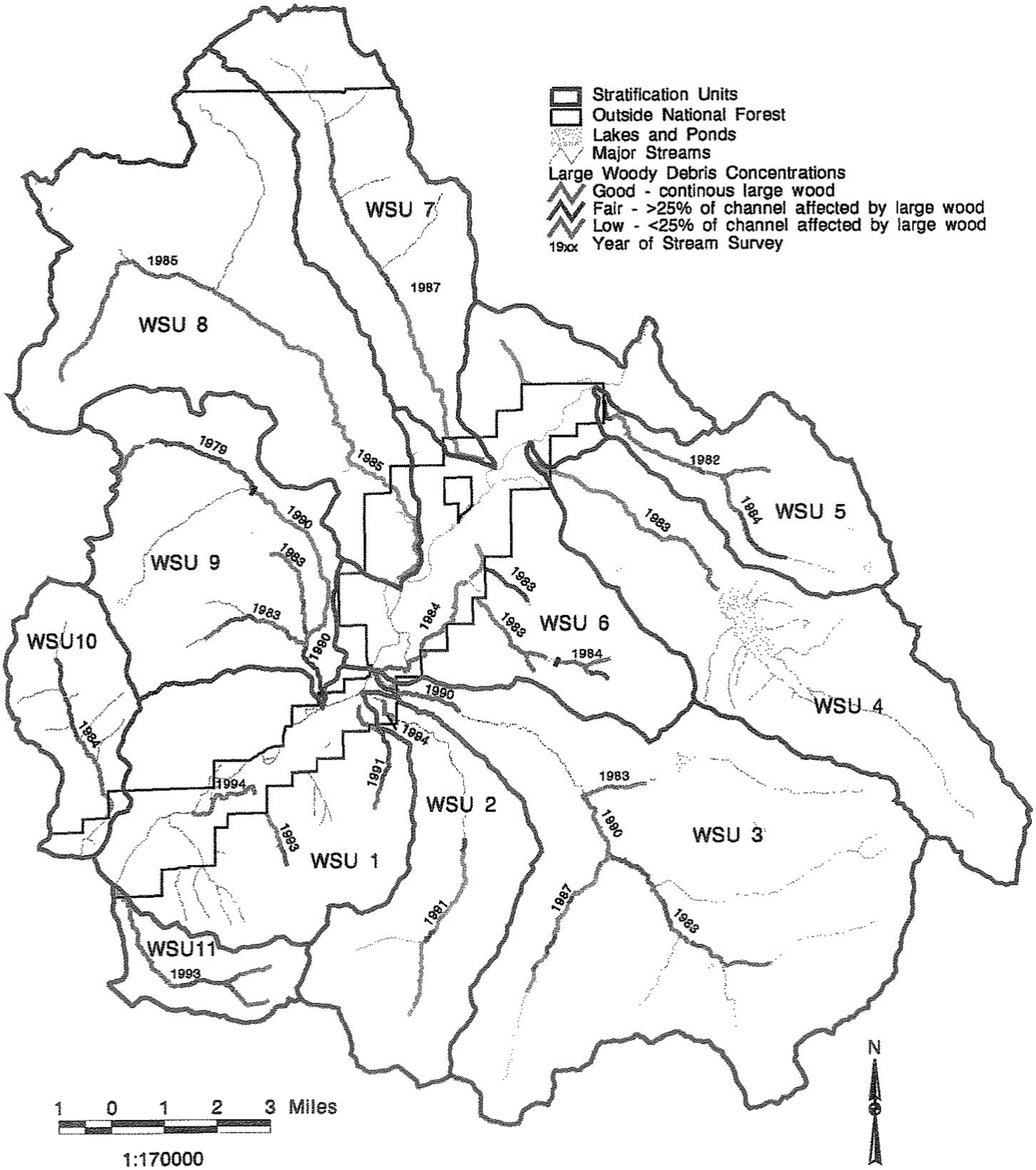
POOR	Indicates that less than 25% of the stream channel area in a stream reach is affected by LWD
FAIR	Indicates that more than 25% of the stream channel area in a reach is affected by LWD, providing good cover and forming large pools
GOOD	LWD is very abundant.

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

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

Map 19

UPPER COWLITZ WATERSHED ANALYSIS
Large Woody Debris Concentrations in Surveyed Streams



Stream Channel Types

Stream reaches in the upper Cowlitz river basin have been classified using the Rosgen stream channel classification methodology (1994) which identifies stream channel types based on the stream channel gradient, sinuosity, width/depth ratio, and entrenchment ratio. Appendix A displays the analysis area stream channel classification by reach and associated physical parameters.

Noticeable trends of the dominant and subdominant stream channel substrate alterations are apparent: large boulders and cobbles dominate the headwater reaches of the upper Cowlitz River basin tributaries. Closer to the confluence with the main Cowlitz River system, smaller cobbles intermixed with gravels and sands tend to dominate. Valley configurations in the steeper 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, moderately erosive, geologic basins. Sideslope stream channels within the upper Cowlitz become less steep as one moves further west until reaching the lower basin and outlet areas for the individual WSUs near the Upper Cowlitz River. Refer to Appendix A for a complete description of indicator reaches (stream reaches from which sediments are routed) and response stream channel reaches (stream sections where sediments are deposited), analyzed using the Rosgen methodology.

Stream Channel and Streambank Stability

Pre-1880 Conditions

Fish species are assumed to have been distributed in relation 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 fish reference populations are not known. Further information on early stream surveys can be found in the analysis file.

Current Conditions

Physiographic descriptions from historical stream and stocking surveys is included below. Additional information may be found in the analysis file.

Dry WSU 1

The Dry Creek WSU is primarily made up of Cowlitz River valley (28.6 % private land), and contains Garrett, Burton, Karr, and Dry Creeks. Within the Dry Creek area the Cowlitz River is bordered by pastures and homes. Cattle grazing and hay production are the main uses for the river valley. The substrate is composed of cobble/small boulder with many transverse bars forming in the channel. Braiding is occurring in many sections of the channel and woody debris of varies sizes are scattered on the bars and in small jams. The larger wood pieces have been salvaged. In some places the river channel has been diked to protect commercial interests. There are numerous side channels that are filled with wood debris with substrates ranging from silt/sand to cobble/small boulder. The river banks along most of the pasture lands are continually undercut and in some location over 20 feet in height.

Garrett Creek flows subsurface from the confluence with the Cowlitz River to Natural Sequential Order (NSO) #9 a distance of 0.85 mile. It is dry, depending on year, from late July to the end of October. The substrate is composed of silt and sand in the confluence area. As the one moves up stream there is an increase in the amount of gravel and cobble. The channel appears to have been channelized at NSO #5 (USDA Forest Service, 1994c).

There is a lack of large woody debris (LWD). Garrett Creek flows from the confluence to NSO #63 through horse pasture, overgrown fields and cutover timberland with hardwoods and second growth timber. Bank cutting is contributing to an increase of sedimentation in the channel. Pools are fairly shallow and some filling with coarse material is occurring. (USDA Forest Service, 1994c).

Burton Creek flows out of a very steep valley and enters the Cowlitz River alluvial valley south of State Highway 12. The channel above Highway 12 is bedrock, large boulder, pocket pool controlled. There is a lack of LWD in the channel below highway 12 due to the use of the land in this area, pastures and cut over timberlands (USDA Forest Service, 1994a).

The channel from the confluence with the Cowlitz River to NSO #14 contains a series of beaver ponds with a substrate of mainly silt and sand. This section of stream flows subsurface during the driest part of the summer (USDA Forest Service, 1994a). The confluence area has been diked to reduce flood damage to the NACO campground and tires have been added to the stream bank in an effort to protect the dike.

The Dry Creek gradient changes from 3% reach 1 to 50% in Reach 6. The substrate in Reach 1 is gravel/cobble. There are adequate numbers of LWD in the upper reaches of Dry Creek. (USDA Forest Service, 1991).

Smith WSU 2

Smith Creek was included in the spawning survey conducted by Washington Department Fisheries in 1962. "The stream is about 25 feet wide, and all but the lower 1/4 mile is in a steep canyon. The lower 1/4 has been channelized and fish would have difficulty ascending above the mouth." (Birtchet 1963)

Johnson WSU 3

Johnson Creek was included in spawning survey conducted by Washington Department of Fisheries in 1962. The lower 1 ½ miles have been channelized to protect the White Pass Highway during periods of heavy run off and, area was reported to be 40 feet wide and composed of large rubble (Birtchet 1963).

In the alluvial valley segment of Johnson Creek, the LWD has been flushed out by past floods, the most recent in 1996. The only fish habitat in this segment is the remains of an old bridge. The summer of 1995 saw the completion of a new home at the confluence of Hall Creek and Johnson Creek. The foundation is within the floodplain of both Hall and Johnson Creeks. The substrate is cobble/small boulder. This lower section is easy accessible to the public and is a gathering spot for parties, litter, bottles, and other forms of trash. The pool formation is bedrock influenced with scour caused by large boulder or bedrock. There is little spawning gravels in the pool tail outs (USDA Forest Service, 1987b)

The lower section of Johnson Creek (Glacier Creek to old hatchery site) is bedrock canyon with high vertical cliffs. Large woody debris is scarce in this area, however, there are a couple of very large log jams at nick points that are acting as sediment traps. The recruitment potential is high for LWD as the riparian area is mainly mature conifers.

The upper section of Johnson Creek (Glacier Creek to Hugo Lake) is a more open valley type with a substrate of dominate rubble/cobble. There is more LWD in the stream channel and it is causing some bank cutting. Beavers have been active in the headwaters area of Johnson Creek and are providing good habitat complexity.

Reaches 1 through 4 of Deception Creek have high channel gradients, from 13 to 18 percent. The gradient levels out in Reach 5 at 6% and drops as low as 1% in Reach 8. The substrate in the lower reaches is boulder/cobble and in the upper reaches is gravel/cobble. There is a lack of LWD and pools throughout the stream. In Reach 9, in the area of F.R. 2130038 crossing Deception Creek is subsurface. (USDA Forest Service, 1987a)

A fisheries enchantment project in Deception Creek was completed in 1992. This project placed large logs and boulder in the stream for fish cover, pool development and scour. Monitoring of the site indicates that there is still "severe aggradation" in this area (Deception Creek Stream Structure Project 1992).

Lake WSU 4

The lower 1.9 miles of Lake Creek was surveyed to an impassable 25 foot falls. The stream is 41 feet wide with turbid and highly silt laden water conditions. There are some debris jams and many rapids and cascades. There is excellent spawning area in the lower 300 yards, but only small patches above. (Bryant 1949)

Lake Creek averages 25 feet in width with a flow of 65 CFS The lower one-quarter mile has a moderate gradient and spawning gravel is available throughout the entire section (Meekin, 1962).

Based on a 1993 stream survey conducted by the Packwood and Randle District Fisheries department, lower Lake Creek (from Packwood Lake down) has a lack of LWD and good pool habitat. The bankfull width to depth ratio is high for all of the measured reaches.

Coal WSU 5

Previous stream surveys indicate the area is used as spawning habitat.

Hall WSU 6

The Cowlitz River is bordered by pastures and homes. Cattle grazing and hay production are the main uses for the river valley. The substrate is composed of cobble/small boulder with many transverse bars forming in the channel. Braiding is occurring in many sections of the channel and woody debris of varies sizes are scattered on the bars and in small jams. The larger wood pieces have been salvaged. In some places the river channel has been diked to protect commercial interests. There are numerous side channels that are filled with wood debris and have substrates ranging from silt/sand to cobble/small boulder. The river banks along most of the pasture lands are constantly being undercut and in some location over 20 feet in height.

The confluence area of Hall Creek is an old section of the Cowlitz River. It has a substrate of silt and sand and the bankfull width to depth ratio is 15 for reach #2 (not measured for Reach #1). There is a lack of LWD but good pool habitat. Beavers are active throughout the stream coarse with most dams in Reach 2 (USDA Forest Service, 1994d).

The headwaters of Hall Creek is a large marsh/swamp in the Cowlitz valley below the Washington State Power Generating Powerhouse. This area is criss-crossed with beaver dams and was dry at time of stream survey, August 1994. There is bank cutting and banks damaged from cattle grazing in areas where Hall Creek passes through pasture lands (USDA Forest Service, 1994d).

During a 1938 stocking survey, Hager Creek was found to contain "excellent" spawning grounds. (Roth 1938)

Hinkle Tinkle Creek flows off of the north valley wall of the Cowlitz valley and enters the Cowlitz River at RM 128.75. At the base of the valley wall, there is a deposit of sediment and the water flow is subsurface from this point to the Cowlitz River (distance of 1.1 miles). The channel substrate from the valley wall to Cannon Rd. is composed of gravel and sand. After Cannon Rd., the channel is lost in a recent harvest unit and is redefined in a series of beaver ponds before entering the Cowlitz River. There is a water diversion for private residence at R.M. 1.5. (USDA Forest Service, 1994e)

Butter WSU 7

Butter Creek was surveyed in 1987 from the mouth upstream for one mile. The stream varies from 20 to 50 feet in width and in the lower one-half mile consists of several channels. The stream flows on the Cowlitz River floodplain and has a moderate gradient up to the bridge. The stream section from the bridge downstream for one-quarter mile was channelized in the fall of 1960 to improve the area for real estate development. This has tended to direct the flow of water through one main channel and to increase the water velocity (measured as 75 CFS). Previously the water flowed through two primary channels and many small secondary ones. Since the channelization the main downstream channel is now dry and many of the smaller channels are dry or carrying reduced amounts of water.

The ½ mile section above the mouth of Butter Creek changes as a result of beaver dam construction. The present channel, from the mouth upstream about 200 yards, contains "excellent" spawning habitat with even flows and excellent gravel substrate. (Stockley, *et al.* 1955).

Sections of Reach 1 have been channelized, dredged, and diked for protection of homes and properties against flooding. There is a lack of LWD and pool habitat, braiding is occurring in the response reaches and the substrate is cobble/small boulder.

Skate WSU 8

Historic surveys show spawning habitat and resting pools within Skate Creek (see analysis file)

The channel conditions for Skate Creek display the following: 1) recommended thresholds for bankfull width to depth ratios are exceeded on all reaches, 2) all reaches lack LWD and recommended numbers of pools, and 3) the channel substrate is dominantly cobble with small boulder being a major contributor (USDA Forest Service, 1995i). Skate Creek has been rip-rapped in many places for protection of Forest Road (FR) 52. Rip-rap and road are restricting the use of the floodplain by the stream.

Willame WSU 9

Willame Creek is 21 feet wide and large rubble predominates Bryant (1949). Reach 1 of Willame Creek has a substrate of cobble/gravel and the upper reaches have a mixture of bedrock, boulder, and gravel. There is LWD in moderate amounts up Willame Creek. There is some mass wasting occurring along the stream banks and these are contributing to stream braiding and sediment deposits (USDA Forest Service, 1990b).

Willame Creek flows out of an incised valley to the Cowlitz alluvial valley, at this point the stream gradient drops from 5-7% to 3%. The substrate in this section is dominantly cobble/small boulder. There is a lack of LWD and pools.

Davis WSU 10

The lower mile of Davis Creek is located on the Cowlitz River floodplain, often with several shifting channels. The stream bed is composed mostly of mud or sand, and seepage causes some channels to go nearly dry in the summer. (Bryant 1949) In December 1962, a spawning survey found spawning area for approximately 200 pairs of silver salmon in the one mile section between the floodplain and Hwy 12. (Birtchet, 1963) The maximum measured water temperature for the Davis Creek survey was 16.1 ° C. Starting at the confluence with the Cowlitz River, Davis Creek is deeply entrenched in some locations. In some instances immediate banks are 40 feet high. There are six beaver ponds (dams) within the first 0.6 mile of stream. As a result of beavers, the current is slow and the dominate feature is pools with substrate of silt and aquatic vegetation.

At NSO #17 Davis Creek flows subsurface for the next 0.7 mile. Along this section (dry channel) cattle grazing is permitted. Cattle impact was noted in the channel where the fence line was non-existent or weakened. NSO #31 is the site of a small water diversion to a small pond.

The channel has been dredged at NSO #33. Both banks are raw and about 10 to 15 feet high. Above highway 12 the channel shows signs of migrating and the channel is less incised as it climbs up out the alluvial valley floor of the Cowlitz River.

Kilborn WSU 11

The lower ½ mile of Kilborn Creek contains spawning area for a few fish, but the gradient is very steep above that point (Bryant 1949). Kilborn Creek flows subsurface at the confluence with Cowlitz River (USDA Forest Service, 1993c).

The channel gradient for Reaches 2, 3, and 4 averages 14 percent. These reaches are contained in a deeply incised valley with a substrate of cobble/small boulder. There is evidence of debris flows from tributaries flowing into Kilborn Creek. The pool quality is low due to sediment input. Wood is being recruited by Kilborn Creek from mass wasting sites, debris flows, and wind thrown areas (USDA Forest Service, 1993c).

Table 3-38: Stream Miles by Class and Watershed Unit.

WSU	Class I Stream Miles	Class II Stream Miles	Class III Stream Miles	Class IV Stream Miles	Total Stream Miles	Stream Density (mi/mi2)
1 - Dry	12	11	12	91	126	5.1
2 - Smith	1	9	5	77	92	5.7
3 - Johnson	1	32	18	235	286	5.9
4 - Lake	11	11	5	107	134	5.2
5 - Coal	0	7	3	67	77	7.5
6 - Hall	15	5	12	69	101	3.5
7 - Butter	1	12	4	75	92	4.9
8 - Skate	10	9	24	156	199	5.7
9 - Willame	0	15	12	69	96	4.6
10 - Davis	2	6	4	38	50	6.3
11 - Kilborn	0	1	5	23	29	5.4
Totals	**53**	**116**	**104**	**1007**	**1282**	

Sediment Transport and Storage

Pre-1880 Conditions

Since the analysis area is considered to have been relatively undisturbed by human development prior to 1880, it is assumed that sediment generation, transport and storage reflected the natural disturbance regime. The dominant sediment sources in the upper Cowlitz were deep-seated rotational mass movements, which were usually located at the base of mountain structures or avalanche and debris chutes from steep ridges. Small inner gorge failures and channel erosion were also sources of sediment, but to a much lesser extent than the chutes in the upper watershed. The dominant sediment sources reaching the main Cowlitz River were transported down river and deposited as sediment storage bars throughout the basin, either in debris fans (where smaller tributaries confluence with the Cowlitz River) or as altering point and sediment bars. Table 3-39 displays the concern areas at the 6th field sub-watershed level where deep-seated rotational slides, debris flows, and avalanche chutes have the most impact to the stream channel sediment loads. It should be noted that there are inherent difficulties in interpreting past sideslope failures and the impacts to stream channels. Often such failures are misinterpreted.

Table 3-39: Areas of High Sedimentation Impacts to Stream Channels Based on Upslope Failures Including Deep-Seated Rotational Slides, Debris Flows, and Avalanche Chutes *

WSU	6th Field Watershed	Deep Seated Rotational Concerns	Debris Flow Areas of Concern	Avalanche Chute Areas of Concern
1 - Dry	Burton	NC	NC	NC
	Davis	NC	NC	Low
	Pothole	High	NC	High
	Garrett	NC	NC	Moderate
2 - Smith	Smith	NC	NC	Moderate
3 - Johnson	Deception	Low	NC	High
	Jordan	Low	NC	High
	Mission	NC	NC	High
	Glacier	Low	NC	NC
	Lower Johnson	NC	NC	High
	Upper Johnson	NC	NC	Low
4 - Lake	Lower Lake	High	NC	NC
	Upper Lake	Moderate	NC	High
5 - Coal	Lost	NC	NC	Low
6 - Hall	Hager	Low	Low	NC
	Hinkle Tinkle	NC	NC	Low
	Snyder	NC	NC	NC
7 - Butter	Butter	Moderate	NC	High
8 - Skate	Lower Skate	Moderate	NC	High
	Upper Skate	Moderate	Low	Low
9 - Willame	South Fork Willame	NC	Low	Low
	Willame	NC	NC	NC

Table 3-39: Areas of High Sedimentation Impacts to Stream Channels Based on Upslope Failures Including Deep-Seated Rotational Slides, Debris Flows, and Avalanche Chutes *				
WSU	**6th Field Watershed**	**Deep Seated Rotational Concerns**	**Debris Flow Areas of Concern**	**Avalanche Chute Areas of Concern**
	North Fork Willame	NC	Low	NC
	West Fork Willame	NC	Low	NC
10 - Davis	Davis	Moderate	Low	Moderate
11 - Kilborn	Kilborn	NC	NC	Low

** Classification is by 6th field sub-watershed. The determination of concern areas was based on a percentage of the entire 6th field area using the following: <1% = No Concern, 1-3% = Low Concern; 3-5% = Moderate Concern; and >5% = High Concern. Only National Forest lands were evaluated.*

It is estimated that sediments were moved through the system in pulses during storms and catastrophic events, as opposed to a continual flow of sediments (Ketcheson 1996, Benda 1997, *pers. communication*). Tributaries originating in the Goat Rocks (Johnson, Lake and Coal - WSU 3, 4, and 5 respectively) and Tatoosh Wilderness Areas (Upper Butter Creek basin - WSU 7) and the Smith (WSU 2), Skate (WSU 8), Willame (WSU 9), and Davis (WSU 10) Creeks generally have steeper headwaters and stream channel reaches. These transport reaches deliver sediments to lower gradient stream channels. These channels probably did not experience the negative impacts of large sediment flushes which occurred closer to the flood plain area (i.e. WSU 1 - Dry and WSU 6 - Hall Creek areas, which consist of depositional reaches).

Current Conditions

A review of stream surveys (late 1980's through 1996) and 1989 aerial photos indicated that the quality of fish habitat can be severely reduced or limited in stream channel types with hydrologic flow energies capable of moving large amounts of bedload through the system. In addition to causing channel aggradation and widening, this sediment fills pools, which serve as important habitat for holding adult and rearing juvenile salmon. Decreased channel and pool depth increases the heating effects from solar radiation, resulting in higher water temperatures.

Within the mainstem of the Cowlitz River (RM 114-132); main Deception Creek (WSU 3), lower Butter Creek (WSU 7), Skate Creek (WSU 8), and the North Fork Willame and main Willame Creeks (WSU 9), increases in sediment deposition appear to be related to past forest management activities and associated road structure. Within the main upper Cowlitz River system and the lower reaches of Johnson, Butter, Skate, and Willame Creeks (WSU 3, 7, 8, and 9 respectively) enough sediment deposition has occurred to cause problems with stream channel migration.

The mainstem of the upper Cowlitz River continues to route sediments through the watershed. It would appear that the Cowlitz River slowly but steadily transports the high sediment load downstream towards the Middle Cowlitz River 5th field watershed area and floodplain. In the process, any existing pools along the channel are often partially or wholly filled by sediment pulses. Several sites are temperature sensitive and, at times, exceed 16.3° C during the summer months.

Aquatic Organisms and Stream Habitat

Data Sources/Data Gaps

Historical fishery and habitat information is scarce for the area. Data sources include watershed analysis conducted on private lands, Randle and Packwood Ranger Districts, Region 6 stream surveys, Washington Department of Fish and Game anadromous/resident surveys, and surveys of the Columbia River and its tributaries by the U. S. Department of Interior.

Assumptions

Fish species and distribution coincides with actual survey, or historical sources; a large amount of potential habitat and unknown populations may exist in the watershed. No field collection, or validation was done for this analysis.

Spring chinook (*Oncorhychus tshawytscha),* coho (O.*kisutch*), and winter steelhead *(O. mykiss)* are being reintroduced into the upper Cowlitz River and larger tributaries as mitigation for Cowlitz Falls Dam. Table 3-40 indicates the available habitat based on the reintroduction effort. Cowlitz River winter steelhead *(O. mykiss)* is a fish stock proposed for listing as "Threatened" under the Endangered Species Act. As of this writing, the upper Cowlitz watershed is being considered for inclusion to the Lower Columbia Evolutionary Significant Unit management area for steelhead. These fish or hatchery progeny of these fish are known to exist in the planning area, and are being used for reintroduction purposes.

Reference (Historic) and Current Conditions

Water Quality and Channel Conditions

Table 3-40: Maximum Amount of Habitat for Anadromous / Resident Fish and Potential for Large Woody Debris *

WSU	River Mile on Cowlitz River	Miles of Anadromous Habitat	Miles of Resident Habitat	Riparian Vegetation % Large Tree	Miles of Road in Riparian Corridor
1 - Dry	NA	6.5	6.5	26	7
2 - Smith	122.2	1.2	6	19	9
3 - Johnson	122.7	3.4	13.9	30	24
4 - Lake	129.2	1.9	9.1	44	9
5 - Coal	130.7	3.6	7	44	4
6 - Hall	123.2	9.1	12.1	21	12
7 - Butter	128.2	1.2	8	9	5
8 - Skate	125.7	9.1	13.4	38	33
9 - Willame	121.4	0.75	4.7	26	20
10 - Davis	114	1.2	3.2	29	8
11 - Kilborn	115	NA	0.7	59	2

** All data except miles of resident and anadromous fish habitat are from National Forest lands only.*

Aquatic Organism Distribution

The following descriptions refer to Natural Sequential Order (NSO) numbers for given stream locations. NSO numbers correspond to specific field locations, determined during stream surveys on the Randle and Packwood Ranger Districts. Table 3-41 lists the streams and lakes with fish populations.

Cowlitz River: WSU 1 & 6

Fish species known to inhabit this section of the Cowlitz River include: Spring and fall chinook *(Oncorhychus tshawytscha)*, coho *(O. kisutch)*, steelhead *(O. mykiss)*, coastal cutthroat *(O. clarki)*, rainbow trout *(O. mykiss)*, German brown trout *(Salmo trutta)*, mountain whitefish *(Prosopium williamsoni)*, as well as less recreational species such as sculpin. (Bryant 1949, USDA Forest Service, 1995d)

Currently, spring chinook, coho, and steelhead are begin reintroduced into the upper Cowlitz River system in Skate, Johnson, Smith, Hall, and Willame Creeks.

Dry WSU 1

***Garrett Creek*:**

The confluence with Cowlitz River is used by coho, chinook, and rainbow trout (USDA Forest Service, 1995d).

During the late summer, Garrett Creek flows subsurface from Cowlitz River to NSO #9. Cutthroat trout were seen from NSO # 9 to NSO #63 (USDA Forest Service, 1994c).

Burton Creek:

Burton Creek was first stocked in 1928 with eastern brook trout and has 3.0 miles of fishable water (USDA Forest Service, 1936).

Burton creek is 40 feet wide with frequent, shallow pools. The lower half mile is swampy and lacks spawning rubble. There is spawning area for a few salmon in the next 2/3 mile, but the remainder of the stream up to the falls has an exceptionally steep gradient (Bryant 1949). Reach 1 of Dry Creek has subsurface flow during the summer months. Two culverts act as migration barriers for fish.

Burton was included in the 1962 salmon survey conducted by the Washington Department of Fisheries. The stream is 15 feet wide and the lower half-mile is swampy and lacks spawning gravel. There are pools and riffles in the next 2/3 mile and suitable spawning area to accommodate approximately 50 pairs of silver salmon. (Birtchet 1963)

Bryant (1949) reports that "although silver and chinook salmon, steelhead, and cutthroat trout have been reported, the stream has little value". Within East Fork Burton Creek, "silver salmon and trout are reported, and silver fingerlings were numerous. A large run of silvers for the size of the stream was reported in 1935." East Fork Burton flows into Burton Creek swampy section (below Highway 12).

Rainbow and cutthroat trout were observed during the 1994 stream survey. Coho and chinook were observed up to the first beaver dam during snorkel surveys (USDA Forest Service, 1995b).

Dry Creek:

Dry Creek has a fishable length of 2.0 miles with a native population of rainbow trout (USDA Forest Service, 1936).

Smith WSU 2

Smith Creek:
Smith Creek has a fishable length of 10.0 miles with a native population of cutthroat trout (USDA Forest Service, 1936).

Stocking surveys found the lower section of Smith Creek to have "excellent" spawning grounds (Roth, 1938). Review in 1949 found suitable spawning for only a very few salmon. The stream was considered too steep and rough above the falls for any additional value to anadromous fish (Bryant 1949). Smith Creek was included in the spawning survey conducted by Washington Department of Fisheries in 1962. Findings displayed that the lower 1/4 RM had been channelized and fish would have difficulty ascending above the mouth (Birtchet 1963).

Rainbow and cutthroat trout use Smith Creek from the confluence with Cowlitz River to above F.R. 20 crossing (USDA Forest Service, 1986).

Johnson WSU 3

Johnson Creek:
Johnson Creek has a fishable length of 15.0 miles and was first stocked with rainbow trout in 1929 (USDA Forest Service, 1936). There are 200 pools per mile and "many hundreds of fingerlings seen". (Roth 1938)

A fair run of silver salmon is reported, and fingerlings were observed below the lower log jam. Steelhead trout are also reported. All tributaries large enough to support salmon enter above the falls and are therefore inaccessible. (Bryant 1949) Birtchet (1963) indicated that the lower 1.5 miles had been channelized and that fish would have difficulty ascending above the mouth.

Under the salmon reintroduction program, chinook and coho have been aerial planted in Johnson Creek, below the anadromous barrier.

Rainbow and cutthroat trout are the primary sport fish in Johnson Creek.

Glacier Creek:
Glacier Creek has a fishable length of 2.0 miles and was first stocked in 1922 with rainbow trout (USDA Forest Service, 1936).

Deception Creek:
A small population of rainbow trout.

Middle Fork Johnson Creek:
Small population of rainbow trout.

Glacier Lake:
Glacier Lake supports a strong population of eastern brook trout. The lake was stocked with rainbow trout in 1941 and 1947 by the state of Washington, and with cutthroat trout in 1954 and 1971 (Lucas 1989). Eastern brook trout were stocked in 1932 (USDA Forest Service, 1921-1953).

Wright Lake:
Wright Lake was first stocked with rainbow trout in 1942 (Lucas 1989) and is on stocking schedule of every three years. The lake is presently stocked with Twin Lakes cutthroat trout.

Hugo Lake:
Hugo Llake was first stocked with eggs from Walupt Lake rainbows in 1940 (Lucas 1989), and had been restocked infrequently until 1973. The last recorded stocking was in 1988 with Twin Lakes cutthroat trout. Hugo Lake has been recommended to be removed from the stocking schedule due to a lack of spawning, its shallow depth (5 feet), small size and proximity to a busy road.

Lake WSU 4

Lake Creek:
Lake Creek has a fishable length of 6.0 miles and was first stocked in 1922 with rainbow trout (USDA Forest Service, 1936). Historical stream surveys indicate numerous silver salmon fingerlings with 30 steelhead redds in the lower section (Bryant 1949).

An eight foot fall acts as an anadromous barrier at R.M. 2.4, NSO 219 (USDA Forest Service, 1993d).

There is a strong population of rainbow trout in Lake Creek.

Packwood Lake:
Packwood Lake was used as a source of rainbow trout as early as 1916, when an egg-eyeing station was located at the lake. It has been stocked on numerous occasions, but electrophoretic data indicate the stock has remained remarkably pure. The fish resemble "inland" rainbow trout and are considered a unique population. These trout add to the genetic diversity of the fish species in the upper Cowlitz. In order to preserve their genetic integrity, no fish have been stocked in Packwood Lake since 1965 (Lucas 1989).

Rainbow trout from the lake use all of the tributaries to the lake for spawning.

Coal WSU 5

Coal Creek:
Coal Creek has a fishable length of 6.0 miles and was first stocked in 1923 with rainbow trout (USDA Forest Service, 1936).

Roth (1938) reported "fair" spawning grounds during the 1938 stocking survey while work by Bryant (1949) reported that there is a spawning area for about 100 pairs of salmon near the mouth. A steep gradient of over 435 feet per mile in a canyon above makes the stream of little value. No migratory fish were seen or reported. Electroshocking data indicates a small population of rainbow trout in the upper section of Coal Creek. (USDA Forest Service, 1986)

Lost Lake:
Lost Lake was first stocked in 1921 with rainbow trout and had been stocked infrequently until 1983. The recommended stocking interval is every two years, using Twin Lakes cutthroat trout (USDA Forest Service, 1921-1953).

Beaver Lake:
No fish

Hall WSU 6

Hall Creek:
Hall Creek has a fishable length of 6.0 miles and was first stocked in 1931 with rainbow trout (USDA Forest Service, 1936). Roth (1938) reported "excellent" spawning grounds while Bryant (1949) reported a small run of silver salmon and steelhead . The lower one-quarter mile had been utilized as an index area for early and late run silver salmon since 1955. There is suitable spawning gravel to accommodate 25 pairs of salmon. (Meekin 1962) Coho, chinook, rainbow, cutthroat, and German brown trout were seen in Hall Creek during 1994 snorkel surveys.

Hager Creek:
Hager Creek was stocked in 1923 with eastern brook trout and again in 1931 with steelhead fry (USDA Forest Service, 1921-1953).

Snyder Creek:
This creek has a small population of cutthroat trout (USDA Forest Service, 1983).

Hager Lake:
Hager Lake was first stocked in 1922 with eastern brook trout (USDA Forest Service, 1921-1953) and was last stocked in 1987 with Twin Lakes cutthroat trout (Lucas 1989). Rotenone was applied in 1980 in an attempt to kill off the eastern brook trout population and to establish a self-reproducing cutthroat population. The project was unsuccessful and several eastern brooks survived the rotenone to repopulate the lake. Eastern brook trout are again the primary fish species in Hager Lake.

Snyder Lake:
Snyder Lake once served as the water source for the town of Packwood. It was opened to fishing in 1983 and was stocked the same year with Twin Lakes cutthroat trout. Eastern brook trout were first introduced in 1922 with supplemental planting in 1924 and 1928. (interestingly, the lake was closed to fishing during this time period) The eastern brook trout out competed the cutthroats and in 1984, German brown trout were added in hopes of reducing the numbers of eastern brook. This effort was unsuccessful, and in 1989 it was recommended that Snyder Lake be managed as an eastern brook trout fishery.

Butter WSU 7

Butter Creek:
Butter Creek has a fishable length of 10.0 miles and was first stocked in 1935 with rainbow trout (USDA Forest Service, 1936). Field review by Roth (1938) reported "excellent" spawning grounds. Bryant (1949) reported that in the lower half mile section on the Cowlitz River floodplain there is spawning area for at least 300 pairs of salmon. Numerous silver salmon fingerlings indicate that is well utilized by that species. Trout fingerlings were also seen.

The half mile section above its mouth changes as a result of beaver dam construction. The present channel from the mouth upstream about 200 yards contains “excellent” spawning habitat, with even flow and excellent gravel. (Stockley, *et al.* 1955) The lower mile has been utilized as an index area for early and late silver salmon since 1952. Meekin (1962) reports that there is suitable spawning gravel to accommodate 135 pairs of silver salmon. However, much of the spawning gravels that had been previously utilized are above water level.

Butter Creek has a moderate population of rainbow trout and a small population of eastern brook trout. (USDA Forest Service, 1986)

Skate WSU 8

Skate Creek:
Skate Creek has a fishable length of 12.0 miles and was first stocked in 1929 with rainbow and cutthroat trout (USDA Forest Service, 1936).

The lower mile on the Cowlitz flood plain has a slight gradient and spawning area of at least several hundred salmon. The middle section of the stream is in a canyon 4 miles long where there are some scattered patches of spawning rubble. A review by Roth (1938) reported "good" spawning grounds. Bryant (1949) reported that the upper 3 miles of the creek are in a wider valley and have spawning area for a few hundred more salmon. The stream can support at least 1400 pairs of salmon and has a potential higher carrying capacity if the stream channel was not subject to severe scouring by freshets in the narrow canyon. Silver salmon and steelhead trout runs are reported. Steelhead fingerlings were fairly abundant throughout, but silver fingerlings were most abundant in lower 2 miles. (Bryant 1949)

The lower mile of Skate Creek has been used as an index area for early and late run silver salmon since 1955. Suitable spawning gravel is available in the area surveyed to accommodate 40 pairs of silver salmon. (Meekin 1962)

Skate Creek is being developed as a high profile trout stream in Eastern Lewis county. During the summer months it is stocked with rainbow trout in several locations. Above the last stocking site cutthroat trout were seen. (USDA Forest Service, 1994f)

Johnson Creek:

Johnson Creek entering Skate Creek at R.M. 7 is blocked by a series of 6 to 10 foot falls 400 yards above the confluence and is not considered a valuable anadromous fishery. (Bryant 1949). Electroshocking data shows that Johnson Creek has a small population of cutthroat trout.

Johnson Lake:

The lake was first stocked in 1983 with Twin Lakes cutthroat trout. It has limited spawning areas, but fry were seen when surveyed later. It was recommended that the stocking level be dropped from 600 fish to 300 fish. (Lucas 1989)

Willame WSU 9

Willame Creek:

Willame Creek has a fishable length of 6.0 miles and was first stocked in 1929 with rainbow trout (USDA Forest Service, 1936).

Silver salmon fingerlings were numerous and the available spawning area is well utilized. The stream is believed to be too steep and rough above the falls (R.M. 0.75) to be much value to migratory fish (Bryant 1949). Birtchet (1963) reported a suitable spawning area for approximately 200 pairs of silver salmon in the second river mile. Electroshocking data indicates that there are small populations of rainbow, cutthroat, and eastern brook trout scattered throughout the stream system, shocking sites are on the mainstem Willame Creek. (USDA Forest Service, 1986)

There is no data on the South Fork, West Fork, and North Fork Willame Creeks.

Long Lake:
Long Lake was first stocked with rainbow trout in 1949, stocked with cutthroat trout from 1963 to 1987, and German brown were stocked in 1988. The present management strategy is to stock with German brown trout every other year. (Lucas 1989)

Willame Lake:
Willame Lake was first stocked in 1966 with cutthroat trout and was on an irregular stocking schedule until 1980. From 1980 to present, the lake is stocked every three years. (Lucas 1989)

Davis WSU 10

Davis Creek:
Davis Creek has a fishable length of 6.0 miles and had a natural population of eastern brook trout (USDA Forest Service, 1936). Bryant (1949) reported numerous silver salmon fingerlings and a few steelhead fingerlings (Bryant 1949). A 1986 stream survey reported a small population of rainbow trout in Davis Creek. (USDA Forest Service, 1986)

Kilborn WSU 11

Kilborn Creek:
Kilborn Creek has a fishable length of 3.0 miles and had a natural population of cutthroat trout (USDA Forest Service, 1936). Silver salmon and steelhead are reported to ascend to the falls. Cutthroat trout were observed, and Montana black spotted trout (west slope cutthroat) have been planted above the falls. (Bryant 1949) Cutthroat trout were reported up to NSO 113 (USDA Forest Service, 1993c).

Limiting Factors

Several factors combine to limit anadromous and non-anadromous fish in the upper Cowlitz basin area. Natural and human-caused barriers such as bedrock falls, high stream channel gradients, logjams, and road crossings prevent migration of spawning adults and rearing juveniles. The high gradients in most secondary tributary stream channel systems limit available spawning and rearing areas and prevent the migration of anadromous and resident species. The mainstem upper Cowlitz River is low gradient for most of its length, but water quality may become more limited as sediment deposition widens the wetted channel width, leading to increased temperatures. Sedimentation of the associated steeper side tributary channels such as Smith Creek (WSU 2), Johnson Creek (WSU 3), Hager Creek (WSU 6), lower Lake Creek (WSU 4), lower Coal Creek (WSU 5), lower Butter Creek (WSU 7), Skate Creek (WSU 8), and both the North Fork and main stem Willame Creek (WSU 9) also limits both quality and quantity of fish production within the analysis area. A variety of factors outside the analysis area further limit fish production, including: the placement of dams on the lower Cowlitz River outside of National Forest lands which act as an anadromous fish passage barriers, oceanic conditions, commercial harvest, recreation harvest downstream, hatchery plants, and existing habitat conditions (both water quality and riparian conditions) related to management activities such as urbanization and forest practices.

Effects of Natural Processes on Habitat and Aquatic Organisms

Salmonid habitat is a product of the existing geology and soils, topography, vegetation, climate, and hydrology of a watershed. Changes in these conditions may greatly affect fish habitat (Meehan 1991). Salmonids are adapted to a dynamic landscape. Stocks of salmon and trout 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 (Bijorn *et al.* 1991). However, this flexibility is not unlimited and has evolved under existing environmental conditions for 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 have had a major influence on the existing aquatic ecosystem within the upper Cowlitz River basin. Flood events occurring during the late fall to early spring (typically from November to early March) have the potential to adversely impact stream channels and fish habitat. Such flood events occurred in 1996. Flood impacts are further compounded by rain-on-snow effects, as described previously in this chapter. Floods are and have been a part of the natural disturbance pattern in the upper Cowlitz River basin. Periodic major floods (ie. 1996 flood), along with fire, have altered and changed stream channel and fish habitat conditions through time. The interval (from years to decades) between such major events allows fish populations to respond and adjust to altered channel and habitat conditions. These populations remain intact, viable, and self-sustaining. The ability to cope with the natural disturbance regime most likely changed as a result of road construction, timber management activities, and riparian stand or streambank alterations in the upper Cowlitz River. These activities compounded 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. 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. Such sediment delivery processes provide substrate that provide for fish spawning purposes. periodic flushing of sediments clean 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. A certain amount of natural erosion or disturbance to both upslope and in-stream channel conditions is beneficial to the aquatic habitat within the area. Fish populations have

UPPER COWLITZ WATERSHED ANALYSIS
Fish Distribution
Map 20

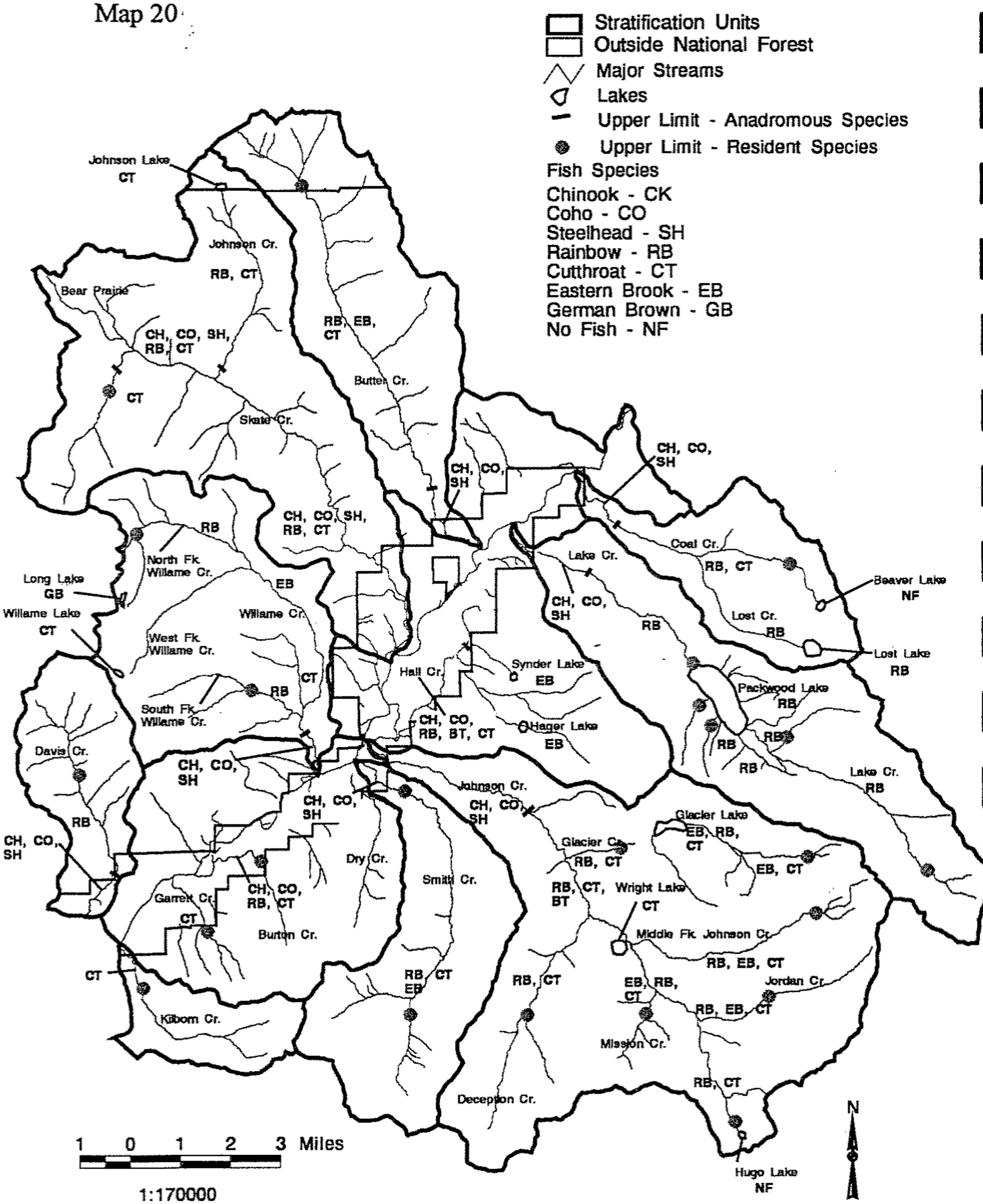


Table 3-41: Fish Distribution within Upper Cowlitz Watershed

WSU	Stream	Anadromous	Resident	Comment
1, 6	Cowlitz River	All Reaches, 15.6 mi.	All reaches, 15.6 mi.	Includes spawning index areas. Coho, Chinook, Steelhead, Rainbow, Cutthroat, Mountain whitefish
1	Garrett Cr.	Confluence Area	NSO 9 to NSO 63	Flow subsurface part of the year. Coho, Chinook, Steelhead, Rainbow, Cutthroat, and Mountain Whitefish
1	Burton Cr.	Confluence Area	Resident seen in beaver ponds between dry sections.	Channelized and diked. Flows subsurface part of the year. Coho, Chinook, Steelhead, Rainbow, Cutthroat, and Mountain Whitefish.
1	Dry Creek	Confluence Area	Mouth to first set of falls	Flows subsurface part of the year. Coho, Chinook, Steelhead, Rainbow, Cutthroat, and Mountain Whitefish.
2	Smith Cr.	Mouth to R.M. 1.2	Mouth to above F.R. 20 crossing	The lower 1/4 mile has been channelized, Coho, Chinook, Steelhead, Rainbow, Cutthroat, and Mountain Whitefish
3	Johnson Cr.	Mouth to R.M. 3.4	Mouth to Hugo Lake, 11.5 mi	The lower section has been channelized, diked. Coho, Chinook, Steelhead, Rainbow, Cutthroat
3	Glacier Cr.	NA	Mouth to F.R. 21	Rainbow trout are found above F.R. 21
3	Deception Cr.	NA	Mouth to R.M. 4.7	Rainbow trout
3	John Bob Cr.	NA	No Fish	
3	Middle Fk.	NA	No Data	
3	Jordan Cr.	NA	No Fish	
3	Mission Cr.	NA	Mouth to 25' falls	Rainbow Trout
3	Glacier Lake	NA	26 acres	Stocked in 1932, E. Brook
3	Wright Lake	NA	3 acres	Stocked in 1942, Cutthroat
3	Hugo Lake	NA	1.5 acres	Stocked in 1952, No fish
4	Lower Lake Cr..	Mouth to R.M. 3.4	Mouth to Lake 6.6 miles	The lower section has been channelized. Coho, Chinook, Steelhead, Rainbow.
4	Upper Lake Creek	NA	No Data	
4	Packwood Lake	NA	452 acres	Unique natural population of rainbow trout, Stocked in 1921
4	Art Lake	NA	1.5 acres	Stocked in 1937, Rainbow
5	Coal Creek	Mouth to R.M. 3.6	Mouth to R.M. 3.6	Lower section is diked, Coho, Chinook, Steelhead, Rainbow, cutthroat
5	Lost Creek	NA	Mouth to Lake 3.4 mile	Rainbow Trout

Table 3-41: Fish Distribution within Upper Cowlitz Watershed

WSU	Stream	Anadromous	Resident	Comment
5	Lost Lake	NA	21 acres	Stocked in 1933, Rainbow
5	Beaver Lake	NA	7 acres	No fish
6	Hall Greek	Mouth to R.M. 3.0	Mouth to R.M. 3.0	The lower section has been diked and channelized. Coho, Chinook, Steelhead, Rainbow, Cutthroat, Mountain Whitefish
6	Hager Creek	NA	No fish	Stocked in 1921
6	Synder Creek	NA	Mouth to lake 1.0 mile	Cutthroat Trout below F.R. 1260 and Eastern Brook above F.R. 1260
6	Hager Lake	NA	2 acres	Stocked in 1922, E. Brook
6	Synder Lake	NA	3 acres	Stocked in 1922, E. Brook
7	Butter Creek	Mouth to R.M. 1.2	Mouth to R.M. 8	The lower section has been channelized, diked, and is lined by homes. Coho, Chinook, Steelhead, and Rainbow Trout
8	Skate Creek	Mouth to R.M. 9.1	Mouth to R. M. 9.7	There is a lot of braiding on the lower section. Coho, Chinook, Steelhead, Rainbow, and Cutthroat.
8	Johnson Creek	Confluence Area	Mouth to RM 3.7	Road restricting stream, Cutthroat Trout
8	Johnson Lake	NA	8 acres	Stocked in 1983 Cutthroat
9	Willame Cr.	Mouth to R.M. 0.75	Mouth to NSO 135	Braiding is occurring on the alluvial valley. Release site for Coho, Chinook, and Steelhead. Rainbow
9	S. Fork Willame Cr.	NA	Mouth to r each 6	Rainbow Trout
9	W. Fork Willame Cr.	NA	No Data	No Data
9	N. Fork Willame Cr.	NA	Confluence with Willame Creek to middle of reach 1	Rainbow Trout
9	Long Lake	NA	7 acres	Stocked in 1940, G. Brown
9	Willame Lake	NA	7 acres	Stocked in 1966, Cutthroat
10	Davis Creek	Mouth to R.M. 1.2	Mouth to R.M. 3.2	Flows subsurface from NSO 17 to NSO 27, and some cattle impacts. Coho, Chinook, Steelhead, and Rainbow Trout
11	Kilborn Creek	NA	Mouth to R.M. 0.7	Flows subsurface from confluence with Cowlitz River upstream for 50 feet. Cutthroat Trout, Montana black spotted trout

Note: Stocking dates for lakes are the first known date when the lake was stocked. Fish species listed for the lakes are those known to populate the lakes at present time, 1997.

evolved over time in stream channels that are relatively balanced with bedload transportation and deposition and a stable channel condition. Periodic high 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).

Fine sediments that lodge in the interstitial spaces between gravel particles reduces permeability and slows the flow rate through the gravel substrate (Johnson 1980). Numerous studies have associated higher fine sediment **loads** (such as would be expected in the main Cowlitz River basin, Skate Creek, and Willame Creek basin areas) with elevated rates of mortality and reduced fitness of the surrounding fish (Chapman 1988; Everest *et al.* 1987; Koski 1975). The Washington State 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 (Peterson, *et al.* 1992).

Stream channel scouring events have 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 varies among the salmonid species. In areas of high volume of sediment inputs, such as those during higher peak flow events, redds get covered and temperatures and oxygen flows 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

Logging has affected stream habitats within the Cowlitz basin area over the past 90-100 years (Buddy Rose, *pers. communication*, 1997). Splash dams were constructed to help transport logs to mills or to areas where the logs could be more easily handled. Streams and rivers were cleared of wood and boulders to prevent jams during the log drives, while repetitive flushing of logs led to scouring, channel widening, and gravel displacement in larger mainstems. Such dams also posed barriers to upstream fish passage. 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).

Timber harvests can modify hydrologic processes and stream morphology. Increases in peak flows from rain-on-snow events can increase scouring and accelerate bank erosion. Increases in sediment causes aggradation in pools and degrades spawning gravels (both quality and quantity). Stream habitat diversity declines due to removal of in-stream structure-forming agents such as woody material. The size, number, and density of timber harvest clear-cut units and road construction over a relatively short time period (1950 - 1980's) is suspected to have played a major influence on channel and aquatics habitat conditions. Such road related flood damage are 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 crossing sites
- diversion of streams at stream crossings
- fish passage blockage at stream crossing sites

Fish Species Occurrence and Relative Abundance

Fish Barrier Removal

As access is provided to anadromous fish, resident fish populations must compete for space and food. Interbreeding opportunities are also introduced.

Recreational Fishing

Current information on recreational fishing use is limited. Starting in 1969 management re-introduced steelhead runs above the Cowlitz dam barriers to the west and out of the analysis area. Since this time the population has improved to a minor degree but fishing availability is still very limited. The primary fishing interests at this time are the resident cutthroat, rainbow, and brook trout 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 a natural fish population on a yearly basis due to extreme cold winter conditions and potential full water freezings.

Other Recreational Impacts

Habitat degradation occurs 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 streams and lake areas. Lack of nearby toilet facilities leads to water quality concerns. In-stream impacts occur from small impoundments constructed with cobbles and when people walk up channels (this is a particular concern for resident spawning areas due to timing).

Poaching

Poaching concerns are very limited and expect to be scattered about the analysis area. Such events are thought to be most dominant within the main fishing areas such as the Packwood Lake, Johnson Creek, and Skate Creek areas.

Fish Habitat Management Strategies

Forest Service Fisheries Habitat Improvement and Watershed Restoration

The US Forest Service has been planning, developing, and implementing fish habitat improvements within the Upper Cowlitz Analysis Area since 1983. The effort has been primarily to stabilize alluvial channels and restore in-channel large woody material where lacking. Among the channels which need work in this area are the Smith Creek (WSU 2), portions of Johnson Creek (WSU 3), Hager Creek (WSU 6), the lower Butter Creek (WSU 7), Skate Creek (WSU 8), the North Fork and main Willame Creeks (WSU 9) and Kilborn Creek (WSU 11). Refer to the Riparian Conditions and Habitat Conditions section above for descriptions of existing woody debris, its benefits, and recruitments.

Monitoring of these sites and locations to determine project effectiveness is not well documented but varying levels of implementation and effectiveness monitoring has been going on. Success of these projects in providing more rearing habitat and therefore providing more juveniles is unknown.

Little or no in-channel structure placement has occurred in these tributaries since the early to mid 1980's. From roughly the 1940's through the 1980's, the Forest carried out log jam removal and boulder blasting. The purpose was two-fold: 1)as a flood control/prevention measure (to reduce the potential a log jam to downstream bridges or road segments), and 2) to remove what were then perceived as barriers to fish passage. With the results of new studies, the Forest Service has attempted to restrict any human activities within the riparian area that are suspected to alter aquatic habitat conditions. One exception is when woody debris or large bedrock/boulders present within the stream channels pose a threat to the existing road or bridge systems.

The Forest Service has been actively working to restore the riparian zone and enhance soil stability since the late 1980's. Major rain-on-snow flood events in February 1996 caused significant amounts of watershed damage due to nature and human-related parameters, and several watershed restoration sites were identified as a result. Aquatics related damage includes loss of road facilities and associated stream channel impacts, natural sideslope failures within debris shoots resulting in debris flows and debris slides which reach stream channels, riparian displacement associated with high flow flood events, and filling of pool habitat from the upslope sediment sources.

Table 3-42: Riparian Areas Damaged by the February 1996 Flood in the Upper Cowlitz Analysis Area.

WSU	Stream Name	Recommended Action
1	Cowlitz River Garrett Creek Burton Creek Dry Creek	None.
2	Smith Creek	3.7 miles of decommissioning/stabilization 3/4 miles of in-stream work
3	Johnson Creek	16.6 miles of decommissioning/stabilization 3 culvert upgrades 25 waterbars 3/4 mile of in-stream work 3/4 mile of bank stabilzation 1 vented ford 19.55 acres of erosion control work
4	Lake Creek	6.9 miles of decommissioning/stabilization 2 culvert replacements 4 road grade changes (clips) tree planting (slides and fill slopes)
5	Coal Creek Lost Creek	4.4 miles of decommissioning/stabilization
6	Hall Creek / Cowlitz River	None.
7	Butter Creek	None.
8	Skate Creek	5.0 miles of in-stream channel work.

Table 3-42: Riparian Areas Damaged by the February 1996 Flood in the Upper Cowlitz Analysis Area.

WSU	Stream Name	Recommended Action
9	Willame Creek	3 culverts 7.6 miles of pavement removal (4600 rd) 9.82 miles of decommissioning 69.61 miles of weatherization construct waterbars to control surface erosion 1 culvert conversion to ford 3.0 miles of in-stream work 4.24 miles of bank stabilization 2 culvert conversion for fish passage 3.1 acres of riparian planting 5.0 acres of erosion control blankets
10	Davis Creek	None.
11	Kilborn Creek	None.

In order to stabilize high stream channel sediment delivery zones, the Forest Service has undertaken a restoration approach. The goal of the process is to identify the zones of highest soils and geologic instabilities with the potential of sediment delivery to the aquatics system, and to determine the most reasonable and cost-effective method to complete the restoration projects. Work is currently in progress, in the initial stages following the 1996 flood event.

Monitoring

Projects completed in the past 5 years have received monitoring emphasis. The procedure for monitoring varies depending on the restoration/stabilization project, including its location, riparian condition, and relation to the sideslope and stream channels. Some of the methods used to monitor riparian enhancement for stabilization include: 1) photo points, 2) percent canopy cover, longitudinal profile changes over time, 4) measurements of stream flow alterations over time, and 5) alterations in the existing water temperatures, pool conditions, and associated fisheries habitat.

Chapter 4 - Interpretations/Areas of Concern

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 this 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 Upper Cowlitz watershed.

Social Elements

Past Human Uses

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 page 2-4). 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.

Comparing the reference (historic) and current conditions, the most obvious change in species composition and distribution is that of human populations. As the ethnohistoric data suggest, the properly functioning, self-sustaining ecosystem of 200 years ago included a human population of probably 50 to 75 people. The subsistence economy of 200 years ago limited human populations to sustainable levels *within the watershed ecosystem.* As the ethnic composition of the area changed in the late 19th century, the structure of the economy shifted toward greater reliance on a regional market economy. As different resources were exploited by non-native residents, the entire relationship to the local ecosystem changed radically, both in terms of land use patterns and the quantities of resources extracted from the environment. The underlying question, which cannot be fully explored within the scope of this analysis, remains, "Can a properly functioning, self-sustaining ecosystem exist without humans occupying a niche as hunter-gatherers at historic population levels".

Historic shifts in local land use practices and the resource demands of an increasing *regional* population resulted in impacts to the distributions of other plants and animals native to the analysis area. The following summarizes historic occurrences of and impacts to populations of seven species that were of traditional economic importance to indigenous people within the analysis area.

- **Coho (silver) salmon** (*Onchorhynchus kisutch*) - Jim Yoke and Lewy Costima, Taitnapam men interviewed in 1927 by anthropologist Melville Jacobs (1934), described places where "silverside" salmon could be found in the Cowlitz River above Randle. Identification as coho (silver) salmon is based on Sahaptin fish taxonomy (Hunn 1990) which uses the noun *sinux* for this species, instead of *tkʷinat* for Chinook, *shushaynsh* for steelhead, or the generic *núsux* for all salmonids.

- **Chinook salmon** (*Onchorhynchus tschawytscha*) - Lewy Costima (1934) mentions fishing sites for chinook salmon at locations above Randle in the upper Cowlitz watershed.

- **Steelhead** (*Oncorhynchus mykiss*) - Lewy Costima (1934) mentions locations in the Cowlitz watershed.

- **Dolly Varden trout** (*Salvelinus malmo*) - Lewy Costima (1934) mentions "a great many" Dolly Varden, *ashchinsh* in Sahaptin, at locations on the Cowlitz River, above and below the analysis area.

- **Huckleberries** (*Vaccinium spp.*) - The Tatoosh Range, including Butter Butte and Tatoosh Mountain, was a highly productive huckleberry area used historically by Taitnapam people. Historic sources indicate that huckleberries had been collected here for generations, with collection focused on *V. membranaceum*. Plummer's map of 1899 shows the area as a former burn. Comparison of historic maps, aerial photographs, and personal inspection (1989) indicate huckleberry production within the historic berry field is greatly reduced as a result of timber encroachment.

- **Mountain goats** (*Oreamnos americanus*) - Historically, a small population of mountain goats occupied the Dixon Mountain ridge.

Past human use of the upper Cowlitz watershed analysis area by indigenous people included hunting, fishing, and gathering of a variety of native plants and animals. These species were important components of the naturally functioning ecosystem prior to 1883, when non-native people began settlement of the area. 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 must abundant. 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 trout are now extinct. This situation suggests a significant imbalance within the structure of the aquatic ecosystem.

Distribution and density of huckleberry species, particularly *Vaccinium membranaceum*, has been reduced in historic patches associated with former burns.

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 *et al.* 1996), the collection of information on recreational use trends in non-Wilderness areas should be considered to be of high importance. Information on use levels, type of use, numbers of dispersed recreation sites, conditions of sites, etc. would be extremely useful for future decision making.

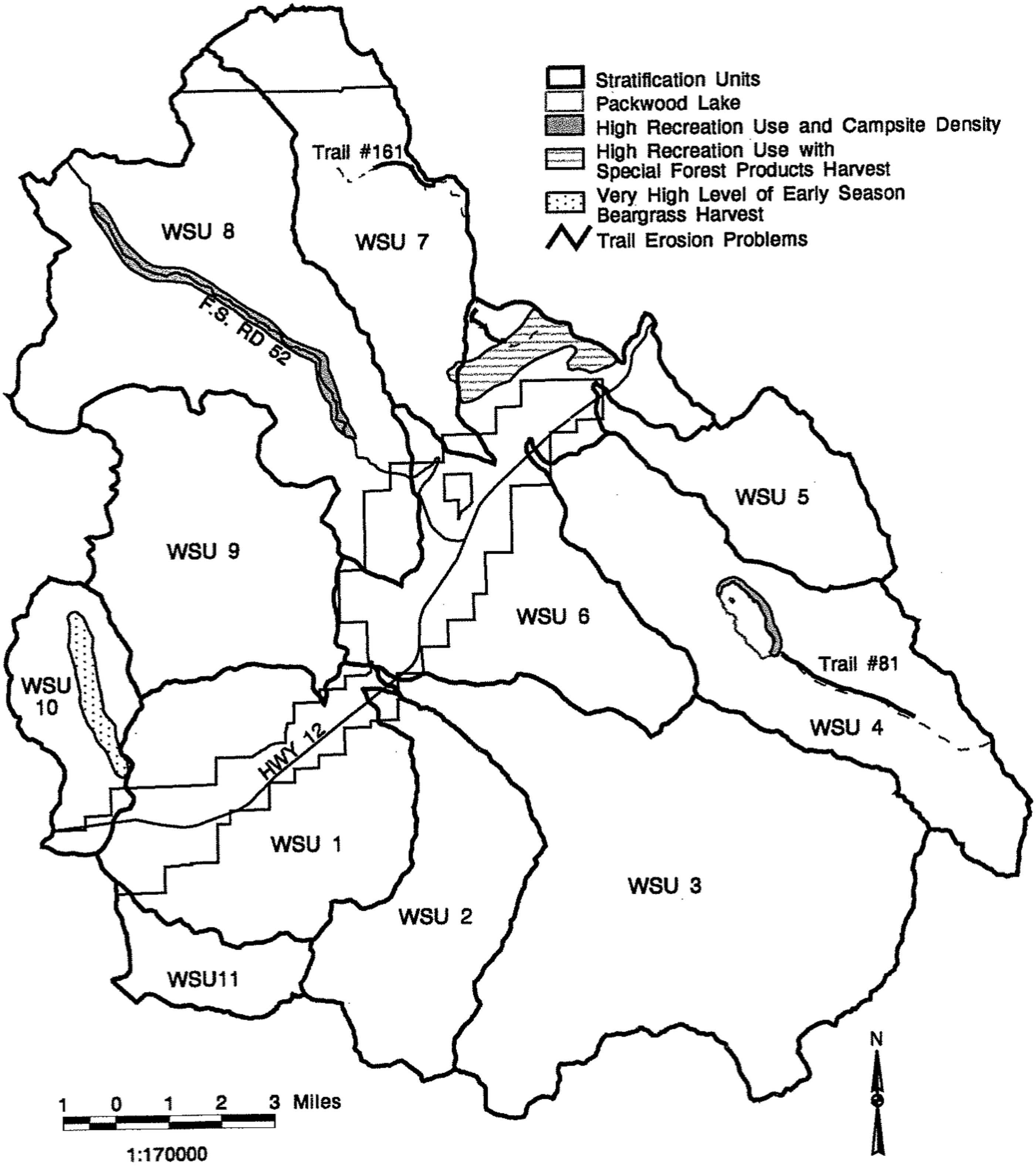
The Skate Creek Corridor (FR 52) is an area of concern because of its popularity for fishing and dispersed camping and the associated litter, sanitation and streamside impacts. Thirty six individual camp locations have been identified in a 9 mile stretch with many of the sites clustered in a few areas. Road closure violations have also been an ongoing problem on this road. The road is gated during the winter months and the locks and gates are damaged frequently each year. This area of concern is within WSU 8. This and other human use concern areas are displayed on Map 21.

The FR 5290 road system beyond the High Valley Subdivision is another area where litter and road closure violations are common. An informal target shooting range has developed near the junction with FR 5292. This is an area where there are frequent accumulations of litter. Further up FR 5292 is an area where harvest of special forest products such as salal is common and there have been frequent harvesting encroachments into the Tatoosh Wilderness. These encroachments are frequently accompanied by accumulations of litter along the 5292 road system and up to a mile inside Wilderness boundary.

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 Heart Lake (WSU 3), Lost Lake (WSU 5), Beaver Lake (WSU 5), and the alpine meadows west of Tatoosh Lakes (WSU 7). These areas have limited physical capability to support additional recreational pressure due to vegetation and terrain features that constain the number of suitable campsite and activity locations. In addition, a high percentage of the documented campsites within the Goat Rocks Wilderness, 82%, are within 300' of water sources. Of particular concern is the Packwood Lake area (WSU 4) where most of the sites are within 100' of the lake or inlet streams and several sites are in close proximity to Redband trout spawning areas.

Map 21

UPPER COWLITZ WATERSHED ANALYSIS
Human Concerns



Two trails have been identified as having erosion or tread stability problems. The Tatoosh Trail has two areas (WSUs 6 & 7) with severe rutting and tread loss. Both are relatively steep trail sections which has tended to encourage downslope movement and/or loss of the trail tread. Upper Lake Creek Trail (WSU 4) was extensively damaged by flooding in 1995-96. Several sections of the trail were washed away or damaged by channel relocations of upper Lake Creek and flooding from intermittent stream tributaries of upper Lake Creek.

Road washout and sloughing problems have limited access to several trailheads in recent years including Lily Basin Trail #86, Angry Mountain Trail #90, Purcell Mountain Trail #284, Jordan Creek Trail #96 and Tatoosh Trail #161. Options for road improvements and/or trailhead relocations should be considered for these and other trails where road access and maintenance concerns are identified.

A concern for the Tatoosh and Goat Rocks Wildernesses is the historic suppression of wildfire. 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. 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.

Within wilderness areas, an additional concern is 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.

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 the 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.

Completion of the Forest wide LSR Assessment will provide several opportunities for additional Special Forest Product harvest including profitable Matsutake mushrooms, especially in WSU 8. 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.

The over-harvest of beargrass is also a concern for specific areas such as WSU 10, which becomes snow free early in the year. 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 of the watershed. Stewardship contracts for salal and beargrass will be awarded for stands along Road 1256 (WSU 1) for the first time in an effort to improve harvest administration and monitoring.

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 thanks to education efforts.

Road access is not essential for the harvesting of these forest products. 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

Minerals

While the apparent level of mining activities within the watershed analysis area is minimal, mining is a legitimate activity on National Forest lands, as recognized by 125 years of mining laws. Proposals will be evaluated to ensure that the resulting on-the-ground operations in accordance with all pertinent federal laws and regulations.

Special Uses

Water transmission Lines. Current authorized users are long standing. These facilities will continue to be authorized as long as permit holders comply with the terms of their permits, and actual use continues. Current regional policy is to discourage the issuing of new permits for water transmission lines, so as not to limit National Forest management options upstream of such facilities.

Utility lines. Underground utility lines may need to be replaced periodically. The corresponding ground disturbance will vary with the terrain.

Private Commercial Hydroelectric Facilities. The Packwood Lake WPPSS facilities operate under a Federal Energy Regulatory Commission (FERC) license. The first phase of the relicensing process will begin in 2005, and is expected to take several years to complete. The Forest Service will be involved in the process, to assess the past, current, and future impacts to

National Forest lands, and to determine how the license can contribute to the mitigation of these impacts.

Private use of National Forest roads. The Forest Service is required by law to allow access across National Forest land for the benefit of adjacent private lands, when such access is deemed reasonable.

Terrestrial Elements

Disturbance Regimes

The Role of Fire

Currently, the watershed is outside the natural condition for fire "effects". Past harvest activity in the watershed has been extensive, resulting in the loss of certain structural elements, such as snags, large down coarse woody debris, and possibly duff layers. Additionally, only 2% of the analysis area has had a stand replacing fire event in the 87 years since 1910. This is far below the 50% of the area that experienced stand replacing fires during the previous 110 years. The reduction in stand replacing fire has contributed to the loss of meadows to conifer encroachment.

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 was of such magnitude as to adversely affect the ecosystem. However, these events could have been masked by wildfires that occurred in conjunction with them.

Balsam woolley adelgid occurrences/outbreaks have the potential to be rather large. Although we have no record of large outbreaks of this insect in this watershed, it has happened on the Gifford Pinchot National Forest (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.

White pine blister rust occurrences/outbreaks could also be rather impactive, but in a different way. The host tree, western white pine, is not a major component of most stands in this watershed. It is usually a lesser, somewhat scattered, associated species in mixed-species stands, and does not occur in large numbers (relatively speaking) in this watershed. There are a few exceptions. On occasion, significant numbers of western white pine (mostly with stock that is believed to be resistant to white pine blister rust) have been planted in young managed stands infected with laminated root rot due to its tolerance of the disease. A potential problem is increased white pine mortality which may threaten its continued existence, over time, in this watershed. The odds of that happening are unknown.

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. Disease infections generally move slowly and inexorably through the forest. In this watershed, root disease occurrences are generally small in size (<1 acre to 15+ acres), and the number of infection centers across parts of this watershed (while generally small in size) can be quite high. The severity of disease occurrences in this watershed ranges from very low to very high, and for most diseases is most often in the very low to moderate range. But for laminated root rot, severity can often be in the high to very high range.

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.

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 killing them) 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 the event of a large windthrow event or wildfire, especially if there was no significant salvage of the dead/down material.

Laminated root rot is expected to continue killing trees 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 his 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 portion of the watershed (see Map 22, Terrestrial Concerns) in the vicinity of the Cowlitz River valley (lower Davis Creek, lower Karr Creek, middle and lower Willame Creek, middle and lower Skate Creek, middle and lower Butter Creek, lower Dry Creek, lower Smith Creek, Hinkle Tinkle Creek, lower Coal Creek, lower Lake Creek, Snyder Creek, lower Hager Creek, and middle and lower Johnson Creek), as well as the forested portion of the private/state lands along the Cowlitz River.

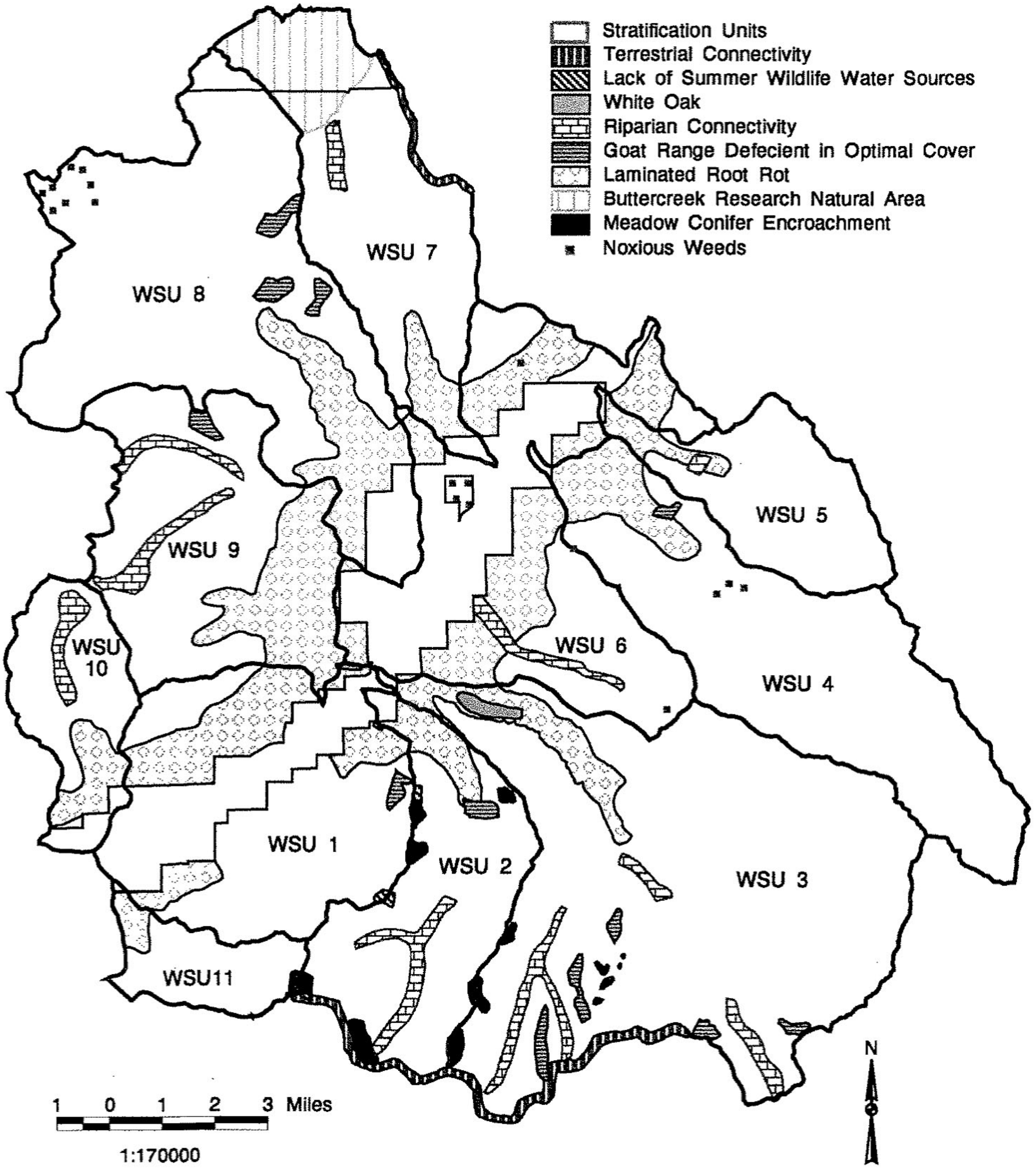
In the recent past (1980's and 1990's) efforts have been made to reduce the level and spread of laminated root rot where we can, through the regeneration harvest of infection centers, followed by the planting of intermediately susceptible, tolerant, resistant, or immune tree species to grow for a rotation. The Forest Service is attempting to manage regenerated infection centers with a mix of tree species less susceptible to the disease, thereby slowing or limiting its damage and spread.

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 above naturally occurring levels in this watershed. Prior to the start of timber harvest activities in the late 1940's/early 1950's it appears (from looking at the 1959 aerial photos) 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 smaller patches.

Map 22

UPPER COWLITZ WATERSHED ANALYSIS
Terrestrial Concerns



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 1997). 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 for this watershed. It would be erroneous to conclude that the differences described between forest vegetation in 1880 and 1997 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 not drastically different than those found in 1880 (see Table 4-1 below). From 1880 to 1997, the dominance of forest vegetation has shifted from grass/pole forest and small tree forest to small tree forest and large tree forest. During this period, three primary factors have influenced forest vegetation structure: 24,324 acres of regeneration timber harvest within the last 50 years, a large wildfire in portions of WSU's 1,2 and 3, and forest growth. The amount of large tree forest has increased in this watershed by 5,978 acres 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 117 years.

Table 4-1: Comparison of Historic and Current Vegetation by Structural Stage

Structural Stage	Year 1880		Year 1997	
	Acres	%	Acres	%
Grass/Pole	44,370	29	32,697	21
Small Tree	41,815	27	44,465	29
Large Tree	37,606	24	43,584	28
Non-Forest	31,665*	20	34,710*	22

* *Note: The difference in these two non-forest acreage figures is due to the fact that there were areas of current private/state land that were forested before the Euro-American settlers arrived. But since their arrival those areas have been converted to permanent non-forest acres (e.g., fields/pastures, towns, homesites, etc.).*

With the advent of fire suppression activities in the 1930's, the number of acres lost to wildfire has dropped substantially. This meant that the large grass/pole forest component of 1880 moved undisturbed into the small tree condition of today. The amount of grass/pole forest in 1997 is primarily attributed to regeneration harvest activity. Regeneration harvest acted as a surrogate for wildfires.

A major difference exists in the location, size, timing of initiation, structure, and shape of the grass/pole forest patches created by timber harvest from the grass/pole forest patches that would have been created by naturally-occurring wildfire events. The grass/pole patches resulting from clearcut harvest and broadcast burning contain very few contain 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, (and eventually large tree 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 these existing grass/pole stands over time.

The small tree forest forms the largest, most connected, and least fragmented patches in the watershed. However, its connected and unfragmented nature is not nearly as well connected and unfragmented as it was in 1880. In 1997, the size of large, intact patches of large tree forest has been greatly reduced since 1880. Between the late 1940's/early 1950's and today, most of the large, unfragmented, and connected large tree forest patches have been highly fragmented, disconnected, and isolated by high concentrations of clearcut regeneration harvest. The 1997 landscape displays a much-reduced connectivity (in number, width, and size of connections) between large tree forest patches when compared to the 1880 landscape.

The nature of many of these currently narrow, gangly, (and often 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 recreate larger, more connective patches of large tree forest that will have structural and spatial characteristics more like those found in the watershed before the advent of clearcut regeneration harvest.

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 timber harvest and wildfire suppression.

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 contains a significant amount of Late Successional Reserve (LSR) where essentially no regeneration harvest is anticipated. Only treatments such as precommercial thinning and commercial thinning in stands up to 80 years of age are permitted. Over the next few decades, much of the grass/pole forest in the LSR (the vast majority of it being located in portions of WSU's 3, 4, 5, 6, 7, and 8) will become small tree forest. Much of the current small tree forest will succeed to large tree forest. This largely undisturbed succession of structural stages, (assuming the continued absence of large wildfires) will also occur in other land allocations that currently do not allow regeneration harvest (e.g., Riparian Reserves, Unroaded Recreation Without Timber Harvest, Wilderness).

In the Matrix and Adaptive Management Area allocations 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. Although the overall amount of timber harvest in the watershed has declined (and will in all likelihood remain relatively low in the future), that 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 will likely be nearly as high as it was prior to the advent of the Northwest Forest Plan.

The forest vegetation link across the Cowlitz River valley (which stretches across the entire middle of this watershed) has been largely broken and/or dramatically altered since 1880. It now consists principally of grass/pole forest broken by fields, pastures, a town, homesites, and a major U.S. highway. The forest vegetation on those private/state-owned acres in the river valley will very likely never reach the large tree forest condition (as defined by the Forest Service). At best, those forest acres will largely remain some mixture of grass/pole and small tree forest with very little structural or vegetation species diversity due to the forest management regimes of the entities that own those acres.

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 1,000 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, and timber production, etc.). There are currently about 1,870 acres of known/documented precommercial thinning needs in this watershed. There are an estimated 3,000 to 4,000 acres currently or soon to be in need stocking control (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 and thus do not accurately portray the distribution of these species across the landscape. Unique habitats supporting white oak (*Quercus garryana*) have the potential to support some species of TES plants, however these areas are not currently mapped as discrete polygons within the existing GIS vegetation layer. These areas have been approximated by hand on mylar working maps, and are displayed in Map 22, Terrestrial Concerns.

Of the eleven known sites of TES plants within the analysis area, seven are partially protected by virtue of the land allocation (Late Successional Reserve) 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 late successional reserve. The remaining four sites are located within the Cispus Adaptive Management Area and are currently vulnerable to management activities that might occur in those areas. 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	WSU	Land Allocation	Status
Pleuricospora fimbriolata	1	Adaptive Management Area	Vulnerable
Orobanche pinorum	1	Adaptive Management Area	Vulnerable
Orobanche pinorum	1	Adaptive Management Area	Vulnerable
Pleuricospora fimbriolata	4	Late Successional Reserve	Partially Protected
Pleuricospora fimbriolata	4	Late Successional Reserve	Partially Protected
Pleuricospora fimbriolata	4	Late Successional Reserve	Partially Protected
Pleuricospora fimbriolata	4	Late Successional Reserve	Partially Protected
Orobanche pinorum	4	Late Successional Reserve	Partially Protected
Orobanche pinorum	6	Late Successional Reserve	Partially Protected
Orobanche pinorum	7	Late Successional Reserve	Partially Protected
Pleuricospora fimbriolata	11	Adaptive Management Area	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 change during the planning phase of management activities, this information is not pertinent here.

Survey and Manage Botanical Species

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 has been described within Chapter 3 of this report. In 1880 (the time period chosen to represent historic vegetation) approximately 23% of the National Forest lands within the analysis was in a large-tree or late-successional stage. Currently (1997), approximately 29% of National Forest lands support late-successional habitats. While this increase in habitat acres would appear to benefit late-successional dependent species, other important factors such as the pattern and distribution of habitat must also be considered. The current distribution of habitat late-successional habitat is much more fragmented than what was known from 1880 and patch sizes are generally much smaller. Refer to Chapter 3, "Forest Vegetation" for a thorough comparison of historic and current conditions of vegetative landscape patterns.

No specific surveys for survey and manage species have been conducted within the analysis area. Known sites are not based upon thorough surveys and thus do not accurately portray the distribution of these species across the landscape.

Known sites of *Allotropa virgata* within WSU's 6 and 9 were located during the TES plant surveys for the proposed Willame Timber Sale. Management recommendations for this species are currently being developed within the Region, but have not been approved for use at this time. Until such measures have been finalized, it is recommended that known sites be protected from adverse impacts. A similar situation exists for *Tholurna dissimilis* until formal management recommendations are approved. Table 4-3 provides a summary of the vulnerability of known survey and manage plant 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	WSU	Land Allocation	Status
Tholurna dissimilis	2	Adaptive Management Area	Vulnerable
Allotropa virgata	6	Matrix	Vulnerable
Allotropa virgata	9	Matrix	Vulnerable
Allotropa virgata	9	Matrix	Vulnerable
Allotropa virgata	9	Matrix	Vulnerable
Allotropa virgata	9	Matrix	Vulnerable

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 FSM 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 requiring 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 sites have been identified where an effort should be made to prevent weed populations from becoming established. These sites (shown in Map 22, Terrestrial Concerns) include high quality wetland habitats, access points to Research Natural Areas, and trailheads leading into wilderness areas where heavy stock use has been recorded. The following is a preliminary list of sites that meet the previous definition:

1) Bear Prairie and associated palustrine emergent wetlands (near FR 5220).
2) The "Boneyard" swamp.
3) Access point to the Butter Creek Research Natural Area (end of FR 5270).
4) Trailhead to Packwood Lake, and camping area at the lake.
5) Trailhead to Tatoosh Wilderness (off FR 5292).
6) Trailhead into Lily Basin, Goat Rocks Wilderness (off FR 48-122).

These (and similar) sites are high priority areas for future surveys to determine potential threats from noxious weeds. If populations of weeds are found at these areas it is recommended that control measures be implemented as soon as possible to protect unique resources.

Wildlife

This section is grouped by watershed stratification units. Due to the nature of wildlife habitat and species movements, several WSU's fall within a single "concern category", such as big game winter range, riparian connectivity, fragmentation, etc. Areas of concern for each WSU within the upper Cowlitz watershed are summarized in Table 4-4. The following abbreviations were used:

DEWR Deer and elk winter range optimal cover acreage below Amendment 11 goals over the entire watershed but are more problematic in these WSU's.

MGR Mountain goat optimal cover acreage below Amendment 11 goals due to timber harvests of optimal cover and natural fires.

CONN WSU contains an important riparian travel corridor with fragmented late-successional habitat

FRAG Large-tree habitat in WSU is fragmented, reducing habitat capability for dependent species.

MM WSU is within Zone 2 and/or Critical Habitat for the marbled murrelet.

NSO WSU contains northern spotted owl habitat within owl home range(s) that have been reduced below "incidental take" threshold.

CLUS WSU contains a high density cluster of spotted owl pairs or singles

TES Known nest, den, or occurrence site of TES, or other protected species requiring site-specific protection.

MEH Meadow habitat disappearing due to conifer encroachment

Table 4-4: Wildlife Habitat and Species Concerns by WSU

WSU	DEWR	MGR	CONN	FRAG	MM	NSO	CLUS	MEH	TES
1	X	X						X	X
2	X	X	X	X		X	X	X	X
3		X	X	X		X	X	X	X
4		X							X
5		X							X
6	X		X	X	X				X
7	X	X			X	X			X
8		X			X	X			X
9		X	X	X	X				X
10			X	X	X				X

Table 4-4: Wildlife Habitat and Species Concerns by WSU

WSU	DEWR	MGR	CONN	FRAG	MM	NSO	CLUS	MEH	TES
11				X				X	X

Fire and Habitat Enhancement

Concerns have been raised about the loss of sub-alpine and alpine meadow habitat due to conifer encroachment in the upper Cowlitz watershed and middle and upper Cispus watersheds. These meadows appear to be important foraging habitat for mountain goats and are also used by the yellow-bellied marmot and numerous neotropical bird species.

Over approximately the last 50 years, the Forest Service has actively fought and suppressed fires as they occurred on National Forests. As a result, some meadows within this watershed have shown a marked reduction in open meadow acreage (Kogut, 1996). A comparison of 1959 and 1993 aerial photos shows an increase in the presence of conifer trees. The most noticeable loss of meadow habitat is near Stonewall Ridge (WSU 3), Southpoint Ridge (WSU's 2,3), and Smith Ridge (WSU's 1,2). The long-term trend is a reduction in open meadow habitat unless prescribed or natural fire, or mechanical means such as chainsaws are considered.

An opportunity exists to develop a plan to allow some natural fires to burn within selected areas under a defined set of conditions. The same results could be achieved using prescribed fire via trained fire-fighting specialists for ignition, containment and mop-up as needed. Certain risks are involved, including the spread of fire beyond the desired area. While the use of fire may be appropriate, conifer encroachment could also be controlled using mechanical means such as chainsaws or hand clippers to remove smaller seedlings. This would remove the overstory but would not rejuvenate native grasses, forbs, and shrubs, as compared to a fire.

The southwest portion of the watershed falls within the boundaries of the Cispus AMA. The AMA plan, nearing completion, will contain a landscape design, a series of management strategies and related learning opportunities. The AMA plan provides a unique opportunity to experiment with fire and monitor its effectiveness in maintaining habitats for wildlife species. Partnerships could be developed with other agencies to secure funding sources for implementation and monitoring.

Other Wildlife Habitat Enhancement Opportunities

The lack of a permanent water source on Smith Ridge may be limiting full utilization of its wildlife habitat potential. From preliminary field reconnaissance, it appears that following snowmelt, there are no springs, streams, or ponds which would serve as watering sources for wildlife species (Kogut, *pers com.* 1997). More field reconnaissance is needed to determine what types of water catchment systems would be appropriate if the need is confirmed. Again, funding sources could be obtained through cooperative agreements or challenge-cost share projects.

A large herd of elk winters in the High Valley Park housing development north of the town of Packwood. In this area, known as the Boneyard Swamp, there is an opportunity to conduct a small burn to enhance forage availability, particularly during the spring months prior to the elk calving season in June.

Aquatic Elements

Disturbance Regimes

Geologic 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 get out of the way in time. Mount St. Helens has erupted, on average, once per century over the last 500 years, and that at least two of these eruptions have deposited ash and tephra across the upper Cowlitz 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 *et al.* 1995a). 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 traveled down the Cowlitz River drainage less often than other major drainages such as the White River, Puyallup, and Nisqually rivers (Scott *et al.* 1995a).

Seismic activity in the area can also be expected to continue, usually in the form of smaller earthquakes (Magnitude 0.5 to 3.0) but with occasional larger earthquakes greater than M 3.0. Larger earthquakes can pose the additional hazard of causing landslides that either directly effect human habitations, or block stream drainages that then form dam break floods along stream channels. Most of the major stream valleys in the upper Cowlitz watershed have small communities near their confluence with the Cowlitz River that would be vulnerable to such an event.

Mass Wasting

Mass wasting in the form of large landslides has been occurring in the Butter/Skate/Lake Creek drainages 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. Site specific investigation is required to further refine areas of these slides that are active/dormant/past active.

A number of shallow, rapid landslides have been observed in the Willame Creek drainage since at least the early 1970's. Many have been linked to roads and/or timber harvest. Increased levels of mass wasting related to roads and timber harvest have also occurred throughout the Deception Creek, Smith Creek, Skate Creek, and Kilborn Creek drainages. In particular, 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, roads in the Willame, Skate, Lake, Deception, Smith, and Kilborn Creek drainages have been identified as concerns. Listed below, by watershed, are roads noted for needing some type of restoration work. This listing is not all inclusive, but does identify a majority of road restoration projects.

WSU 1 No roads on Federal land are a concern. However, private landowners should be aware of naturally occurring slides and debris flows that occasionally originate from steep forested slopes, particularly on the south side of the valley.

WSU 2 2010

WSU 3 2130 (not yet surveyed, but historically a problem area)

WSU 4 1266, -041, -069, -076, 1262, 4830-066

WSU 5 4610, 4610-041, -072, -405

WSU 6	48, 4830, 4840, 4840-024, 1262-029, 4610 south of Purcell Creek
WSU 7	5270 (last mile), 5270-066
WSU 8	4720, 4745, 5240, 5260 (not yet surveyed, but suspect)
WSU 9	1256, -100, 47, 47-011, -410 (on Skyo Mt.), 4710, 4725-023, 4740, -013, 4745
WSU 10	63-057
WSU 11	2304 (some restoration has already been done; future road condition surveys may disclose further work needs).

Hydrology

Rain-on-snow/Peakflows and Flooding

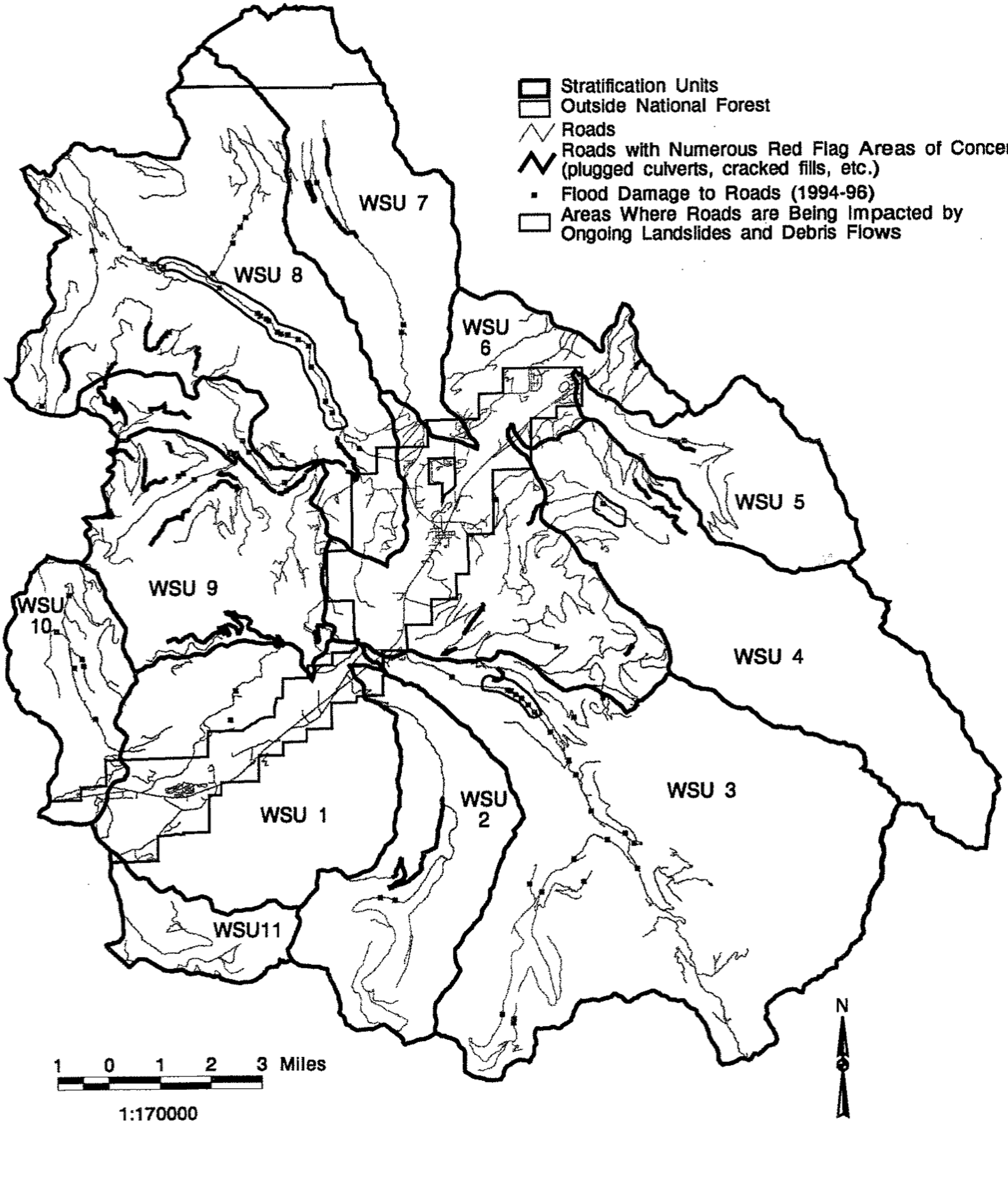
Peak flow events associated with heavy, warm, rain-on-snow events will continue to occur at estimated 30-50 year intervals at the entire analysis area scale. Specific sites within WSU's and 6th field areas, with relatively high rain-on-snow (>30%) area concentrations, may experience more frequent peak flows associated with precipitation events. Two- to five-year peak flow magnitude is expected to *decrease* in areas of the National Forest which were extensively clearcut, as the vegetation recovers and road systems are either stabilized, naturally revegetated, decommissioned, or storm-proofed.

In areas outside of National Forest lands, peak flow augmentation may persist due to continued timber harvest. Increased peak flows are a concern in both the lower Dry Creek (WSU 1) and the Hager/Snyder basins (WSU 6), along the mainstem Cowlitz River. High concern areas outside of National Forest lands are located between RM 114 and 133 where aggravated streambank erosion and sediment transport will result in damage to private property and National Forest infrastructure.

Within National Forest lands, peak flow occurrence is expected to *decrease* in areas that had previously been subject to high volumes of timber harvest. These areas include Johnson Creek (WSU 3), Lake Creek (WSU 4), Coal Creek (WSU 5), and Butter Creek (WSU 7). Significant portions of these areas are also located in the Goat Rocks and Tatoosh Wilderness, and the southern tip of the Mt. Rainier National Park.

Map 23

UPPER COWLITZ WATERSHED ANALYSIS
Aquatic Concerns - Road Conditions



Impacts from peakflow events will increase in both magnitude and frequency in the following federal and non-federal subwatersheds:

- Dry Creek (WSU 1)
- Karr Creek (WSU1)
- Burton Creek (WSU 1)
- Garrett Creek (WSU 1)
- Mainstem Willame (WSU 9)
- West Fork Willame (WSU 9)
- North Fork Willame (WSU 9)
- Lilian Creek (WSU 9)
- Davis Creek (WSU 10)
- Kilborn Creek (WSU 11)

Water Temperatures

Water quality is expected to decrease in the following areas due to sediment input and domestic pollution, as indicated by increased temperatures from limited spot and trend data. Water temperatures are expected to be most strongly affected by human activities in the following areas:

- Lower Johnson Creek (WSU 3) (RM 0 - 0.8)
- Lower Lake Creek (WSU 4) (RM 0 - 4.0)
- Lower Butter Creek (WSU 7) (RM 0 - 1.0)
- Lower Skate Creek (WSU 8) (RM 0 - 2.5)
- North Fork Willame Creek (WSU 9) (RM 0 - 4.0)

Packwood and Willame Lakes have exceeded Washington State temperature standards for Class AA waters in the past. Water quality in 6th-field subwatersheds on National Forest land, and in smaller stream channels previously subject to riparian harvest, is expected to increase over time due to vegetative recovery, watershed restoration efforts, fish habitat improvements and increased canopy closure within the riparian corridor. Water temperatures within the analysis area, particularly on National Forest lands, will continue to be considerably lower than those downstream of the analysis area (middle Cowlitz watershed). National Forest lands will become increasingly important in maintaining downstream water temperatures and preventing further degradation of water quality as impacts from human activities and development continue.

Riparian Conditions

There are a total of 52,282 acres in the riparian corridor within the entire analysis area, of which 15% consists of grass/pole structural stage. The most significant improvements in riparian area structure class are expected to occur on National Forest lands where the predominant riparian structure class is non-forest, grass/pole, or small-tree. These areas include: Smith Creek (WSU 2); portions of Johnson Creek (WSU 3); the lower segment of Lake Creek (WSU 4); the lower portions of Coal Creek (WSU 5); parts of Butter Creek not within the Tatoosh Wilderness (WSU 7); Skate Creek (WSU 8); the North Fork, West Fork and main Willame Creek areas (WSU 9); Davis Creek (WSU 10); and Kilborn (WSU 11) watershed areas. The amount of large-tree structural class within the above mentioned areas is expected to improve over time, based on altered timber sale approaches. The non-federal portions of Dry (WSU 1) and Hall (WSU 6) in the main Cowlitz River basin, and lower Skate Creek (WSU 8) drainage areas, are expected to maintain a moderately high percentage of younger-aged stands, based on future timber harvest by the State of Washington and private landowners. The portion of lower Butter Creek (WSU 7) outside of National Forest land is expected to remain residential, with almost no riparian vegetation.

The recovery of riparian vegetation on National Forest land will be most evident in areas where a large portion of past riparian timber harvest has occurred. The greatest change is expected in the following areas:

- Upper Smith Creek (WSU 2) (RM 3.5 - 7.0)
- Mainstem Johnson Creek (WSU 3) (From Glacier Creek to Wright Lake)
- Deception Creek (WSU 3) (RM 1.2 - 4.0)
- Lower Hager Creek (WSU 6) (RM 0.3 - 1.0)
- North Fork Willame Creek (WSU 9) (RM 4.0 - 5.0)
- West Fork Willame Creek (WSU 9) (RM 0.5 - 3.0)

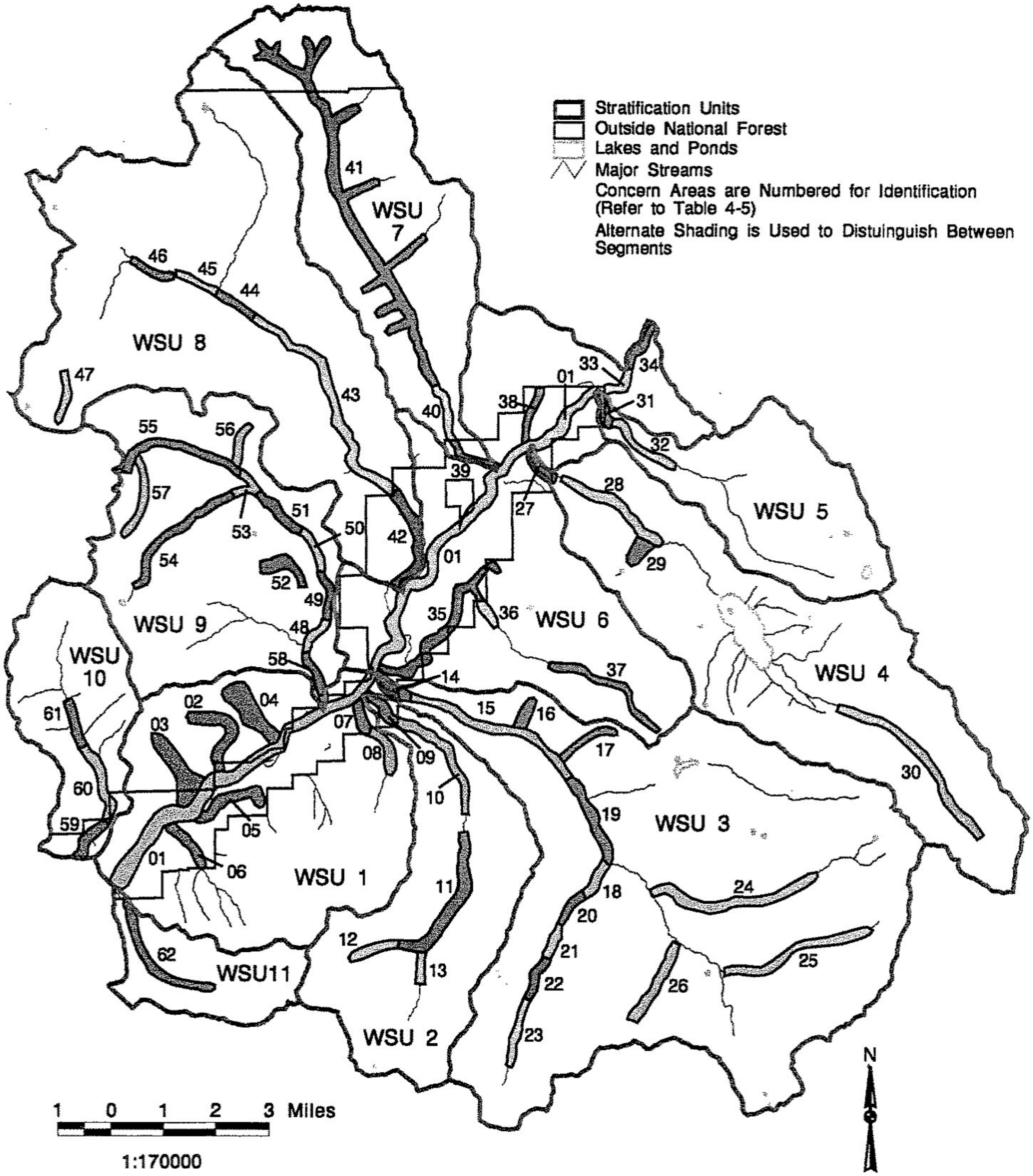
Riparian vegetation within the Goat Rocks and Tatoosh Wilderness areas and the southern tip of Mt. Rainier National Park is expected to change only in response to natural processes such as disturbance (e.g. fire) or succession. The following areas are included in this category:

- Glacier Creek (WSU 3)
- Middle Fork Johnson Creek (WSU 3)
- Jordan Creek (WSU 3)
- Upper Lake Creek (WSU 4)
- Upper Coal Creek (WSU 5)
- Much of the east side of Butter Creek (WSU 7)

Within alpine areas characteristic of steep mountains, typically 15% - 20% of the riparian area is located in debris chutes. Existing stands in these areas are less likely to develop into a mature structural class. Within the Goat Rocks and Tatoosh Wilderness, such areas are present in the following creeks:

Map 24

UPPER COWLITZ WATERSHED ANALYSIS
Aquatic Concerns - Flow Conditions



- Glacier Creek (WSU 3)
- Middle Fork Johnson Creek (WSU 3)
- Jordan Creek (WSU 3)
- Upper Lake Creek (WSU 4)
- Upper Butter Creek (WSU 7)

Outside of National Forest lands, the condition of riparian areas is expected to improve at a much slower rate (if any) due to future vegetative disturbance. Activities such as private timber harvest and cattle grazing affect the age, size, and species composition of riparian vegetation. The following areas may experience the highest level of impacts in the future:

- In state and private lands along the main Cowlitz River (WSU's 1 and 6)
- Lower Burton Creek (WSU 1) (RM 0 - 1.5)
- Lower Garrett Creek (WSU 1) (RM 0 - 1.3)
- Lower Dry Creek (WSU 1) (RM 0 - 1.0)
- Lower Smith Creek (WSU 2) (RM 0 - 0.8)
- Lower Johnson Creek (WSU 3) (RM 0 - 0.8)
- Lower Lake Creek (WSU 4) (RM 0 - 0.7)
- Lower Coal Creek (WSU 5) (RM 0 - 0.5)
- Upper Cowlitz Floodplain (WSU 6)
- Hall Creek (WSU 6) (RM 0 - 2.5)
- Lower Hager Creek (WSU 6) (RM 0 - 0.3)
- Lower Butter Creek (WSU 7) (RM 0 - 1.2)
- Lower Skate Creek (WSU 8) (RM 0 - 2.5)
- Davis (WSU 10) (RM 0 - 1.0)

Riparian conditions within the following areas, on National Forest lands, are either currently poor or may experience the greatest impacts from future management activities:

- Smith Creek (WSU 2, within AMA)
- Upper and Middle Fork Johnson Creek (WSU 3, within matrix)
- Deception Creek (WSU 3, within matrix)
- Mission Creek (WSU 3, within matrix)
- Lower Synder Creek (WSU 6) (RM 0 - 0.1)
- North Fork Willame Creek (WSU 9) (RM 0.5 - 4.0)
- Skate Creek (WSU 8) (RM 2.5 - 9.7)
- West Fork Willame Creek (WSU 9) (RM 0.5 - 3.0)
- Mainstem Willame Creeks (WSU 9)

Connectivity

It is expected that stream channel connectivity will be adversely affected by future road placement and the influence of management activities on stream channel systems. Within the analysis area, stream channel connectivity will remain lowest on state and private lands. Connectivity will remain poor on the following non-federal lands:

- Lower Cowlitz floodplain area (WSU 1)
- Upper Cowlitz floodplain area (WSU 6)
- Lower Burton Creek (WSU 1) (RM 0 - 1.5)
- Lower Garrett Creek (WSU 1) (RM 0 - 1.3)
- Dry Creek (WSU 1)
- Lower Smith Creek (WSU 2) (RM 0 - 0.8)
- Hall Creek (WSU 6)
- Skate Creek (WSU 8)
- Lower Davis Creek (WSU 10) (RM 0 - 1.0)

On National Forest land, connectivity is expected to remain poor in the following areas:

- Smith Creek (WSU 2) (RM 5.5 - 6.0)
- Deception Creek (WSU 3) (RM 1.0 - 1.5 and RM 2.0 - 4.0)
- Jennings Creek (WSU 3)
- Hager Creek (WSU 6)
- Hinkle Tinkle Creek (WSU 6) (RM 0 - 1.0)
- Skate Creek (WSU 8) (RM 2.5 - 9.7)
- North Fork Willame Creek (WSU 9) (RM 0.5)
- West Fork Willame Creek (WSU 9) (RM 0.5)

Inner Gorge

Sideslope failure is expected to continue in the future, especially within upper headwall portions of secondary stream channels. Within the upper Cowlitz watershed, inner gorge failures are expected to play a continuous role in high sediment delivery in the following areas:

- Dry Creek (WSU 1) (RM 1.0 - 2.0)
- Smith Creek (WSU 2) (RM 1.0 - 3.0)
- Lower Johnson Creek (WSU 3) (RM 0.8 - 5.0)
- Deception Creek (WSU 3) (RM 0.1 - 0.6)
- Lower Lake Creek (WSU 4) (RM 1.0 - 3.5)
- Coal Creek (WSU 5) (RM 0.5 - 2.5)
- Main upper Cowlitz (WSU 6) (RM 131.5 - 132.5)

- Lower Butter Creek (WSU 7) (RM 1.2 - 2.2)
- Skate Creek (WSU 8) (RM 2.5 - 8.4)
- Lower Willame Creek (WSU 9) (RM 0.4 - 1.2)
- Davis Creek (WSU 10) (RM 1.0 - 3.5)
- Kilborn Creek (WSU 11) (RM 0.5 - 3.0)

Flood Plain

Flooding events associated with rain-on-snow events or scattered high peak flows are expected to continue to impact the existing floodplain conditions, especially in areas strongly affected by existing or future riparian stand age alterations. Such areas primarily consist of scattered patches of non-Federal lands, including the following:

- Cowlitz River (WSU's 1 and 6)
- Main Johnson Creek (WSU 3) (RM 0 - 0.8)
- Skate Creek (WSU 8) (RM 0 - 2.5)
- Main stem Willame Creek (WSU 9) (RM 0 - 0.3)
- Davis Creek (WSU 10) (RM 0 - 1.0)

Within National Forest lands, flooding events are expected to continue to impact scattered flood plain areas, including the following:

- Smith Creek (WSU 2) (RM 4.5 - 5.0)
- Johnson Creek (WSU 3) (RM 0.8 - 6.0)
- Deception Creek (WSU 3) (RM 0 -2.5)
- Skate Creek (WSU 8) (RM 2.5 - 9.0)
- Main Willame Creek (WSU 9) (RM 0.3 - 5.0)

Flooding frequency is expected to remain relatively constant in areas located primarily within Mt. Rainier National Park and the Goat Rocks and Tatoosh Wilderness.

Large Woody Debris

LWD recruitment potential in the upper Cowlitz basin is expected to remain constant, similar to pre-1880 conditions in the Middle Fork Johnson, Glacier, and Jordan Creeks (WSU 3), as well as Upper Lake Creek (WSU 4), upper Coal Creek (WSU 5), and upper Butter Creek (WSU 7), subwatersheds located in either the Goat Rocks or Tatoosh Wilderness areas.

Within non-federal lands, LWD recruitment is expected to remain low due to human developments, road placement, range lands and cattle grazing. Such areas include the following:

- Lower Cowlitz floodplain area (WSU 1)
- Lower Burton Creek (WSU 1) (RM 0 - 1.5)
- Lower Garrett Creek (WSU 1) (RM 0 - 1.3)
- Lower Dry Creek (WSU 1) (RM 0 - 0.7)
- Lower Smith Creek (WSU 2) (RM 0 - 0.8)
- Lower Johnson Creek (WSU 3) (RM 0 - 0.8)
- Lower Lake Creek (WSU 4) (RM 0 - 0.7)
- Lower Coal Creek (WSU 5) (RM 0 - 0.5)
- Upper Cowlitz floodplain area (WSU 6)
- Hall Creek (WSU 6)
- Lower Hager Creek (WSU 6) (RM 0 - 0.3)
- Lower Snyder Creek (WSU 6) (RM 0 - 0.1)
- Lower Hinkle Tinkle Creek (WSU 6) (RM 0 - 1.0)
- Lower Butter Creek (WSU 7) (RM 0 - 1.2)
- Lower Skate Creek (WSU 8) (RM 0 - 2.5)
- Mainstem Willame (WSU 9) (RM 0 - 0.3)
- Lower Davis Creek (WSU 10) (RM 0 - 1.0)

Within National Forest land, future LWD recruitment into stream channels will continue to be restricted by a low level of stream channel connectivity and the presence of grass/pole and small-tree stands in the following areas:

- Smith Creek (WSU 2) (RM 3.5 - 6.0)
- Deception Creek (WSU 3) (RM 1.0 - 1.5 and RM 2.0 -4.0)
- Jennings Creek (WSU 3) (RM 0 - 1.2)
- Johnson Creek (WSU 3) (RM 0.8 - 11.5)
- Lake Creek (WSU 4) (RM 0.8 - 6)
- Hager Creek (WSU 6) (RM 0.3 - 1.0)
- Butter Creek (WSU 7) (1.2 - 8.0)
- Skate Creek (WSU 8) (RM 2.5 - 9.7, RM 11.0 - 12.0)
- North Fork Willame Creek (WSU 9) (RM 0.5 - 4.0)
- West Fork Willame Creek (WSU 9) (RM 0.5 - 3.0)
- Mainstem Willame Creek (WSU 9) (RM 0.5 - 1.0, RM 4.0 - 5.0)

The following areas are expected to continue as high LWD sources due to the presence of mature stands and high connectivity:

- Upper Dry Creek (WSU 1)
- Upper Burton Creek (WSU 1)
- Upper Garrett Creek (WSU 1)
- Glacier Creek (WSU 3)

- Middle Fork Johnson Creek (WSU 3)
- Jordan Creek (WSU 3)
- Upper Lake Creek (WSU 4)
- Coal Creek (WSU 5)
- South Fork Willame Creek (WSU 9)
- Upper Davis Creek (WSU 10)

Future LWD recruitment is expected to improve due to a reduced level of riparian stand age management (resulting in improved connectivity) in the following subwatersheds on National Forest lands:

- Smith Creek (WSU 2)
- Mainstem Johnson Creek (WSU 3)
- Deception Creek (WSU 3)
- Lower Lake Creek (WSU 4)
- Coal Creek (WSU 5)
- Hager Creek (WSU 6)
- Hinkle Tinkle Creek (WSU 6)
- Upper Butter Creek (WSU 7)
- Skate Creek (WSU 8)
- North, West and mainstem Willame Creek (WSU 9)
- Kilborn Creek (WSU 11)

In areas where past timber stand management has strongly impacted the riparian corridor (e.g. within tributary stream channels on National Forest lands and the main upper Cowlitz River system on private and state lands), woody material will continue to be short in length and small in diameter. Such areas consist of the lower Burton, Garrett, Karr, and Dry Creeks of WSU 1 and the lower portions of Hager, Snyder, and Hinkle Tinkle Creeks within WSU 6. Through catastrophic delivery, such as debris torrents, woody material, unless caught in log jams, will be transported out of the main upper Cowlitz River between RM 114 and 132.5.

The input of large woody material from non-federal lands will continue to be low due to human development. It will be decades before inputs from these areas will be of sufficient size to remain stable in the channel for the long-term. Instream wood in the mainstem Cowlitz River, will continue to occur in jams at stream-bends, with individual pieces transported annually. Human removal of in-channel large woody material in the mainstem is increasing, emphasizing the importance of existing wood.

Stream Channel Width/Depth Ratio Alteration

Alteration of stream channel types is most likely in areas with a high level of vegetative disturbance, highly disturbed riparian zones, frequent peak flow occurrence, and areas of active sediment-rich sideslope failures. Future width/depth ratios are expected to remain poor in the following areas:

- Mainstem Cowlitz River (WSU 1 and 6)
- Upper and Lower Smith Creek (WSU 2)
- Lower Johnson Creek (WSU 3)
- Deception Creek (WSU 3)
- Lower Butter Creek (WSU 7) (RM 0 - 1.2)
- Little Johnson Creek (WSU 8)
- Skate Creek (WSU 8) (RM 2.5 - 9.7)
- Mainstem Willame Creek (WSU 9) (RM 3.0 - 4.0)
- West Fork Willame Creek (WSU 9) (RM 0 - 2.0)
- North Fork Willame Creek (WSU 9) (RM 0 - 0.5)
- Lillian Creek (WSU 9)
- Davis Creek (WSU 10) (RM 0 - 1.0, 2.5 - 3.5)

Alterations in the stream channel are expected to be dominated by changes in substrate and the width/depth ratio. Confined reaches are expected to be stable and less prone to alterations of stream channel sedimentation and the associated change in width/depth ratio. Reach fluctuations, over time, will continue in unconfined reaches. The future width/depth ratios are expected to improve on the following stream channel reach areas on National Forest land:

- Burton Creek (WSU 1)
- Smith Creek (WSU 2)
- Johnson Creek (WSU 3)
- Mission Creek (WSU 3)
- Butter Creek (WSU 7)

Channel and Streambank Stability

Over the next 15 to 20 years, bank erosion is expected to be most evident in the Willame and Smith subwatersheds. Alluvial erosion is expected to be highest in the mainstem of Johnson (WSU 3), Skate (WSU 8), Willame (WSU 9) and Davis (WSU 10) Creeks for the next 15-30+ years. Changes in the estimated time-frame will largely be based on future upslope vegetative conditions (Benda, *personal communication,* 1997).

Areas of channel and streambank instability, as a result of local silty volcanic rich deposits, within non-federal lands include:

- Mainstem Cowlitz River (WSU 1 and 6) (RM 114-132.5)
- Lower Butter Creek (WSU 7) (RM 0 - 1.2)

Stream channels and banks on National Forest land in the upper Cowlitz watershed which are expected to continue to be unstable due to the high percentage of unstable soils in the subwatershed include:

- Karr Creek (WSU 1)
- Smith Creek (WSU 2)
- Upper Lake Creek (WSU 4)
- Lillian Creek (WSU 9)
- West and North Forks Willame Creek (WSU 9)
- Davis Creek (WSU 10) (RM 2.5 - 3.5)

Impacts from channel scour are expected to decrease in stream channels in the following watershed areas. These areas were strongly impacted by 1996 combined rain-on-snow erosional events, intensified by heavy road stacking and the presence of younger-aged stands. Conditions are expected to improve as road density is decreased and stands mature.

- Johnson Creek (WSU 3)
- Deception Creek (WSU 3)
- Lower Skate Creek (WSU 8)
- Main Willame Creek (WSU 9)
- Davis Creek (WSU 10)

Sediment Transport and Storage

Sediment transport and storage capacities on National Forest land subject to past timber management are expected to remain relatively constant over the next 20+ years. As the surrounding sediment input sources decrease, there will be a corresponding, slow, decrease in sediment transport and storage capacities. This will occur on the following creeks:

- Karr Creek (WSU 1)
- Smith Creek (WSU 2) (RM 5.5 - 6.0)
- Lower Butter Creek (WSU 7) (RM 1.5 - 9.0+)
- Lower Skate Creek (WSU 8) (RM 2.5 - 9.0)
- West Fork Willame Creek (WSU 9) (RM 0 - 0.2)
- North Fork Willame Creek (WSU 9) (RM 0 - 0.5)

- Mainstem Willame Creek (WSU 9) (RM 3.0 - 4.0)
- Kilborn Creek (WSU 11) (RM 0 - 3.0)

Strong depositional reaches located are expected to greatly influence the main upper Cowlitz River over the next 30+ years. Depositional reaches on private lands with the capacity to store sediments will continue to be located within the following stream channels:

- Upper Cowlitz River (WSU 1 and 6) (RM 89.8 - 133)
- Johnson Creek (WSU 3) (RM 0 - 0.8)
- Lower Lake Creek (WSU 4) (RM 0 - 0.7)
- Hager Creek (WSU 6) (RM 0 - 3.0)
- Hinkle Tinkle Creek (WSU 6) (RM 0 - 1.0)
- Lower Butter Creek (WSU 7) (RM 0 - 1.5)
- Skate Creek (WSU 8) (RM 0 - 2.5)
- Lilian Creek (WSU 9)
- Davis Creek (WSU 10) (RM 0 - 1.0)

These depositional reaches are expected to store existing sediments for the next 30-50 years (Benda, *pers. comm.*, 1997). Alterations will primarily occur during less frequent, high-flow events, in response to rain-on-snow precipitation.

Stream channels are expected to stabilize as upslope vegetative recovery proceeds. In the interim, degradation/aggradation events will continue in most stream channels before reaching equilibrium. This will mainly occur in the following areas, composed primarily of National Forest land:

- Smith Creek (WSU 2) (RM 3.5 - 5.5)
- Brownie Creek (WSU 3)
- Deception Creek (WSU 3) (RM 0 - 4.0)
- Middle Fork Johnson Creek (WSU 4)
- Jordan Creek (WSU 4)
- Mission Creek (WSU 4)
- Upper Lake Creek (WSU 4)
- Upper Cowlitz River (WSU 6)
- Skate Creek (WSU 7) (RM 2.5 - 8)
- Main Willame Creek (WSU 9) (RM 0 - 2.2, RM 3.0 - 4.0)
- North and West Forks Willame Creek (WSU 9)
- Davis Creek (WSU 10) (RM 1.0 - 3.5)
- Kilborn Creek (WSU 11) (RM 0 - 3.0)

Avalanche chutes located on steep hillsides and alpine areas, as well as and naturally unstable soils will continue to add natural sediment to the following stream channels at a uniform rate:

- Pothole (WSU 1)
- Lower Johnson Creek (WSU 3)
- Deception Creek (WSU 3)
- Middle Fork Johnson (WSU 3)
- Jordan Creek (WSU 3)
- Mission Creek (WSU 3)
- Lower Johnson Creek (WSU 3)
- Lower Lake Creek (WSU 4)
- Upper Lake Creek (WSU 4)
- Butter Creek (WSU 7)
- Lower Skate Creek (WSU 8)

Lakes, Ponds, and Wetlands

Increased recreational use of lakes throughout the analysis area will result in additional impacts to riparian habitat, riparian/aquatic organisms, water quality and wetland areas. The need for information on lakes, ponds, and wetlands is of an increasing concern.

Summary - Aquatics Areas of Concern

Several areas of concern for aquatic resources were identified during the synthesis process of this watershed analysis. Management focus will be needed to help achieve the objectives for these areas, as described in the ROD and the Gifford Pinchot Land and Resources Management Plan. A summary for these areas of concern is displayed in Table 4-5. Aquatic areas of concern are displayed in Map 24, Flow Conditions. Management in these areas will focus on achieving the objectives of the Aquatic Conservation Strategy, as outlined in the Northwest Forest Plan.

The following areas of concern are discussed in Table 4-5:

<u>Segment</u> number refers to Map 24, Flow Conditions.

<u>Ownership</u> is either private (pvt.), National Forest (NF), or National Park (NP).

<u>Peak Flow</u> is defined as those areas where future peak flows are anticipated to be of higher flow rates, potentially enhancing flood occurrence.

<u>Temp</u> is defined as those areas where future stream channel temperature concerns are anticipated.

Riparian Veg. is defined as areas where future riparian vegetation conditions are anticipated to be composed of younger aged stands, such as the grass/pole stage.

Conn. is defined as areas where stream channel connectivity is anticipated to be poor or restricted, resulting in negative impacts to aquatics refugia.

Inner Gorge Present is defined as those areas consisting of narrow steep valleys located along riparian corridors, smaller than a canyon and more steep-sided than a ravine.

Flood Plain Areas are defined as those areas which are more susceptible to future flood events. Negative impacts to stream channels and riparian areas are due to anticipated management.

LWD is defined as areas where future woody material availability within stream channels is anticipated to be low

W/D Ratio Change is defined as those areas where future stream channel width to depth ratios are anticipated to be relatively large due to higher sediment pulses.

Channel Stability. is defined as areas with expected channel instabilities.

Sediment Transport and Storage is defined as areas where future sediment transport and storage volumes are anticipated to be relatively high.

Fisheries

General Habitat Conditions

Intact upper portions of the Upper Cowlitz River system will become increasingly more important as a crucial refugia for at-risk fish species and stocks, and in providing high-quality water. In the Upper Cowlitz River mainstem (RM 114-132.5), habitat quality (spawning, adult holding, juvenile rearing and transportation habitats) in lower gradient reaches, has been partially degraded by increased sediment deposition, and salmonid/steelhead use is suspected to have declined. This decline is expected to continue, as the conditions exist presently along privately owned lands which are subject to sediment input.

Adult holding habitat (deep pools) and spawning habitat located in all WSU areas are filling/aggrading, and will continue to provide degraded, low quality habitat until the watershed areas stabilize from human-influenced sedimentation and riparian species are allowed to regenerate.

Table 4-5: Watershed Concern Areas by 6th Fields Within WSU's.

Seg	Stream	WSU	Ownership	PeakFlow	Temp	Riparian Veg.	Conn.	Inner Gorge Present	Flood Plain Areas	LWD	W/D Ratio Change	Channel Stability	Sediment Transport and Storage
1	Cowlitz	1,6	pvt.	X		X	X		X	X	X	X	X
2	Karr	1	NF, pvt.	X			X					X	
3	Unnamed	1	NF, pvt.	X									X
4	Unnamed	1	NF	X									X
5	Burton	1	pvt.	X		X	X			X			
6	Garrett	1	pvt.	X		X	X			X			
7	Dry	1	pvt.	X		X	X			X			
8	Dry	1	NF	X				X					
9	Smith	2	pvt.			X				X	X		
10	Smith	2	NF			X		X					X
11	Smith	2	NF			X	X			X	X	X	X
12	Smith	2	NF			X				X	X		X
13	Smith	2	NF			X	X			X	X		
14	Johnson	3	NF, pvt.		X	X			X	X			X
15	Johnson	3	NF					X					
16	Brownie	3	NF										X
17	Jennings	3	NF				X			X			
18	Deception	3	NF			X			X				X
19	Johnson	3	NF					X	X		X		
20	Deception	3	NF			X			X	X	X		X
21	Deception	3	NF			X	X		X		X		X

Table 4-5: Watershed Concern Areas by 6th Fields Within WSU's.

Seg	Stream	WSU	Ownership	PeakFlow	Temp	Riparian Veg.	Conn.	Inner Gorge Present	Flood Plain Areas	LWD	W/D Ratio Change	Channel Stability	Sediment Transport and Storage
22	Deception	3	NF			X	X		X	X	X		X
23	Deception	3	NF			X				X	X		X
24	Middle Fork Johnson	3	NF			X							X
25	Jordan	3	NF										X
26	Mission	3	NF			X							X
27	Lower Lake	4	NF, pvt.		X	X				X			X
28	Lower Lake	4	NF		X			X					X
29	Unnamed	4	NF										X
30	Upper Lake	4	NF									X	X
31	Coal	5	NF, pvt.			X				X			
32	Coal	5	NF					X					
33	Cowlitz	6	NF	X			X						X
34	Cowlitz	6	NF				X	X					
35	Hall	6	NF, pvt.	X		X	X			X			
36	Hager	6	NF, pvt.	X		X	X			X			X
37	Hager	6	NF	X			X			X			X
38	Hinkle Tinkle	6	pvt.	X									X
39	Butter	7	pvt.		X	X				X	X	X	X
40	Butter	7	NF					X					
41	Butter	7	NF, NP										
42	Skate	8	pvt.		X	X	X		X	X	X		X

Table 4-5: Watershed Concern Areas by 6th Fields Within WSU's.

Seg	Stream	WSU	Ownership	PeakFlow	Temp	Riparian Veg.	Conn.	Inner Gorge Present	Flood Plain Areas	LWD	W/D Ratio Change	Channel Stability	Sediment Transport and Storage
43	Skate	8	NF			X	X	X	X	X	X		X
44	Skate	8	NF			X	X	X	X	X	X		X
45	Skate	8	NF			X	X		X	X	X		X
46	Skate	8	NF				X		X	X	X		X
47	Skate	8	NF							X			
48	Willame	9	NF	X		X				X			
49	Willame	9	NF	X		X			X	X			
50	Willame	9	NF	X		X			X		X		X
51	Willame	9	NF	X		X			X		X		
52	Lillian	9	NF	X							X	X	X
53	W/N Fork Willame	9	NF	X							X	X	X
54	West Fork Willame	9	NF	X		X	X				X	X	X
55	North Fork Willame	9	NF	X	X	X	X			X	X	X	X
56	Unnamed	9	NF	X									X
57	Unnamed	9	NF	X						X			
58	Willame	9	NF, pvt.	X				X	X	X			X
59	Davis	10	pvt.	X		X				X	X		X
60	Davis	10	NF	X				X			X		X
61	Davis	10	NF	X				X			X	X	X
62	Kilborn	11	NF	X				X					X

Limiting Factors

Natural barriers to fish migration (e.g., from gradient) will 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 decline.

The following are known natural barriers to fish movement:

- Smith Creek (WSU 2) anadromous barrier (approx. RM 1.2)
- Johnson Creek (WSU 3) anadromous barrier (approx. RM 3.4)
- Lake Creek (WSU 4) anadromous barrier (approx. RM 3.4)
- Butter Creek (WSU 7) anadromous fish barrier (approx. RM 1.2)
- Skate Creek (WSU 8) anadromous barrier (approx. RM 9.1)
- Willame Creek (WSU 9) anadromous barrier (approx. RM 0.75)
- Davis Creek (WSU 10) anadromous barrier (approx. RM 1.2)

Pressure from other agencies, tribal governments, and non-governmental organizations to evaluate anadromous barriers for removal will generally increase. Human-influenced barriers from roads and past harvest activities are expected to decrease over time (est. 20-30+ years) throughout the analysis area.

Following are significant human-related fish barriers that are expected to continue to be a problem:

- North Fork Willame Creek (RM 0.6)
- Packwood Lake Dam (WSU 4) Non-anadromous fish barrier (approx. RM 5.5)
- Cowlitz Falls Dam outside of the analysis area

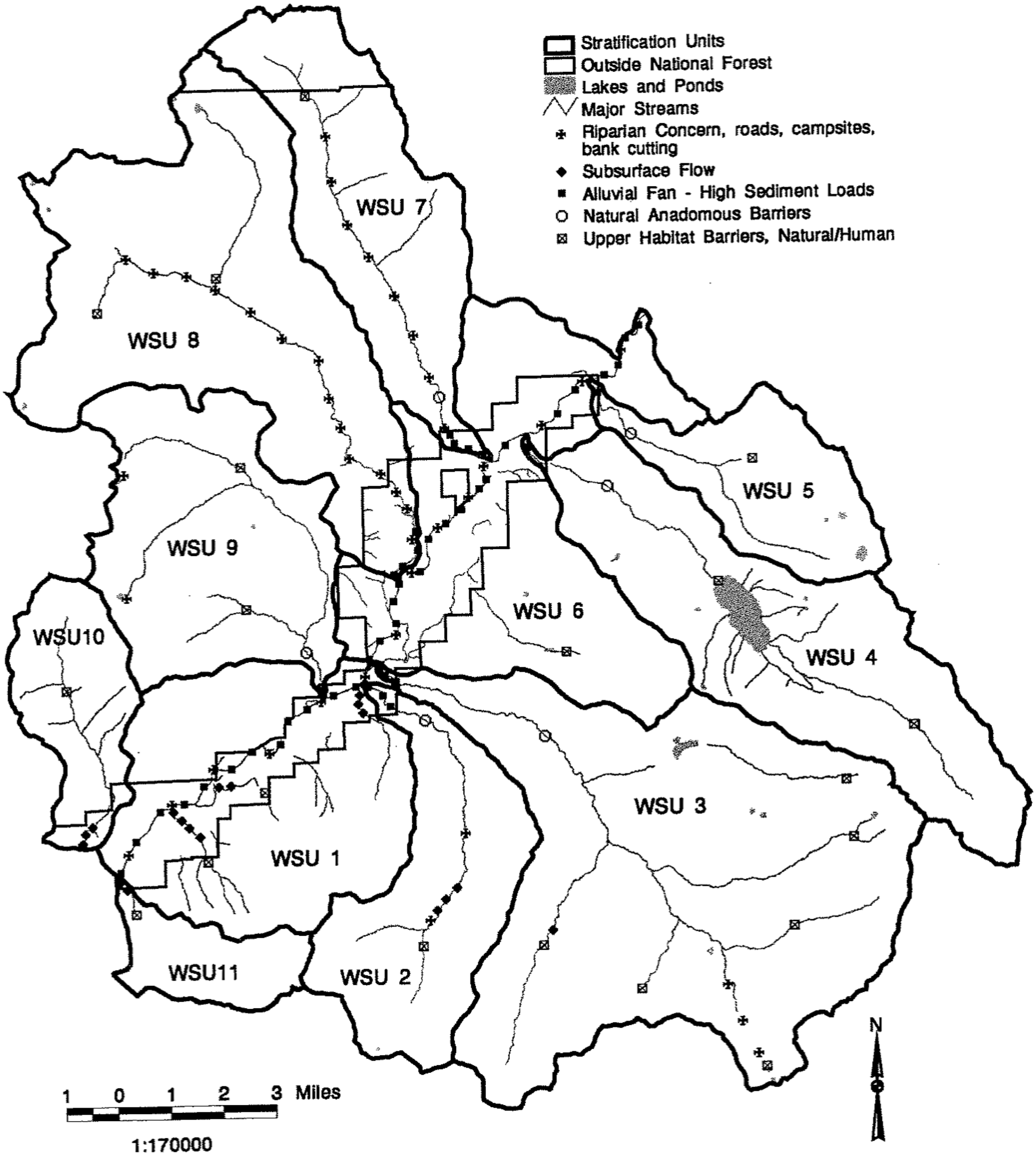
Recreational Fishing and Poaching

Increased mortality associated with fishing is expected to range from 1-5 percent. Catch and release efforts are expected or double or triple over the next decade (Mt. Baker-Snoqualmie N.F. 1996).

Poaching is expected to continue in scattered portions of the Upper Cowlitz analysis area. This is probably most dominant in areas that receive heavy recreational pressure, such as Packwood Lake. Increased environmental education and awareness programs will help to discourage habitat conversion, pollution, and poaching.

Map 25

UPPER COWLITZ WATERSHED ANALYSIS
Aquatics Concerns - Fisheries



Chapter 5 - Watershed Stratification Unit Evaluations

Watershed Stratification Unit Evaluations

In the ensuing tables, each watershed stratification unit 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. Take special note of the amount of non-federal land in each subwatershed as this has an influence on the ratings. A brief description of each of these 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 ROD.

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 that 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 mi / mi^2), 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; 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 - macroinvertebrate 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:
   - **Good:** > 90%
   - **Fair:** 71 - 90%
   - **Poor:** < 71%

   WAR:
   - **Good:** < 5%
   - **Fair:** 5 - 9.9%
   - **Poor:** >10%

   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 10%, the sub-basin 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.

   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 wetland. No quantitative data an exists for this topic; all evaluations presented in the following tables are based on observation factors such as roading and housing development along floodplains, conversion of wetlands and meadows to agricultural, flood control structures along the main stem Cowlitz River, and confinement or disconnection of oxbows from Cowlitz River channel.

Assumptions - A majority of inventoried wetlands are associated with either high ridges and talus slopes or floodplains adjacent to streams. A 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 floodplain for the Cowlitz River channel is the 100 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 species 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. connectivity and structural characteristics of forest in riparian zone

Assumptions - Large tree structural habitat provides required components and complexity (horizontal and vertical diversity within plant communities) to achieve the objective. Small tree structural habitat achieves the objectives to a lesser degree; grass/pole structural habitat least achieves the objectives. It was assumed that non-National Forest lands would be managed for small tree structural habitat.

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 following conditions:

   a. riparian habitat connectivity
   b. percent and distribution of small and large tree habitat in riparian reserves
   c. riparian dependent species presence (plant and animals)

Note: Data on species occurrence and populations in riparian areas are very limited, as is site-specific habitat data. The percentage breakdown of structural stages is for federal lands only. Qualitative review of non-federal lands was factored into the evaluations.

LS. Evaluate late-successional and old-growth species habitat within the watershed.

   Evaluation Criteria - Assess and examine the current conditions of late-successional habitats (*inside and outside* of riparian reserves) with respect to amount, distribution and condition. The following specific criteria will be used:

   a. fragmentation of late-successional habitat patches (i.e. reduction in "interior habitat")
   b. connectivity of late-successional habitat patches and Late-Successional Reserves (LSRs)
   c. condition of late-successional habitats with respect to insects, disease, windthrow, etc..

Rating Definitions and Confidence

The evaluation criteria listed above for each objective are rated in the tables below according to the following scale. A "+" or "-" was used in some instances to further refine the ratings.:

Good (G) Criteria elements have not changed; they are essentially the same as historic/ reference conditions. The subwatershed meets the management objective with only minor exceptions.

Fair (F) Criteria elements have changed somewhat from historic/reference conditions. The subwatershed is near the margin for meeting the management objective.

Poor (P) Criteria elements have definitely changed from historic/reference conditions. The subwatershed does not meet the management objective.

Data Gap (D) No information, or not enough information available to assign a rating.

The evaluation ratings are assigned a level of confidence for accuracy according to the following scale:

High (H) High confidence that assigned rating is accurate.

Moderate (M) Moderate confidence that assigned rating is accurate.

Low (L) Low confidence that assigned rating is accurate.

Table 5-1: WSU #1 - Dry Creek (*15,781 acres, 28.6% private, 71.4% NF*)			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	F	M	**Perennial Streams:** Little change from reference conditions **Intermittent Streams:** Valley bottom alluvial fans restricted to one channel. Some minor increase of intermittent channels where road ditches have extended the drainage network. **Wetlands:** General decrease in the acreage of wetlands, where floodplains have been converted to pasture on private lands. **Lakes & Ponds:** Few changes known; some oxbows lost. Above effects occur on private lands.
2) Connectivity between watersheds	P	L	Reduction of anadromous habitat. Cowlitz River: oxbows and ponds disconnected from main channel along Hwy 12 and other roads. Hwy 12 dissects Cowlitz floodplain by Garrett Creek (RM 0 - 1.3), Burton Creek, and Dry Creek flow subsurface during the summer, due to activities on private land. Karr Creek may also flow subsurface.
3) Integrity of aquatic systems	P	M	Lack of LWD in Cowlitz River floodplain, Lower Burton Creek (RM 0 - 1.5), and lower Garret Creek (RM 0 - 1.3). Braiding taking place along stretches of the Cowlitz River and Lower Karr Creeks. Lack of riparian vegetation along lower Dry Creek in the Cowlitz floodplain. Channelization has occurred on lower Garrett, Burton, and Dry Creeks. Suspected alterations of the main Cowlitz River width/depth ratios are associated with high sediment loads. Removal of LWD has impaired the stream's ability to flush it out.
4) Water quality for healthy ecosystems	D	–	Data gap - stream temperatures unknown. Domestic water source on Garrett and Carr Creeks. Domestic water source in Dry Creek on state land.
5) Appropriate sediment regime	G	H	Davis Mt. slide (large, deep-seated landslide) - steeper channel. Road density is 1.5 mi / mi^2. Continued high natural sediment delivery is expected from the Dry Creek inner gorge (RM 1.0 - 2.0).
6) In stream flow	F	M	Poor WAR (12.6%). Fair ARP (82%). Peak flow concerns in mainstem lower Cowlitz River, Burton Creek, Garrett Creek, Dry Creek, and unnamed tributaries. Modifications to vegetation have occurred primarily on private lands in the valley bottom. There has been little vegetative management on NF lands.
7) Floodplain Function	F	L	Highway 12 dissects the floodplain and oxbow lakes. Housing developments drained wetlands and converted to pasture. Roads may influence floodplain function such as water tables and unrestricted water movement. Channelization has occurred on lower Garrett, Burton, and Dry Creeks

Table 5-1: WSU #1 - Dry Creek (*15,781 acres, 28.6% private, 71.4% NF*)			
Management Objectives	**Rating**	**Confidence**	**Rationale**
8) Structural diversity of plant communities riparian reserves	F	H	The majority of the National Forest portion is either small tree or large tree in riparian reserves. Most of the small tree structure is the result of natural succession. Very little grass/pole is present. The rating of "fair" is due to a wide band of private and state land bisecting the WSU, which contains mostly grass/pole and agricultural land.
9) Habitat to support well distributed populations of riparian species	F	H	In the riparian reserves there is 79% small or large tree, 7% grass/pole, and 14% non-forest habitat (federal lands only). The southern portion of the WSU (Dry, Burton and Garrett Creeks) is well connected stands of small and large tree habitat. Large tree stands in this area are concentrated in the headwaters. Riparian habitat along streams in the northern half of the subwatershed are fragmented. Private lands bisecting the WSU are either agricultural or grass/pole. No species data for this WSU.
LS) Late successional habitat	F	H	22% of the WSU is large tree (federal and non-federal lands). A large block of small tree habitat in the southern portion of the WSU originated following natural fires at the turn of century. LS habitat connectivity within the WSU is poor, but there are some good connections to LS habitat in adjacent WSU's. There are some consolidated blocks in the upper elevations of the southern half of the WSU, but LS blocks in the deer and elk winter range are well fragmented. LS habitat in the northern half of the WSU is affected by laminated root rot infections. LS habitat (optimal cover) is deficient in the big game allocations. Large tree stands historically present in the valley bottom, have been replaced by pasture agricultural lands and are likely to remain so in the future.

Comments:

ACS #1: Dry Creek received a "fair" rating due to the conversion of wetlands to pasture on private lands, the possible loss of oxbow lakes along the Cowlitz River floodplain and restricted stream channels on the valley bottom alluvial fans.

ACS #4: Cowlitz River supports coho, chinook, steelhead, rainbow, cut throat, and mountain whitefish. Burton, Garrett, and Dry Creeks support these same species for part of the year.

ACS #6: Dry Creek received a "poor" rating based on a high percentage of privately owned lands and a poor WAR value (12.6%).

ACS #7: The natural meandering of the Cowlitz River channel that formed oxbow lakes and floodplain wetlands has been discouraged over the last 50 years, with some loss of pond, floodplain, and alluvial fan function.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-2: WSU #2 - Smith Creek (*10,347 acres, 1.7% private, 98.3% NF*)			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change from reference conditions. **Intermittent Streams:** Some increase in confinement of alluvial channel of valley bottom. **Wetlands:** Few changes known. **Lakes & Ponds:** Few changes known.
2) Connectivity between watersheds	P	H	Reaches of Smith Creek go subsurface due to sediment buildup (seg. 13, Table 4-5). 2nd crossing (FS rd 20, MP 5.9) is too small for peak flow events. Channelization and pasturization of channels on private land.
3) Integrity of aquatic systems	P	H	Widening of floodplain on private land. Lack of LWD due to riparian vegetation removal in the Lower Smith Creek, located on private land (RM 0 - 0.8). Human caused sediment delivery above RM 5.9 due to slides. Widening and shallowing of the stream channel in response reaches of upper Smith Creek have been observed and are attributed to increases in sediment load and peak flows. Streambank cutting has been observed on Smith Creek (RM 3.5 - 5.5). Smith Creek has been channelized.
4) Water quality for healthy ecosystems	G	H	Yearly water temperature monitoring. Temperatures are below 14°C.
5) Appropriate sediment regime	P	H	Numerous debris flows from roads; supported by subsurface flow due to sediment in other reaches of Smith Creek. Mass failures from roads are expected to decline after obliteration of sections of FS Rds 2010 and 2020 in 1993. Road density of 1.46 mi / mi^2. Continued high natural sediment delivery from inner gorge area of Smith Creek (RM 1.0 - 3.0). Natural mass wasting is minor and limited to a few avalanche chutes.
6) In stream flow	F	H	Fair WAR (5.8%) Fair ARP (89%).
7) Floodplain Function	F	M	Roads and timber harvest are influencing floodplain function and diversity in Upper Smith Creek (RM 4.5 - 5.0), the extent of which is unknown. Channelization of Smith Creek in the Cowlitz River floodplain on private land.
8) Structural diversity of plant communities in riparian reserves	F-	H	Riparian reserves in the upper Smith Creek basin of the WSU are highly fragmented from timber harvest (particulary within RM 4.5-5.0) alternating sections with grass/pole and large tree. The lower Smith Creek basin of the WSU is largely unfragmented, comprised mostly of small tree with occasional grass/pole.
9) Habitat to support well distributed populations of riparian species	F	H	In the riparian reserves there is 55% small or large tree, 21% grass/pole, and 24% non-forest habitat (federal lands only). Connectivity is poor and large tree habitat confined to the headwaters of Smith Creek. The lower portion of Smith Creek is well connected with small tree habitat. Several populations of Cascades frogs (*Rana cascadae*) have been noted in Smith Creek.

Table 5-2: WSU #2 - Smith Creek (*10,347 acres, 1.7% private, 98.3% NF*)			
Management Objectives	**Rating**	**Confidence**	**Rationale**
LS) Late successional habitat	F-	H	20% of the WSU is large tree (federal and non-federal lands). A large block of small tree habitat in the lower Smith Creek drainage portion of the WSU originated following natural fires at the turn of century. LS habitat is highly fragmented and connectivity is poor. Adjacent small tree forest helps provide some connection between LS habitat patches. Some of the large tree stands dominated by Pacific silver fir suffer decline due to tephra deposition. LS habitat (optimal cover) is deficient in the big game allocations.

Comments:

ACS #3: Continued alterations of width/depth ratios associated with sedimentation and sideslope failure are expected in Upper Smith Creek (RM 5.5 - 6.0).

ACS #4: Smith Creek supports coho, chinook, steelhead, rainbow, cut throat, and mountain whitefish.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-3: WSU #3 - Johnson Creek *(31,103 acres, 0.2% private, 99.8% NF)*			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change. **Intermittent Streams:** Little change. **Wetlands:** Some loss of wetlands by road construction next to Johnson Creek. **Lakes & Ponds:** No change.
2) Connectivity between watersheds	G	H	The exception to the "Good" rating is the Deception Creek drainage which goes subsurface from RM 2.5 - 3.0 and RM 5.5 - 6.0.
3) Integrity of aquatic systems	F	H	Lack of LWD in lower Johnson Creek (RM 0 - 11.5), Deception Creek (RM 1.0 - 1.5 and RM 2.0 - 4.0), and Jennings Creek (RM 0 - 1.2). Removal of riparian vegetation along lower Johnson Creek (RM 0 - 0.8). Anadromous barrier on Johnson Creek (RM 3.4). Lower section of Johnson Creek has been channelized on private land. High stream channel width/depth ratio change in Deception Creek system. High sediment transport in Deception, Middle Fork Johnson, Jordan, and Mission Creeks.
4) Water quality for healthy ecosystems	G	H	Yearly water quality monitoring rarely exceeds 14°C.
5) Appropriate sediment regime	F	H	Natural rates of mass wasting (avalanches/talus slopes) are present in Jordan, Glacier, and Deception Creeks. Continued high sediment delivery from inner gorge areas of Lower Johnson Creek (RM 0.8 - 5.0) and Deception Creek (RM 0.1 - 0.6). Repeated road related failures have delivered sediment to Deception and lower Johnson Creeks. Road density 1.23 mi/mi^2. (At the 6th field scale, some road densities are substantially higher)
6) In stream flow	G	H	Good WAR (3.6%). Good ARP (91%).
7) Floodplain Function	G	L	Channelization and riprap of stream banks in Lower Johnson (private land). Housing development and roads influence floodplain.
8) Structural diversity of plant communities in riparian reserves	F	H	The overall rating is "fair", with some areas being "poor" and others "good". Deception Creek riparian reserves have been impacted by timber harvest and are highly fragmented with alternating grass/pole and large tree. Riparian Reserves of tributaries of Johnson Creek drainage between Brownie Creek and Middle Fork Johnson are highly fragmented. Jordan Creek, Middle Fork Johnson Creek, and Glacier Creek (located in wilderness) riparian reserves are unfragmented, containing mostly large tree and small tree.

Table 5-3: WSU #3 - Johnson Creek *(31,103 acres, 0.2% private, 99.8% NF)*			
Management Objectives	**Rating**	**Confidence**	**Rationale**
9) Habitat to support well distributed populations of riparian species	F	H	In the riparian reserves there is 55% small or large tree, 17% grass/pole, and 28% non-forest habitat (federal lands only). Connectivity is poor in Deception Creek and fair in Johnson Creek due grass/pole stands in what was large tree habitat. Jordan, Middle Fork Johnson, Mission and Glacier Creeks are well connected with small and large tree habitat. Populations of larch mountain salamander, Cascades frog in Johnson Creek; tailed frogs in Deception creek.
LS) Late successional habitat	F	H	29% of the WSU is large tree (federal and non-federal lands). The wilderness area contains large blocks of well-connected LS habitat (as well as some adjacent areas). LS habitat in Deception Creek and Johnson Creek has been highly fragmented and has poor connectivity. There is poor LS connectivity between the upper Johnson Creek headwaters and the upper Cispus River watershed area. LS habitat (optimal cover) is deficient in the big game allocations.

Comments:

ACS #4: Johnson Creek supports coho, chinook, and steelhead to RM 3.4 and rainbow and cut throat from RM 0 to RM 11.5. Glacier Creek supports rainbow trout. Deception Creek supports Rainbow trout from RM 0 to RM 4.7. Mission Creek supports rainbow trout from RM 0 to 25' falls.

ACS #6: Johnson Creek received a "fair" ARP value based on the lower ARP values of Deception and Lower Johnson Creek, which are influenced by management activities.

ACS #6: Approximately 40% of WSU 3 is located in the Goat Rocks Wilderness, which improves ARP values available for management in 6th fields 25S, 25T, and 25U.

ACS #7: Floodplain sections of National Forest land are in good condition.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-4: WSU #4 - Lake Creek *(16,409 acres, 0.4% private, 99.6% NF)*			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change. **Intermittent Streams:** Little change. **Wetlands:** No change. **Lakes & Ponds:** No Change.
2) Connectivity between watersheds	F	H	Hydroelectric dam affects flow on Lake Creek at Packwood Lake. The section of Lake Creek above Packwood Lake was divided from the lower section by a natural landslide c.a. 1,100 years ago.
3) Integrity of aquatic systems	G	M	Lack of LWD and riparian vegetation along Lower Lake Creek (RM 0 - 0.7) on private lands. Lower section has been channelized on private land. Lack of LWD on Federal lands (RM 0.8 - 6.6), although potential for future recruitment is good. High bank cutting in Upper Lake Creek, above Packwood Lake. High natural sediment transport and storage in the Upper Lake Creek area. Management related increase in sediment transport and storage below Packwood Lake.
4) Water quality for healthy ecosystems	F	H	Water temperature exceed 14°C in a cool water year (1995). Stream survey recorded 18°C below Packwood Lake dam in 1993. This was the only year recorded in which state standards for water temperature was exceeded. .
5) Appropriate sediment regime	F	M	Watershed above Packwood Lake is located in wilderness (natural sediment regime). Continued sideslope failure within inner gorge areas (RM 1.0 - 3.5), many naturally occurring and some possibly related to road drainage farther upslope. In addition several road related failures have occurred down stream of Packwood Lake. Several existing road segments in this watershed are in poor condition and may contribute sediment in the future if not corrected.
6) In stream flow	G	H	Good WAR (3.7%). Good ARP (95%). Note: Water diversion for Packwood Lake power station.
7) Floodplain Function	G	L	Housing developments and roads influence floodplain function. Pristine areas are located within the Goat Rocks Wilderness.
8) Structural diversity of plant communities in riparian reserves	G	H	Some of the side tributaries of lower Lake Creek contain moderate amounts of grass/pole. Lower Lake Creek mainstem is mostly large tree.
9) Habitat to support well distributed populations of riparian species	G	H	In the riparian reserves there is 65% small or large tree, 7% grass/pole, and 28% non-forest habitat (federal lands only). Overall connectivity is good. Portions of the side tributaries to lower Lake Creek are grass/pole habitat. No species data for this WSU.

Table 5-4: WSU #4 - Lake Creek *(16,409 acres, 0.4% private, 99.6% NF)*			
Management Objectives	**Rating**	**Confidence**	**Rationale**
LS) Late successional habitat	F+	H	43% of the WSU is large tree (federal and non-federal lands). The wilderness area (as well as some adjacent areas) around Packwood Lake contains a very large block of LS habitat. This block is well-connected to LS habitat to the north and south. A narrow stringer of LS habitat (bounded mostly by grass/pole) provides a connection from Packwood Lake to the Cowlitz valley.

Comments:

Packwood Dam has stopped most natural hydrologic events on the lower section of Lake Creek. The dam has stopped resident fish passage upstream.

Approximately 70% of WSU 4 is located in Wilderness Areas.

ACS #4: Lake Creek supports coho, chinook and steelhead to RM 3.4, and rainbow trout from RM 0 to 6.6. Upper Lake Creek supports rainbow trout.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-5: WSU #5 - Coal Creek ***(6,613 acres, 0.8% private, 99.3% NF)***			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change. **Intermittent Streams:** Little change. **Wetlands:** Some loss by road construction next to Coal Creek. **Lakes & Ponds:** Little change.
2) Connectivity between watersheds	G	M	No known problems identified (1982 survey).
3) Integrity of aquatic systems	D	-	Lack of riparian canopy and reduced LWD on private lands (RM 0 - 0.5). Lack of data on federal land.
4) Water quality for healthy ecosystems	D	-	Data gap. Stream temperatures unknown.
5) Appropriate sediment regime	G-	M	Several small avalanche chutes and debris flows occur in the headwaters of Coal and Lost Creeks. A few road related failures have occurred, but roads in this watershed are more often the recipient of debris flows than the cause.
6) In stream flow	G	H	Good WAR (4.3 %). Good ARP (91%).
7) Floodplain Function	G	M	Scattered housing developments near confluence of Coal Creek and the Cowlitz River. Road segments crossing stream channels on non-wilderness areas of National Forest land. Campsites in riparian areas of the Goat Rocks Wilderness.
8) Structural diversity of plant communities in riparian reserves	G	H	Most of riparian reserves along Lost Creek and Coal Creek are large tree with side tributaries being large tree and small tree. In Coal Creek there are occasional small gaps of grass/pole stands.
9) Habitat to support well distributed populations of riparian species	G-	H	In the riparian reserves there is 66% small or large tree, 7% grass/pole, and 27% non-forest habitat (federal lands only). Connectivity along Coal Creek is good with only one grass/pole break in large tree habitat. One known population of tailed frogs in Coal Creek.
LS) Late successional habitat	F+	H	44% of the WSU is large tree (federal and non-federal lands). A large block of LS habitat is located in wilderness at the headwaters and provides a good connection to the south. LS habitat between wilderness and the Cowlitz valley is somewhat fragmented and narrow. An adjacent large block of well-developed small tree forest enhances the connectivity.

Comments:

Approximately 50% of WSU 5 is located in the Goat Rocks Wilderness, which improves the ARP values available for management.

ACS #4: Coal creek supports coho, chinook, steelhead, rainbow, and cut throat to RM 3.6. Lost Creek supports rainbow trout from RM 0 to RM 3.4.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-6: WSU #6 - Hall Creek (18,407 acres, 32.6% private, 67.4% NF)			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	F	M	**Perennial Streams:** Little change from reference conditions **Intermittent Streams:** Valley bottom alluvial fans restricted to one channel. Some increase of intermittent channels where road ditches have extended the drainage network. **Wetlands:** General decrease in the acreage of wetlands, where floodplains have been converted to pasture on private lands. **Lakes & Ponds:** Few changes known; some oxbows lost.
2) Connectivity between watersheds	P	L	In general, there is a lack of stream survey data on the Cowlitz River, Hager, Synder, and Hinkle Tinkle Creeks. Heavy sediment loads. Hwy 12 dissects floodplain. Residential development of floodplain. The analysis ratings were base on personal observations of the roads and flood control projects within the Cowlitz floodplain.
3) Integrity of aquatic systems	F-	M	Reduced riparian canopy and LWD outside on National Forest lands in the Cowlitz River floodplain, Lower Hager Creek (RM 0-0.3), Synder Creek (RM 0-0.1) and Hall Creek. Repeated salvage of wood. Snyder Creek has been channelized. Loss of fish habitat. Riparian concerns on Hager Creek (RM 0.3 - 1.0), located on National Forest lands. LWD concerns in Hinkle Tinkle (RM 0 - 1.0), Hall and Hager Creeks. Hinkle Tinkle Creek flows subsurface. Extensive channel migration and bank cutting in the Cowlitz River floodplain noted during the 1995 and 1996 flood events. Channel widening occurs in Hall Creek on private land, cause unknown (segment 36).
4) Water quality for healthy ecosystems	G	H	Hager stream high temperatures under 10°C (1995). Stream survey recorded 10°C water temperature in Hall Creek (1994). Domestic water source on Hinkle Tinkle Creek (water temperature unknown).
5) Appropriate sediment regime	F+	M	Very little mass wasting occurs in this WSU, with exception of a naturally occurring active land slide on Hager Creek (forming Hager Lake). High volumes of sediment are routed through this stretch of the Cowlitz River, much of which is derived from erosional processes on Mt. Rainier and the Goat Rocks wilderness - the extent of management related sediment delivery is currently unknown. However, the relatively high road density (3.75 mi/mi^2) over the entire WSU suggests a substantial contribution of sediment to streams from roads.
6) In stream flow	P	H	Poor WAR (17.6%). Poor ARP (68%). Peakflow concerns in Hall. Hager, Hinkle Tinkle Creeks and the main Upper Cowlitz River.
7) Floodplain Function	P	M	Highway 12 bisects the floodplain and oxbow lakes. Associated town developments (housing, industrial, business) and drained wetlands have been converted to pasture, agricultural, and domestic use. Channelization of the Cowlitz River, Hinkle Tinkle, Golf, and Hall Creeks. Roads and flood control structures influence floodplain function and diversity.

Table 5-6: WSU #6 - Hall Creek (18,407 acres, 32.6% private, 67.4% NF)

Management Objectives	Rating	Confidence	Rationale
8) Structural diversity of plant communities in riparian reserves	P	H	Riparian reserves on private and state lands consist primarily of grass/pole and agricultural land. In general, Hager Creek, Hall Creek, and tributaries are highly fragmented by previous timber harvest resulting in alternating grass/pole and large tree stands. A tributary in upper Hager Creek drainage contains a moderate amount of large tree stands. .
9) Habitat to support well distributed populations of riparian species	P	H	In the riparian reserves there is 55% small or large tree, 27% grass/pole, and 18% non-forest habitat (federal lands only). Small and large tree habitat connectivity is poor throughout the WSU except for one tributary to Hager Creek above Hager Lake and along Hinkle Tinkle Creek. Private lands bisecting the WSU are either agricultural or grass/pole and contain roads within riparian reserves. There are numerous road crossing of riparian reserves in the Hager Creek drainage on federal lands. There is a population of red-legged frogs in Synder Creek; red-legged and northwestern salamanders in "Boneyard" swamp.
LS) Late successional habitat	P	H	20% of the WSU is large tree (federal and non-federal lands). LS habitat is heavily fragmented with poor interior habitat and poor connectivity. A significant portion of the WSU is private/state land, of mostly grass/pole, urban areas, and agricultural lands. LS habitat in the vicinity of the Cowlitz valley is affected by laminated root rot.

Comments:

ACS #1: Dry Creek received a "fair" rating due to the conversion of wetlands to pasture on private lands, the possible loss of oxbow lakes along the Cowlitz River floodplain and restricted stream channels on the valley bottom alluvial fans.

ACS #4: Cowlitz River supports coho, chinook, steelhead, rainbow, cut throat, and mountain whitefish. Hall Creek supports coho, chinook, steelhead, rainbow trout, cut throat, and mountain whitefish to RM 3.0.

ACS #7: Some loss of oxbows, floodplain wetlands, and multiple alluvial channels in the valley bottom (usually on private land). The presence of flood control structures may be contributing to the above conditions.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-7: WSU #7 - Butter Creek *(12,104 acres, 1.6% private, 78.4% NF, 20.0% NP)*			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change known. **Intermittent Streams:** Some increase where roads extend the stream network. **Wetlands:** Some loss of wetlands due to road construction. **Lakes & Ponds:** No change known.
2) Connectivity between watersheds	P	H	Natural landslide at RM 1.5 - 2.0 forms a steep cascade / waterfall. Lower 1 mile has been channelized and rip-rapped. Butter Creek has been confined to one channel on a large alluvial fan; anadromous habitat no longer exists on private land.
3) Integrity of aquatic systems	F	H	Poor riparian conditions and lack of LWD on private and state lands in lower Butter Creek (RM 0 - 1.2). Poor LWD for Butter Creek on National Forest land (RM 1.2 - 8.0). Channelization of lower Butter Creek (RM 0 - 1.2). Poor width/depth ratios in Butter Creek (RM 0 - 1.2). High natural sediment transport and storage is in part associated with bank cutting observed in RM 1.5 - 9+. FS rd. 5270 is within riparian zone for 5 of 8 fish-bearing miles.
4) Water quality for healthy ecosystems	F	H	Water temperatures exceed 14°C in 1995, a cool water year.
5) Appropriate sediment regime	G	H	Mass wasting is dominated by naturally occurring avalanches and debris flow traveling down from steep slopes throughout the entire drainage. A few road related failures have occurred along FS rd. 5270, but most road damage is from debris flows originating above the road system. Road density is 0.75 mi/mi² for the WSU.
6) In stream flow	F	H	Fair WAR (7.9%). Fair ARP (86%). Control of Lower Butter Creek width/depth ratios on private land. High bank cutting within the Butter Creek drainage.
7) Floodplain Function	F	M	Channelization and rip-rap of Butter Creek (RM 0 - 1.2) on private lands. Housing developments and roads on floodplain.
8) Structural diversity of plant communities in riparian reserves	F	H	The upper half of the Butter Creek basin is grass/pole and large tree stands. Stands in the lower half of Butter Creek basin are mostly small tree with occasional grass/pole. Small tree stands are approaching large tree conditions.
9) Habitat to support well distributed populations of riparian species	F	H	In the riparian reserves there is 56% small or large tree, 8% grass/pole, and 36% non-forest habitat (federal lands only). Connectivity is good in the lower Butter Creek drainage with small tree habitat. In upper Butter Creek large tree connectivity is broken by several grass/pole stands. Large tree habitat is located in the upper half of the Butter Creek drainage. No species data available.

Table 5-7: WSU #7 - Butter Creek *(12,104 acres, 1.6% private, 78.4% NF, 20.0% NP)*			
LS) Late successional habitat	F-	H	22% of the WSU is large tree (federal and non-federal lands). The lower two thirds of the watershed is currently in small tree stands that originated from natural fires during the mid-1800's. These stands are soon to reach LS characteristics. A small amount of LS habitat located in the headwaters area is fragmented and poorly connected. LS habitat (optimal cover) is deficient in the big game allocations.

Comments:

Approximately 50% of WSU 7 is located in either the Tatoosh Wilderness or Mt. Rainier National Park.

ACS #4: Butter Creek supports coho, chinook, and steelhead to RM 1.2; supports rainbow trout from RM 0 to RM 8.0.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-8: WSU #8 - Skate Creek *(22,475 acres, 5.4% private, 92.8% NF, 1.9% NP)*

Management Objectives	Rating	Confidence	Rationale
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change known. **Intermittent Streams:** Some increase by extension of drainage network by roads. **Wetlands:** Loss of wetlands due to road construction. along Skate Creek. **Lakes & Ponds:** No change known.
2) Connectivity between watersheds	P	H	Skate Creek has 9.1 miles of anadromous habitat, among the largest stretches remaining in the upper Cowlitz watershed. FS Rd. 5250 crossing of Skate Creek constricts the channel during moderate to peak flow events. Additionally, FS Rd 52 is built along the valley bottom of Skate Creek, with many culvert drop-offs that disconnect valley tributaries from the main channel, resulting in connectivity concerns along RM 2.5 - 9.7. Lower section has been channelized.
3) Integrity of aquatic systems	P	M	Riparian concerns and lack of LWD in the mainstem Skate Creek RM 0 - 2.5 (state/private) and RM 2.5 - 9.7. FS Rd 52 constricts the stream channel from migrating. LWD concerns in Skate Creek (RM 11.0 - 12.0). Flooding events (1990, 1995, 1996) associated with rain-on-snow, heavy precipitation, and associated peak flow events have impacted Skate Creek between RM 0 - 2.5 (state/private), as well as RM 2.5-9.0 (NF land) and are likely to occur in the future. Channel widening in the Bear Prairie tributary (RM 8.0 - 9.0). Scattered changes in width/depth ratio in Skate Creek. Channel width/depth ratio concerns in Little Johnson Creek.
4) Water quality for healthy ecosystems	F	H	Yearly water temperature monitoring. Stream temperatures exceed 14°C on National Forest lands. Temperatures exceed 16°C on private lands.
5) Appropriate sediment regime	F-	H	Several large, deep-seated landslides and numerous avalanche chutes (both naturally occurring) exist in this watershed. High sediment delivery occurs under natural conditions, augmented by road related failures. Road density of 2.04 mi/mi² for WSU.
6) In stream flow	F	H	Fair WAR (6.9%). Fair ARP (84%).
7) Floodplain Function	F	M	Channelization of Skate Creek near the Craig road bridge. Channel confinement (RM 3.0 - 8.0) along FS Rd. 52. FS Rd. 52 located along the edge of Bear Prairie (wet meadow). The location of FS Rd. 52 has affected the floodplain function of Skate Creek (RM 2.9 - 9.0).
8) Structural diversity of plant communities in riparian reserves	F+	H	Almost all of the riparian reserve of Skate Creek is large tree and small tree, with some grass/pole in the headwaters. The riparian reserve of the lower half of "Little" Johnson Creek is small tree and large tree, while the upper half has been highly fragmented by timber harvest, resulting in alternating sections of grass/pole and large tree.

Table 5-8: WSU #8 - Skate Creek *(22,475 acres, 5.4% private, 92.8% NF, 1.9% NP)*			
Management Objectives	**Rating**	**Confidence**	**Rationale**
9) Habitat to support well distributed populations of riparian species	F	H	In the riparian reserves there is 65% small or large tree, 14% grass/pole, and 21% non-forest habitat (federal lands only). Large tree connectivity is very good along Skate Creek. Small and large habitat connectivity is good in lower Little Johnson. In upper Little Johnson large tree habitat is broken by grass/pole stands. That portion of Skate Creek north of Silver Creek pass is large tree broken by grass/pole stands. One known population of Cope's giant salamander in Skate Creek.
LS) Late successional habitat	F	H	29% of the WSU is large tree (federal and non-federal lands). A relatively wide band of well-connected LS habitat bisects the WSU on the northeast side of Skate Creek, with a well-developed band of small tree on the southwest side of Skate Creek. There is a large block of LS habitat in the headwaters (wilderness) of "Little" Johnson Creek. The remaining LS habitat in the northeast and southwest corners of the WSU is highly fragmented and poorly connected. The south end of the bisecting band of LS habitat is affected by laminated root rot infections. LS habitat (optimal cover) is deficient in the big game allocations.

Comments:

ACS #4: Skate Creek supports coho, chinook, and steelhead to RM 9.1, and rainbow trout and cut throat from RM 0 to RM 9.7. Little Johnson Creek supports cut throat to RM 3.7.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-9: WSU #9 - Willame Creek ***(13,435 acres, 0.1% private, 99.9% NF)***			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change known. **Intermittent Streams:** Some increase by extension of drainage from roads. **Wetlands:** Minor loss due to road construction. **Lakes & Ponds:** No change known.
2) Connectivity between watersheds	F	M	Impairments at FS Road 47 and 4725 crossings of North and West Forks Willame Creeks. Most data for this WSU is old.
3) Integrity of aquatic systems	P	M	Road construction adjacent to the channel and lack of LWD in the N. Fork Willame Creek (RM 0.5 - 4.0), W. Fork Willame Creek (0.5 - 3.0), and mainstem Willame Creek. High sediment transport and storage in Willame Creek (RM 3.0 - 4.0), W. Fork Willame Creek (RM 0.0 - 2.0), N. Fork Willame Creek (RM 0.0 - 0.5) and Lillian Creek drainage suggest changes in the stream width/depth ratios, although such changes are unconfirmed.
4) Water quality for healthy ecosystems	F	M	N. Fork Willame Creek exceeds state water quality standards for water temperature. The W. Fork is cooler. The temperature of mainstem Willame Creek is unknown, but is not expected to exceed state standards.
5) Appropriate sediment regime	P	H	The majority of mass wasting events in this WSU over the last 30 years are management related (particularly North Fork and West Fork Willame Creeks. The S. Fork and mainstem Willame Creeks are in better condition, but all drainages have experienced repeated management related failures. Road density is 3.02 mi/mi^2.
6) In stream flow	F-	M	Fair WAR (7.7%). Fair ARP (80%). Peak flow concerns in mainstem Willame, N. Fork Willame, W. Fork Willame, and Lilian Creeks. Because of the relatively high road density, road drainage may be contributing to increased peak flow release which is not accounted for in the ARP and WAR values. Flooding events associated with rain-on-snow and peak flows have occurred in 1975, 1977, 1990, 1995, and 1996 and are expected in the future.
7) Floodplain Function	G	M	1 road crossing the floodplain in 25D. 1 road crossing the floodplain in 25F. Portion of FS Rd. 4715 adjacent to a wetland.
8) Structural diversity of plant communities in riparian reserves	P+	H	The riparian reserve of South Fork Willame Creek is small tree and large tree, with minor grass/pole; and is basically unroaded to date. The riparian reserves of North Fork Willame and West Fork Willame Creeks are highly fragmented by past timber harvest, being comprised of mostly grass/pole, with a minor component of small and large tree. Riparian reserves along the main stem of Willame Creek (below the confluence of West and North Fork Willame Creeks) are primarily small and large tree, with only minor amounts of grass/pole.

Table 5-9: WSU #9 - Willame Creek ***(13,435 acres, 0.1% private, 99.9% NF)***

Management Objectives	Rating	Confidence	Rationale
9) Habitat to support well distributed populations of riparian species	F	M	In the riparian reserves there is 54% small or large tree, 33% grass/pole, and 8% non-forest habitat (federal lands only). The South Forks and mainstem Willame Creek is well connected small and large tree habitat. The West Fork Willame Creek is large tree broken by several grass/pole stands. Small tree connectivity is broken up by grass/pole stands in the North Fork Willame Creek. No species data available for this WSU.
LS) Late successional habitat	F-	H	24% of the WSU is large tree (federal and non-federal lands). A large block of small tree exists in the South Fork Willame drainage and is approaching large tree conditions. The LS habitat in the North and West Forks of Willame Creek is highly fragmented and poorly connected. The LS habitat in the southeast corner of the WSU is affected by laminated root rot infections.

Comments:

ACS # 4: Mainstem Willame Creek supports coho, chinook, and steelhead from RM 0.0 to RM 0.75 and rainbow trout from the mouth to NSO #135. South Fork Willame Creek supports rainbow trout from RM 0 to reach 6. North Fork Willame Creek supports rainbow trout from RM 0.0 to the middle of reach 1.

ACS #6: Willame Creek as given a "poor" rating since approximately 75% of the Willame basin contains ARP levels less than 75%.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-10: WSU #10 - Davis Creek *(9.5% private, 90.5% NF)*			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change from reference conditions **Intermittent Streams:** Valley bottom alluvial fans restricted to one channel. Some minor increase of intermittent channels where road ditches have extended the drainage network. **Wetlands:** General decrease in the acreage of wetlands, where floodplains have been converted to pasture on private lands. **Lakes & Ponds:** Few changes known; some oxbows lost.
2) Connectivity between watersheds	F-	H	Hwy 12 dissects the floodplain. Timber lands have been converted to pasture. Channelization has been and continues to occur.
3) Integrity of aquatic systems	F-	M	The lower RM 0 - 1.0 of Davis Creek is lacking riparian vegetation and LWD on private lands. Scattered areas of channel instability and poor width/depth ratios occur in Davis Creek (primarily RM 2.5 - 3.5). High rate of sediment deposition and channel widening is occurring in Davis Creek (RM 0.0-1.0), from both natural and management related sources.
4) Water quality for healthy ecosystems	F	L	Stream survey spot temperatures recorded 13°C on private land (July, 1984) and an anadromous stream survey recorded 16°C (1994). Domestic water source.
5) Appropriate sediment regime	F	H	Several naturally occurring avalanche chutes exist in this watershed. A number of road related failures have occurred on the 63 Road system. Road density is 2.7 mi/mi^2 for the WSU.
6) In stream flow	F	M	Poor WAR (11.7%). Fair ARP (81%). Peak flow concerns on Davis Creek (RM 0 - 1.0) on both private and federal land.
7) Floodplain Function	F	M	Highway 12 dissects the floodplain and oxbow lakes. Housing developments and channelization of Davis Creek on private lands. Logging roads cross the stream on the floodplain on private lands.
8) Structural diversity of plant communities in riparian reserves	P+	H	Riparian reserves along most of the headwaters mainstem and tributaries are grass/pole due to timber harvest, with minor remnants of large tree. The Lower half of Davis Creek is mostly small tree and large tree, with minor amounts of grass/pole.
9) Habitat to support well distributed populations of riparian species	F-	M	In the riparian reserves there is 50% small or large tree, 30% grass/pole, and 20% non-forest habitat (federal lands only). Lower Davis Creek is well connected with small and large tree habitat. The Davis Creek headwaters are heavily fragmented large tree habitat broken by grass/pole stands. Private lands contain primarily grass/pole and agricultural vegetative conditions. No species data for this WSU.
LS) Late successional habitat	P+	M	28% of the WSU is large tree (federal and non-federal lands). There is a moderately large block of LS habitat on the west flank of Davis mountain, but it has been somewhat fragmented. LS habitat in the headwaters is highly fragmented due to timber harvesting. The LS habitat (optimal cover) is deficient in deer and elk winter range allocations.

Comments:

The upper portions of WSU 10 were Range allotments until the early 1960's.

ACS #3: Poor rating is based on effects to anadromous fish species.

ACS #4: Davis Creek has supported salmon and steelhead fingerlings. Eastern brook trout and rainbow trout have also been observed.

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

Table 5-11: WSU #11 - Kilborn Creek ***(3,262 acres, 0.7% private, 99.3% NF)***			
Management Objectives	**Rating**	**Confidence**	**Rationale**
1) Existence of aquatic features at landscape scale.	G	M	**Perennial Streams:** Little change known. **Intermittent Streams:** Some increase by extension of drainage from roads. **Wetlands:** No known change. **Lakes & Ponds:** No change known.
2) Connectivity between watersheds	F	H	Some constriction at the Cline road crossing of Kilborn Creek; otherwise good overall. Lower section has been channelized. Most effects occur on private lands.
3) Integrity of aquatic systems	F	M	Lack of existing LWD in Kilborn Creek (RM 0 - 3.0). High natural sediment transport and storage has been observed on Killborn Creek (RM 0 - 3.0) from both natural and management related sources. Most effects occur on private lands.
4) Water quality for healthy ecosystems	G	M	Stream survey temperatures recorded 11°C. It is doubtful that the stream temperature exceeded 14°C during the hottest summer months.
5) Appropriate sediment regime	F-	M	This watershed displays a relatively high rate of naturally occurring mass wasting (debris flows). In addition a substantial number of management related failures have also occurred. Road restoration work done on FS Rd. 2304 during the early 1990's was intended to reduce the future mass wasting rate from roads. Road density is 1.91 mi/mi^2.
6) In stream flow	F	M	Poor WAR (11.2%). Fair ARP (79%). Peak flow concerns exist in Kilborn Creek.
7) Floodplain Function	G	M	Minor channelization upslope from Cline road. One housing development.
8) Structural diversity of plant communities in riparian reserves	G	H	Riparian reserves along most of the mainstem Kilborn Creek is large tree, with minor amounts of grass/pole and small tree along its tributaries.
9) Habitat to support well distributed populations of riparian species	G	H	In the riparian reserves there is 89% small or large tree, 9% grass/pole, and 2% non-forest habitat (federal lands only). Kilborn Creek is well connected in large tree habitat. Several side tributaries contain small and large tree habitat broken by grass/pole stands. No species data for this WSU.
LS) Late successional habitat	F	H	45% of the WSU is large tree (federal and non-federal lands). A narrow band of LS habitat is connected along the entire length of Kilborn Creek. A large block of LS habitat is found in the headwaters. LS habitat has been heavily fragmented south of Kilborn Creek.

Comments:

Heavy sediment loads have blocked anadromous fish runs from using the upper sections of Kilborn Creek.

ACS #4: Kilborn Creek supports cut throat and Montana black spotted trout (RM 0.0 - 0.7).

ACS #8: See Map 18, 1997 Vegetation Structure within Riparian Reserves.

LS Habitat: See Map 10, Current (1997) Vegetation Structure.

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.

Historic and current conditions of the watershed were described in chapter 3. In order to best describe 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 Upper Cowlitz watershed and at a combined sixth-field subwatershed (WSU) scale. This will help to avoid duplication of broad recommendations, while listing specific recommendations in WSU tables.

The following is a description of the desired future condition for this watershed.

Desired Future Condition

Vegetation:

There are five broad categories (called Designated Areas) of management direction that drive the course of vegetation development in the Upper Cowlitz River watershed: Administratively Withdrawn Areas, Congressionally Reserved Areas, Late-Successional Reserves, Matrix, and Adaptive Management Area.

Administratively Withdrawn Areas - consist of several Management Area Categories (MAC's): Research Natural Area (W6), Roaded Recreation Without Timber Harvest (RL), Special Interest (9L), Unroaded Recreation (UD, UH), Utility Sites and Corridors (4W), Scenic River (NA), and Wildlife Special (IL). 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 these stands. The proportion of each species is determined by elevation and aspect. Other associated tree species may include bigleaf maple, Pacific yew (lower elevations); 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 - 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 (LSR's) - consist of lands set aside to protect and enhance conditions of late-successional and old-growth ecosystems. The long-term objective is to provide for the protection of current and enhance 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 tree harvest is prohibited, although it may have occurred in the past. Pre-commercial and commercial thinning may occur in stands up to 80 year of age if the purpose is to benefit the creation and maintenance of late-successional forest conditions. Future vegetation will be primarily the result of natural disturbance and succession, except in past harvest plantations where thinnings will occur. The desired condition of vegetation is similar to that described above for Administratively Withdrawn Areas.

Matrix and Adaptive Management Areas (AMA) - consists of the following MAC's: General Forest (TS), Deer and Elk Winter Range (EM/ES), Visual Emphasis (VL/VM), Mountain Goat Winter Range (QM, QX), and Mountain Goat Summer Range (MM, MX). 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 of thinning (pre-commercial and commercial) and regeneration treatments. Structural diversity within stands will be affected by riparian reserves and TES/Survey and Managed species, aggregate retention patches, unthinned patches, and created canopy gaps. The tree species mix will be similar to that described for Administratively Withdrawn Areas. Unroaded Areas (UD, UH) and Special Interest (9L) MAC areas have no scheduled timber harvest. The desired future condition of vegetation is similar to that described for the Administratively Withdrawn Areas.

Wildlife and Botanical Resources

The desired future condition relative to wildlife and botanical resources is to maintain viable populations of all native and 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, re-vegetation with native species, and potentially developing water collection and containment devices.

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 improving habitat conditions for dependent species, particularly those requiring large home ranges. Connectivity between the Packwood and Nisqually LSR's on national forest lands would also be enhanced as young stands mature allowing favorable dispersal conditions for wildlife and botanical species.

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 forest plan guidelines.

On mountain goat ranges, optimal cover acreage would be maintained. On thermal cover stands, innovative commercial thinning approaches could be used to advance succession of stands into 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 Columbia River Basin Anadromous Fish Habitat Management Policy and Implementation Guide (PIG), the Land and Resource Management Plan, Amendment 11, state and federal laws and interpretation of ACS objectives.

Specifically, the desired future condition of the various physical components of streams is evaluated largely using PIG Guidelines. Prior to 1994, LWD was rated as follows: < 25% of the stream reach affected by LWD was considered "poor"; > 25% was considered "moderate"; and the presence of abundant LWD was considered "good". At that time, specific protocols regarding length and diameter measurements had not yet been developed. Since 1994, 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. Evaluation of width to depth ratios was based on Rosgen's (1994) stream channel classification. A width to depth ratio greater than 10 is indicative of negative impacts such as increased water temperatures, filled pools, and covered salmon redds. Streams with a width to depth ratio of 10 or less are generally considered in good condition, depending on channel type (See appendix A). 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 peakflow is to achieve an ARP value > 90% and WAR thresholds (< 5%) as defined in the Gifford Pinchot Cumulative Assessment Report and the Washington State Peakflow Module. Other desired future conditions for the aquatic component are to meet the ACS objectives. (See page 5-3 of this document for interpretation of ACS objectives.)

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 1940'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 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, then, 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 main stem upper Cowlitz river, while 100-year peak flow levels were used along the upper Cowlitz river itself. The desired future condition of riparian reserves is continued large-tree development. However, it is expected that a large portion of privately owned lands will never reach this stage, due to road systems, and residential and agricultural development.

Human Uses within the Watershed

Lands within the Upper Cowlitz 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 ATM plans.

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 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 ROD, are recommended based on the evaluation of each subbasin 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 and fisheries biologist, and silviculturist. The most likely streams to have changes are those that fall into the category of Class IV. It is likely that project-specific surveys will identify many such streams. Any changes to riparian reserves should be based upon "on-the-ground" reviews, and determining that such a change would not affect the 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 the riparian reserves when the harvest activities are *specifically designed to accelerate the improvement of aquatic/wildlife conditions and/or the development of late structural 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 pre-commercial 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 Upper Cowlitz watershed should initially focus on restoring connectivity in riparian reserves associated with upper Butter, upper Smith, Little Johnson, Johnson, Deception, upper Davis, North and West Forks Willame, and Hager Creeks. Because most of the Cowlitz River and Lynx Creek are on private lands, partnerships and possibly funding of restoration projects will be required to restore riparian areas. Restoring connectivity along these watercourses will provide habitat and travel corridors which lead throughout the watershed. Connectivity would be provided between the LSR's located in the north and east portions of the watershed. These corridors would also provide connectivity to the adjacent watersheds. Restoration could include planting riparian species, fencing of the riparian area in pastures, and pre-commercial and commercial thinnings designed to promote late-successional habitat conditions, snag and coarse woody debris placement and/or creation.

Roads

Substantial cumulative hydrologic effects observed in portions of this watershed are in large part are attributable to erosion and mass wasting associated with roads. It is apparent that a need exists to reduce the impacts of these roads on the aquatic conditions. A portion of the Federally administered land in the Upper Cowlitz watershed is in timber producing allocations (Matrix and Adaptive Management Area). The challenge is how best to effectively meet timber production 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 (particularly regeneration harvest) under the current management guidelines appear to be limited in this fifth-field watershed over at least the next 10 years, and in some parts of the watershed for as long as 20-25 years. In particular, regeneration harvest will be limited in the Deception and Willame Creek drainages for a time because of the substantial timber harvest and cumulative effects that have occurred there. However, the current analysis also indicates a need for precommercial thinning on a significant portion of this fifth-field watershed, primarily to promote long-term timber production on ground within Matrix and AMA allocations, as well as contribute to the development of late-successional characteristics where applicable. In addition, there is a concern that the existing condition of the road system is susceptible to severe storm events that occur several times per decade. Storm events in years 1994-96 have combined to create damage to the road network in the Upper Cowlitz watershed that will require greater than $1,112,00 to repair to the same or slightly improved condition; additional funds are being used to upgrade road conditions in an attempt to minimize flood damage in the future. However, continued storm damage costs of this magnitude 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 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 portion 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 plan (ATM) to reflect new information from road condition surveys and timber management assessment. 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), for only those roads or segments determined to pose some risk toaquatic 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, but recognize 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, shortcut 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 Highway 12 and/or the town of Packwood. This may involve cooperative ventures with state and private landowners along the 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 extend 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 Upper Cowlitz watershed has lands where new harvest opportunities should be explored including those within Late-Successional Reserves

(LSRs) following the Forestwide LSR Assessment. Where feasible, stewardship forest product contracts should be established. They allow for more close administration of on-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 Watershed Stratification Unit (WSU) Scale

The following tables contain recommendations and concerns related to specific management activities for each WSU (made up of combined sixth-field watersheds). 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 WSU may not have identified opportunities for certain management activities now, it does not preclude future opportunities.

Table 6-1: WSU #1 - Dry Creek

Activity	Recommendations	Concerns
Regeneration Harvest	North of Hwy 12 some limited opportunity for harvest in VM allocation in next ten years. Little to no harvest opportunity in Deer and Elk Winter Range (EM). Some very limited opportunities for harvest of thermal cover south of Hwy 12 in Goat Summer Range (MM). Minimize fragmentation in the Dry Creek interior forest.	Currently deficient in optimal cover acreage in Deer, Elk , and Goat Winter Range (EM, ES, QM). Note: two spotted owl pairs and northern spotted owl critical habitat. Three known plant TES sites occur in this WSU. Domestic water sources on Karr and Dry Creeks. Inventoried Roadless areas present.
Commercial Thinning	Opportunities for harvest to enhance the development of late-successional habitat in large block of small tree forest (result of large burn south of Hwy 12). Opportunity for some limited commercial thinning in Goat Summer Range (MM, MX), Goat Winter Range (QM), Visuals Emphasis (VL, VM), Deer and Elk Winter Range (EM).	Peak flow concerns in Dry Creek. Domestic water sources on Dry Creek. Inventoried Roadless present. Three known plant TES sites occur in this WSU.
Roads	No projects identified.	None of the roads on federal lands in this WSU have known road condition concerns.
Other Restoration	Reduce conifer encroachment in meadows by fire and mechanical means to improve goat habitat. Development a fire management plan for Mountain Goat habitat improvements. Opportunity to pursue partnerships with private and state land owners to improve fisheries habitat conditions on mainstem Cowlitz River.	None identified at this time.
Recreation and Trails	Construct a trailhead for the Dry Creek Trail. Consider re-establishing old trail route to Dry Creek Pass as part of a possible Roads-to-Trails (RTT) project (see RTT Plan, 1995)	Need to consider private and state land ownership.
Other Issues	Drop the American Marten allocation. There is a possible opportunity to develop a year-round water source for wildlife use on Smith Ridge. Monitor the success of recently established stewardship contracts for salal and beargrass along FS Road 1256 and apply to other areas where appropriate.	None identified at this time.

Table 6-2: WSU #2 - Smith Creek

Activity	Recommendations	Concerns
Regeneration Harvest	No regeneration opportunities in Deer and Elk Winter Range (EM). No regeneration opportunities of thermal cover in Mtn. Goat Winter Range (QX) on Southpoint Ridge only. There are opportunities in AMA TS allocation. Consider salvage harvest in riparian reserves of Castle Butte Creek because of heavy decline/mortality in Pacific Silver Fir stands affected by tephra deposition.	Currently deficient in optimal cover acreage in Deer, Elk and Goat Winter Range. There are three spotted owl pairs and critical habitat. There is one known "survey and manage" plant site. Elevated sediment levels have been delivered to Smith Creek in the past due to road failures, with associated effects to stream width/depth ratios observed. Seek to avoid further fragmentation of large tree stands in upper Smith Creek. Note riparian vegetation and large woody debris concerns (stream segment 11-13). Inventoried Roadless present.
Commercial Thinning	Some limited opportunities in Goat Winter Range (QX) on Southpoint Ridge to accelerate development of optimal cover. Opportunities exist in the General Forest (TS), Visual Emphasis (VM) and Deer and Elk Winter Range (EM) allocations.	Inventoried Roadless present. Note riparian vegetation and large woody debris concerns (stream segment 11-13). There is one known "survey and manage" plant site.
Roads	Restoration opportunities exist on the portion of Rd 2010 that has not been decommissioned. Decommissioning of high risk segments of Rd 2010 and 2020 occurred in the 1993.	None identified at this time.
Other Restoration	Opportunity for .75 miles of in-stream work on Smith Creek. Reduce conifer encroachment in meadows by fire and mechanical means to improve goat habitat.	None identified at this time.
Recreation and Trails	Roads-to-Trails proposals for the Klickitat Trail near Jackpot Lake, FS Road 2020/ South Point Loop and Dry Creek Pass.	Historic status of the Klickitat Trail should be considered.
Other Issues	Drop the Pileated Woodpecker allocation. There is possible opportunity to develop a year-round water source for wildlife use on Smith Ridge. Continue the long-term monitoring of sub-alpine meadows in Mountain Goat habitat.	None identified at this time.

Table 6-3: WSU #3 - Johnson Creek

Activity	Recommendations	Concerns
Regeneration Harvest	Very limited opportunities in Goat Winter Range (QX) allocation (Angry Mtn. area). Limited opportunities in Goat Summer Range (MX) allocation. Most opportunities for harvest in General Forest (TS) are located in Inventoried Roadless.	Nine spotted owl pairs present and critical habitat. Cumulative effects (increased sediment load rate, changes in channel conditions) in Deception Creek; reduced or deferred regeneration for a decade. Aquatic concerns include lack of LWD, heavy sediment transport and storage and stream channel connectivity in Deception Creek. Aquatic concerns include sediment delivery, transport and storage in lower Mission Creek. Terrestrial connectivity concerns in the headwaters of Johnson Creek. Inventoried Roadless present.
Commercial Thinning	Inside LSR - vary minor amounts of thinning opportunities in older plantations. Outside LSR - very limited opportunities in Goat Summer Range (MX) allocation in the Mission Creek drainage. Also limited opportunities in older plantations.	Nine spotted owl pairs present and critical habitat. Inventoried Roadless areas present.
Roads	Restoration opportunities exist on the 4820-015, and the 2130 road system. Evaluate FS Road 2100 for opportunities to improve drainage. Maintain the closure of FS Road 2130-038 to the Stonewall Ridge goat habitat area.	Access for future (apprx. 10 years) TSI projects in Deception Creek.
Other Restoration	Opportunity for .75 miles of in-stream work in Deception Creek. Reduce conifer encroachment in meadows by fire and mechanical means to improve goat habitat.	None identified at this time.
Recreation and Trails	Manage campsite use in the Wilderness at Heart Lake to minimize impacts to riparian vegetation. Allow for natural fires to burn within prescription as specified with the Goat Rocks Wilderness Prescribed Fire Implementation Plan. Johnson Creek Snowpark - improve and expand parking facilities and construct a late-season snowpark parking along Road 2100 between Glacier and Wright Lake. Potential relocation of the Jordan Creek and Angry Mtn. trailheads along Road 2100. Continue and expand efforts to identify and eradicate noxious weeds at Wilderness entry points (ie. trailheads).	Trailhead relocations would eliminate part of the need for public access to Roads 2140 and 2120 which have had washouts and sloughing problems.
Other Issues	Drop the Pileated Woodpecker allocation. Continue the long-term monitoring of meadows in Mountain Goat habitat.	Recent data suggests no distinctions between how goats are using Mountain Goat Summer and Winter Range in the AMA area based on survey flights.

Table 6-4: WSU #4 - Lake Creek

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no regeneration opportunities.	None identified at this time.
Commercial Thinning	Limited opportunities in older plantations.	One spotted owl pair and critical habitat. Five known plant TES sites. Aquatic concerns include sediment transport storage and delivery (segments 28 and 29).
Roads	Restoration opportunties exist on FS Roads 1266, -041, -069, -076, 1262 and 4830-066.	FS Road 1266 provides access to the Three Peaks Trail.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	Manage campsites in the Packwood Lake area to minimize disturbance to spawning trout. Allow for natural fires to burn within prescription as specified with the Goat Rocks Wilderness Prescribed Fire Implementation Plan. Potential relocation of the Lily Basin trailhead down FS Road 48 to eliminate costly road maintenance due to road washouts and sloughing. Reconstruct portions of the Upper Lake Creek Trail #96 damaged during recent flood events. Consider relocation of lower portion of the Three Peaks Trail off of old road route. Continue and expand efforts to identify and eradicate noxious weeds at Wilderness entry points (ie. trailheads).	None identified at this time.
Other Issues	None identified at this time.	None identified at this time.

Table 6-5: WSU #5 - Coal Creek

Activity	Recommendations	Concerns
Regeneration Harvest	LSR and Wilderness - no regeneration opportunities.	None identified at this time.
Commercial Thinning	Limited opportunities in older plantations.	Two spotted owl pairs and critical habitat. Lack of LWD and large tree structure in the riparian area of lower most Coal Creek (Segment 31, see Table 4-5). The remainder of riparian vegetation along Coal Creek is in good shape.
Roads	Restoration opportunities exist on FS roads 4610, 4610-041, -072, and -405.	Access needs for TSI projects in the next 5 years using the 4610 road system. From Wilderness standpoint, preference is for road 4610 to be closed to vehicle traffic beyond Coal Creek due to informal trail access.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	Manage campsite use in the Wilderness at Lost Lake to minimize impacts to riparian vegetation. Allow for natural fires to burn within prescription as specified with the Goat Rocks Wilderness Prescribed Fire Implementation Plan. Continue and expand efforts to identify and eradicate noxious weeds at Wilderness entry points (ie trailheads).	None identified at this time.
Other Issues	None identified at this time.	None identified at this time.

Table 6-6: WSU #6 - Hall Creek

Activity	Recommendations	Concerns
Regeneration Harvest	Most of the federal land in this WSU is in LSR - no regeneration. Defer harvest in Deer and Elk Winter Range (ES, EM) allocation north of Cowlitz River for eight to ten years.	Marbled Murrelet critical habitat. Two spotted owl pairs and critical habitat. One known plant TES site and one known plant "survey and manage" site.
Commercial Thinning	In LSR there will be some opportunities in the lower elevations in older plantations. Outside the LSR there may be very limited opportunities in the Deer and Elk Winter Range (ES) allocation.	A high percentage of ES allocation has been already commercially thinned. One known plant TES site and one known plant "survey and manage" site. Aquatics concerns include stream channel connectivity, deficit LWD, sediment transport, storage and delivery along the lower and upper Hager Creek (Segments 36 and 37, see Table 4-5).
Roads	Restoration opportunities for approximately 10 miles of decommissioning on FS Road 4840, 4820 and 4830. Other restoration includes FS Roads 48, 4820, 4830, 4840-024, 1262-029, 4610 south of Purcell Creek.	Access needs for TSI projects along roads 48, 4820, 4830, and 4840. Dispersed recreation along FS 48 road system and spurs.
Other Restoration	Opportunity to pursue partnerships with private and state land owners to improve fisheries habitat conditions on mainstem Cowlitz River. Investigate potential for noxious weed control in the "Boneyard Swamp".	None identified at this time.
Recreation and Trails	Complete a Prescribed Fire Implementation Plan for Tatoosh Wilderness. Manage public access on FS Roads 5290 and 5292 to minimize garbage dumping, road closure violations, the development of a informal shooting range, and special forest product gathering within portions of the Tatoosh Wilderness. Reconstruct sections of the Tatoosh Trail which are rutted and experiencing tread erosion. Continue and expand efforts to identify and eradicate noxious weeds at Wilderness entry points (ie. trailheads).	None identified at this time.
Other Issues	Drop American Marten and Pileated Woodpecker allocations. Maintain and enhance existing nest boxes, create snags and consider the use of fire to enhance wildlife habitat at the "Boneyard Swamp".	None identified at this time.

Table 6-7: WSU #7 - Butter Creek

Activity	Recommendations	Concerns
Regeneration Harvest	Primarily Wilderness, National Park and LSR - no opportunities. Outside LSR - very limited opportunities in Deer and Elk Winter Range (EM) allocation - defer harvest for eight to ten years.	Lack of deer and elk optimal cover. Marbled Murrelet critical habitat. One spotted owl pair in critical habitat. One known plant TES site. Aquatic concerns include stream channel stability (Segment 40, see Table 4-5).
Commercial Thinning	Inside LSR - very limited opportunities in lower Butter Creek in older plantations. Outside LSR - opportunity in one older plantations.	One known plant TES site.
Roads	Restoration opportunities exist on FS roads 5270 (last mile), and the 5270-066.	Potential relocation of Tatoosh Trailhead down to junction of roads 5270 and 5270-066.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	Manage campsite use in the Wilderness at Tatoosh Lake to minimize impacts to riparian vegetation. Complete a Prescribed Fire Implementation Plan for the Tatoosh Wilderness. Potential relocation of the Tatoosh trailhead down Road 5270 to eliminate costly road maintenance due to road washouts and sloughing. Reconstruct sections of the Tatoosh Trail which are rutted and area experiencing tread erosion. Continue and expand efforts to identify and eradicate noxious weeds at Wilderness entry points (ie. trailheads).	None identified at this time.
Other Issues	Drop American Marten and Pileated Woodpecker allocations.	None identified at this time.

Table 6-8: WSU #8 - Skate Creek

Activity	Recommendations	Concerns
Regeneration Harvest	Inside LSR - no opportunities. Outside LSR - limited opportunity in a small piece of General Forest (TS) allocation. Some opportunity in the Visual Emphasis (VL) allocation.	No opportunity in Deer and Elk Winter Range (EM) due to existing openings. Marbled Murrelet critical habitat. Five pairs of spotted owls and critical habitat. Aquatic concerns include temperature (esp. private lands), riparian vegetation, lack of LWD, stream channel width/depth ratios and sediment delivery transport and storage (Segment 42, see Table 4-5).
Commercial Thinning	Inside LSR - no known opportunities at this time. Outside LSR - possible opportunity in one older plantation.	Presence of Inventoried Roadless acreage.
Roads	Restoration opportunities exist on FS roads 4720, 4745, 5240, 5240-049, and the 5260 system.	Future access needs for future TSI projects using the 4720, 5240, and 5260 road system.
Other Restoration	Opportunities for 3 miles of in-stream work in Skate Creek (segments 43 and 46).	None identified at this time.
Recreation and Trails	Complete a management plan to designate where dispersed campsite use is appropriate within the Skate Creek corridor along FS Road 52; define parking, provide for sanitation and litter control. Potential for interpretive facility at Bear Prairie (wildlife, geology, cultural, fisheries). Consider Road-to-Trail (RTT) proposals for the Lookout Mountain area and Silver Creek Loop (formerly known as Sawtooth Loop, see RTT Plan, 1995). Complete a Prescribed Fire Implementation Plan for Tatoosh Wilderness and the Butter Creek Research Natural Area (National Park Wilderness). Continue and expand efforts to identify and eradicate noxious weeds at Wilderness entry points (ie. trailheads). Develop winter parking (plow snow, sign, and provide for sanitation) at the junction of FS Roads 52/47.	None identified at this time.
Other Issues	Drop all American Marten and Pileated Woodpecker allocations. Maintain existing nest box structures at Bear Prairie. Monitor nest box utilization and created potholes effectiveness. Consider providing for expanded Matsutake mushroom harvest within LSR lands (following LSR assessment) and rotating the harvest between stands to allow for the rebuilding of mushroom populations.	None identified at this time.

Table 6-9: WSU #9 - Willame Creek

Activity	Recommendations	Concerns
Regeneration Harvest	Inside LSR - no opportunities. Outside LSR - best opportunities in the General Forest (TS) allocation, particulary the South Fork Willame drainage.Very limited opportunities in the North Fork and West Fork Willame Creek portions of the General Forest (TS) allocation. Very limited opportunities for harvest of thermal cover within Deer and Elk Winter Range (ES) allocation. Some opportunities in the Visual Emphasis (VM) allocation.	Marbled Murrelet (Zone 2) and critical habitat. Five pairs of spotted owls and critical habitat. Minimize fragmentation in the South Fork Willame Creek. Optimal cover is deficit in Deer and Elk Winter Range (ES) allocation. Four known sites of "survey and manage" species. Aquatic concerns for the West Fork Willame Creek include peak flow, stream channel connectivity, width/depth ratios, channel stability, and sediment transport storage and delivery (Segment 54, see Table 4-5); North Fork Willame Creek include peak flow, lack of LWD, width/depth ratios, channel stability, and sediment transport storage and delivery (Segment 55-57, see Table 4-5); mainstem Willame and Lillian Creeks include peak flow, lack large tree riparian vegetation, lack of LWD (Willame Creek only), width/depth ratios, channel stability, and sediment transport storage and delivery (Willame Creek - Segment 48-51, 58 and Lillian Creek - Segment 52, see Table 4-5);
Commercial Thinning	Inside LSR - possible opportunities in older plantations near the North Fork or mainstem Willame Creeks. Outside LSR - limited opportunities in older plantations in Deer and Elk Winter Range (ES) and General Forest (TS) allocations. Some limited opportunities of natural stands in Deer and Elk Winter Range (ES) and General Forest (TS) allocations in Lillian and South Fork Willame Creeks.	Same as above for wildlife, plant TES and aquatics cocerns.
Roads	Restoration opportunities exist along FS roads 1256, -100, 4700, 4700-011, 4710-410 (on Skyo Mtn.), 4710, 4725 system, 4740, -013, -031, -034, -138, 4715, -030, -039, 4745, and the 4730 road system.	Access for future TSI projects on FS roads 4700, 4710, 4715, 4725, 4730, 4740, and 4745. Recreation opportunities along the 4740 road (Long Lake) and the 4730 road (Willame Lake).
Other Restoration	Opportunities for 3 miles of in-stream work (Segment 50, see Table 4-5), replacement of culverts (Segment 49 and 52) to improve fish passage, bank stabilization on 4.25 miles (Segment 55), 8 acres of erosion control (numerous slides).	None identified at this time.
Recreation and Trails	Consider Roads to Trails proposal for Long Lake/Willame Lake (see RTT Assessment, 1995).	None identified at this time.
Other Issues	Schedule intensive wildlife inventory of the South Fork Willame area for TES and "survey and manage" and other species. Retain the American Marten allocation just south of Willame Lake and drop the Pileated Woodpecker allocation.	None identified at this time.

Table 6-10: WSU #10 - Davis Creek

Activity	Recommendations	Concerns
Regeneration Harvest	Limited opportunities in General Forest (TS) allocation. Very limited opportunities for harvest of thermal cover in the Deer and Elk Winter Range (EM) allocation. Limited opporunity within a small piece of Visual Emphasis (VM) allocation.	Marbled Murrelet (Zone 2). One pair of spotted owls and critical habitat. Deer and Elk optimal cover deficient, recent harvest of adjacent of private lands is providing forage. Aquatic concerns include peak flows, channel stability and sediment delivery, transport and storage (Segments 60-61, see Table 4-5).
Commercial Thinning	Limited opportunities in the older plantations in the General Forest (TS) allocation.	Marbled Murrelet (Zone 2). One pair of spotted owls and critical habitat. Aquatic concerns include peak flows, channel stability and sediment delivery, transport and storage (Segments 61, see Table 4-5).
Roads	Expected road projects on FS 6300, 6300-052, -069, -081, 6320, 6300-100 and the 6300-056.	Accesss needs for future TSI projects on FS roads 6300 and 6320. Trailhead off the 6300-057.
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	Potential relocation of the Purcell Mtn. trailhead to the Road 63/6300-057 junction to eliminate costly road maintenance due to road washouts and sloughing. Consider Roads to Trails proposal for Purcell Mountain Loop (see RTT Assessment, 1995). Consider relocation of southernmost Purcell Mountain trailhead onto National Forest lands to reestablish public access.	None identified at this time.
Other Issues	Drop the American Marten and Pileated Woodpecker allocation. Monitor the harvest of beargrass off FS Road 63 (west slope of Davis Mtn.) to determine long-term impacts to the vegetation.	None identified at this time.

Table 6-11: WSU #11 - Kilborn

Activity	Recommendations	Concerns
Regeneration Harvest	Very limited opportunities in all allocations. Harvest of thermal cover only within Deer and Elk Winter Range (EM).	Deer and Elk Winter Range optimal cover acreage is deficient. One owl pair and critical habitat. One known plant TES site. Aquatic concerns include peak flows, channel stability, sediment delivery, transport and storage (segment 62, see Table 4-5).
Commercial Thinning	Very limited opportunities in General Forest (TS and Visual Emphasis (VM) allocations.	Same as above for aquatic and plant TES concerns.
Roads	Restoration possibilities exist on FS road 2304.	Current and future access needs for timber sale operations along FS road 2304. Access needs for future TSI projects also along FS 2304 road system. Trailhead at the end of FS road 2304 (alternate access opportunities exist).
Other Restoration	None identified at this time.	None identified at this time.
Recreation and Trails	Construct a trailhead near the Cline Road at Killborn for the Pompey Trail.	Concern expressed from adjacent landowner near Killborn Creek.
Other Issues	None identified at this time.	None identified at this time.

The following table summarizes all recommendations (opportunities and needs) identified for the Upper Cowlitz watershed.

Table 6-12: Summary of Recommendations for the Upper Cowlitz Watershed

Activity	Recommendations (opportunity and/or need)	WSU #(s)
Regeneration Harvest	Limited harvest	1 (VM), 2 (TS), 3, (TS/MX), 8 (TS/VL), 9 (TS/VM), 10 (TS/VM)
	Very limited harvest	1 (EM/MM), 3 (QX), 6 (EM/ES), 7 (EM), 9 (ES), 10 (EM), 11 (EM/VM/TS)
Commercial Thinning	Limited harvest	1(MM/MX/QM/VL/VM/EM), 2 (TS/VM/EM/QX), 6 (LSR), 9 (TS/ES), 10 (TS)
	Very limited harvest	3 (MX/LSR), 4 (LSR), 5 (LSR), 6 (ES), 7 (LSR/EM), 8 (VL), 9 (LSR), 11 (TS/VM)
Roads	Road Restoration: 2010, 4840, 4820-015, 2130, 1266, -041, -069, -077, 1262, 4830-066, 4610, -041, -072, -045, 2100, 2130-038, 4820, 4830, 4840-024, 1262-029, 4610, 5270, -066, 4720, 4745, 5240, 5240-049, 5260, 4700, -011, 4710, -410, 4725, -013, -031, - 034, -138, - 4715, -030, - 039, 4745, 4730, 6300, -052, - 056, -069, -081, -100, 6320, 2304,	2-11
Other Restoration	In-Stream Improvements: Cowlitz River, Smith Creek, Deception Creek, Skate Creek, Willame Creek	1-3, 6, 8, 9
	Meadow Maintenance	1-3

Table 6-12: Summary of Recommendations for the Upper Cowlitz Watershed		
Recreation and Trails	Roads-To- Trails: Dry Creek Pass, Klickitat, South Point Loop, Lookout Mtn., Silver Creek Loop, Long/Willame Lakes, Purcell Mtn. Loop;	1, 2, 8, 10
	Trailhead Developments and/or Relocations: Dry Creek, Johnson Creek Snowpark, Jordan, Angry Mtn., Lily Basin, Tatoosh, Bear Prairie, Rd 52/47 Snowpark, Purcell Mtn, Pompey;	1, 3, 4, 7-11
	Allow natural fire to burn in Wilderness areas: Goat Rocks, Tatoosh (need plan);	3-8
	Eradicate noxious weeds at Wilderness entry points;	3-8
	Manage dispersed campsite use: Skate Creek, Wilderness lakes - Packwood, Heart, Lost, Tatoosh,	3, 4, 5, 7, 8
Other Issues	Drop Pileated Woodpecker and American Marten allocations;	1-3, 6-8, 9 (retain American Marten allocation)
	Wildlife habitat enhancements (ie. next boxes, snags creation, Mt. Goat habitat monitoring, water source creation);	1, 2, 3, 6, 8
	Special Forest Product projects;	1, 6, 8, 10
	Wildlife TES inventory;	9

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Appendix A

Water Available for Runoff - Upper Cowlitz Watershed:

Dry Watershed (WSU 1) - 15,781 acres, 24.654 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	7.1%	12.5%	17.2%	33.3%	9.4%	18.4%
5 yr	5.0%	9.3%	12.0%	24.7%	6.6%	14.0%
10 yr	4.5%	8.6%	10.9%	22.8%	6.0%	13.1%
25 yr	3.5%	6.9%	8.4%	18.3%	4.7%	10.7%
50 yr	3.2%	6.3%	7.7%	16.9%	4.3%	9.8%

Smith Watershed (WSU 2) - 10,347 acres, 16.175 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	2.6%	5.8%	11.0%	23.1%	8.1%	16.3%
5 yr	1.7%	4.1%	7.5%	16.7%	5.6%	12.0%
10 yr	1.5%	3.7%	6.5%	14.7%	4.8%	10.6%
25 yr	1.2%	3.0%	5.1%	11.9%	3.8%	8.7%
50 yr	1.0%	2.7%	4.5%	10.7%	3.4%	7.8%
100 yr	0.9%	2.4%	4.1%	9.9%	3.1%	7.2%

Johnson Watershed (WSU 3) - 31,103 acres, 48.592 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	2.0%	3.6%	12.1%	21.5%	9.8%	17.2%
5 yr	1.3%	2.6%	7.9%	15.6%	6.5%	12.6%
10 yr	1.1%	2.3%	6.8%	13.6%	5.5%	11.1%
25 yr	0.8%	1.8%	5.1%	10.8%	4.2%	8.8%
50 yr	0.7%	1.6%	4.5%	9.8%	3.7%	8.0%
100 yr	0.6%	1.5%	4.1%	8.9%	3.3%	7.3%

Lake Watershed (WSU 4) - 16,409 acres, 25.645 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	2.7%	3.6%	15.0%	21.4%	11.9%	17.1%
5 yr	1.7%	2.6%	9.4%	15.4%	7.6%	12.4%
10 yr	1.5%	2.4%	8.4%	14.1%	6.8%	11.4%
25 yr	1.1%	1.8%	6.1%	11.0%	4.9%	8.9%
50 yr	0.9%	1.7%	5.4%	10.0%	4.4%	8.1%
100 yr	0.8%	1.5%	4.8%	9.0%	3.9%	7.3%

Coal Watershed (WSU 5) - 6,613 acres, 10.329 mi^2

Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	2.1%	4.2%	11.6%	22.7%	9.3%	17.6%
5 yr	1.4%	3.2%	8.1%	16.9%	6.5%	13.3%
10 yr	1.3%	2.8%	7.0%	15.1%	5.7%	11.9%
25 yr	0.9%	2.2%	5.2%	11.7%	4.2%	9.3%
50 yr	0.8%	2.0%	4.7%	10.7%	3.8%	8.5%
100 yr	0.8%	1.8%	4.4%	10.0%	3.5%	7.9%

Hall Watershed (WSU 6) - 18,407 acres, 28.76 mi^2

Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	9.8%	17.5%	19.3%	37.2%	8.6%	16.7%
5 yr	7.2%	13.4%	14.0%	28.6%	6.3%	13.3%
10 yr	6.3%	12.1%	12.3%	25.7%	5.6%	12.1%
25 yr	5.0%	9.7%	9.6%	20.8%	4.4%	10.0%
50 yr	4.6%	9.1%	8.9%	19.3%	4.0%	9.4%
100 yr	4.2%	8.4%	8.1%	17.8%	3.7%	8.7%

Butter Watershed (WSU 7) - 12,104 acres, 18.902 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	4.0%	7.9%	11.6%	21.7%	7.3%	12.7%
5 yr	2.9%	6.1%	8.4%	16.7%	5.3%	10.0%
10 yr	2.3%	5.1%	6.8%	14.0%	4.3%	8.5%
25 yr	1.9%	4.3%	5.5%	11.8%	3.5%	7.2%
50 yr	1.6%	3.7%	4.7%	10.3%	3.0%	6.3%
100 yr	1.4%	3.3%	4.1%	9.2%	2.6%	5.7%

Skate Creek Watershed (WSU 8) - 22,475 acres, 35.116 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	3.0%	6.1%	12.6%	25.3%	9.3%	18.1%
5 yr	2.2%	4.6%	9.1%	19.1%	6.7%	13.8%
10 yr	1.8%	3.9%	7.7%	16.4%	5.7%	12.0%
25 yr	1.5%	3.3%	6.3%	13.8%	4.7%	10.1%
50 yr	1.3%	2.9%	5.5%	12.2%	4.1%	9.0%
100 yr	1.2%	2.6%	4.9%	11.0%	3.7%	8.1%

Willame Creek Watershed (WSU 9) - 13,435 acres, 20.986 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	3.7%	7.7%	14.7%	30.0%	10.5%	20.7%
5 yr	2.7%	5.9%	10.9%	23.2%	7.8%	16.2%
10 yr	2.2%	4.8%	8.6%	18.9%	6.2%	13.3%
25 yr	2.0%	4.4%	7.8%	17.3%	5.7%	12.3%
50 yr	1.6%	3.7%	6.5%	14.6%	4.7%	10.5%
100 yr	1.4%	3.3%	5.7%	13.1%	4.2%	9.4%

Davis Creek Watershed (WSU 10) - 5,502 acres, 8.621 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	5.9%	11.6%	13.4%	27.2%	7.0%	13.9%
5 yr	4.7%	9.5%	10.6%	22.4%	5.6%	11.7%
10 yr	3.6%	7.5%	8.1%	17.6%	4.3%	9.4%
25 yr	3.3%	7.0%	7.4%	16.4%	4.0%	8.7%
50 yr	2.7%	5.9%	6.2%	13.9%	3.3%	7.5%
100 yr	2.4%	5.3%	5.5%	12.5%	2.9%	6.8%

Kilborn Creek Watershed (WSU 11) - 3,262 acres, 5.103 mi^2						
Storm	Normal Event Current Conditions % Increase Over All Forest Conditions	Extreme Event Current Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over All Forest Conditions	Extreme Event All Harvested Conditions % Increase Over All Forest Conditions	Normal Event All Harvested Conditions % Increase Over Current Conditions	Extreme Event All Harvested Conditions % Increase Over Current Conditions
2 yr	5.0%	11.2%	13.5%	29.0%	8.0%	16.0%
5 yr	3.5%	8.2%	9.4%	21.3%	5.6%	12.0%
10 yr	2.9%	7.0%	7.8%	18.1%	4.7%	10.3%
25 yr	2.3%	5.6%	6.1%	14.7%	3.7%	8.5%
50 yr	2.1%	5.2%	5.6%	13.6%	3.4%	7.9%
100 yr	1.9%	4.9%	5.2%	12.7%	3.2%	7.4%

Appendix B

Stream Survey Data

Dry (WSU 1) Stream Survey Data													
Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Burton Cr.	1994	1	6864	12	NA	A	P	Sand	Gravel	1%	Early	NA	NA
	1994	2	2112	14	NA	A	p	Cobble	Gravel	10%	Early	NA	NA
	1983	B1	1109	15-25	NA	No	G	Bedrock		31%	Late	4	NA
	1983	B2	2587	15-25	NA	No	G	NA		20%	Late	4	NA
	1983	B3	1478	8-15	NA	No	F	NA		11%	Late	5	NA
Dry Cr.	1991	D1	2640	8-15	G	A?	P	Gravel	Cobble	5%	Early	2	A
	1991	D2	475	8-15	G	A?	P	S Boulder	Cobble	7%	Mid	2	A
	1991	D3	2957	<8	G	No	G	Bedrock	L Boulder	18%	Mid	4	Aa+
	1991	D4	1637	8-15	G	No	F	L Boulder	S Boulder	17%	Mid	5	Aa+
	1991	D5	898	8-15	G	No	F	S Boulder	Cobble	30%	Mid	4	Aa+
	1991	D6	634	15-25	G	No	F	S Boulder	Cobble	45%	Mid	5	Aa+
	1991	D7	2059	8-15	G	No	F	S Boulder	Cobble	15%	Late	4	Aa+
	1991	D8	2957	8-15	G	No	G	Cobble	S Boulder	5%	Late	5	Aa+
	1991	D9	2482	8-15	G	No	G	Cobble	S Boulder	5%	Late	7	Aa+

Burton Creek 1983 data collected from National Forest boundary to headwaters;
Burton Creek 1994 data collected from confluence with the Cowlitz River to the anadromous fish barrier.

Smith (WSU 2) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Smith Cr.	1994	1	6336	31	G	A	P	Cobble	Cobble	4%	Early	NA	B
	1991	1	2218	8-15	G	R	F	Cobble	NA	2%	Early	6	G
	1991	2	1426	>25	G	R	G	Cobble	S Boulder	3%	Early	7	B
	1991	3	2165	>25	G	R	G	Sand	NA	3%	Early	7	B
	1991	4	1426	8-15	G	R	G	Sand	NA	2%	Mid	7	G
	1991	5	2165	>25	G	R	G	Gravel	Cobble	3%	Early	7	B
	1991	6	528	>25	G	R	G	Gravel	Cobble	3%	Early	7	B
	1991	7	1637	8-15	G	R	F	Cobble	NA	3%	Early	7	B
	1991	8	1003	8-15	G	R	G	Cobble	S Boulder	9%	Early	5	A
	1991	9	950	<8	G	R	G	Bedrock	L Boulder	9%	Late	3	A
	1991	10	2165	15-25	G	R	P	S Boulder	Cobble	5%	Early	10	A
	1991	11	686	8-15	G	R	P	S Boulder	Cobble	5%	Early	10	A
	1991	12	4435	8-15	G	R	G	Cobble	S Boulder	7%	Early	7	A

Smith Creek 1994 data collected from confluence with Cowlitz River to anadromous fish barrier;
Smith Creek 1991 data collected from Rd 20 crossing of Smith Creek to headwaters.

Johnson (WSU 3) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Deception	1987	D1	739	8-15	G	R	P	S Boulder	Cobble	13%	Late	4	Aa+
	1987	D2	1426	8-15	G	R	F	S Boulder	Cobble	17%	Early	4	Aa+
	1987	D3	1162	<8	G	R	P	Bedrock	NA	18%	Early	4	Aa+
	1987	NA	3326	<8	G	R	NA	NA	NA	10%	Mid	4	A
	1987	D4	1637	8-15	G	R	P	Bedrock	Het	13%	Early	4	Aa+
	1987	D5	1109	8-15	G	R	F	S Boulder	Cobble	6%	Early	4	A
	1987	D6	1267	>25	G	R	P	Cobble	S Boulder	4%	Early	5	B
	1987	D7	2429	8-15	G	R	P	S Boulder	Cobble	6%	Early	5	A
	1987	D8	2059	15-25	G	No	F	Gravel	Cobble	1%	Late	5	B
	1987	D9	2957	8-15	G	No	P	Gravel	Cobble	2%	Early	7	B
	1987	D10	1003	8-15	G	No	F	Gravel	Cobble	2%	Late	7	B
	1987	D11	2904	>25	G	No	G	Gravel	Cobble	3%	Early	7	B
Glacier	1983	G1	950	8-15	G	R	F	Cobble	S Boulder	6%	Late	3	A
	1983	G2	1320	15-25	G	R	G	Cobble	S Boulder	5%	Late	3	B
	1983	G3	2323	15-25	G	R	G	S Boulder	Cobble	4%	Late	3	B
	1983	G4	686	15-25	G	R	G	S Boulder	Cobble	8%	Early	3	A
Johnson	1987	1	3225	15-25	G	A	P	Cobble	Cobble	10%	Early	2	A
	1987	2	1619	15-25	G	A	P	Cobble	Cobble	1%	Mid	5	F
	1987	3	1033	15-25	G	A	P	Cobble	Cobble	3%	Late	5	B
	1987	4	704	15-25	G	A	P	Cobble	Cobble	2%	Late	5	B
	1987	5	960	8-15	G	A	P	Cobble	Cobble	4%	Late	3	B

Johnson (WSU 3) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Johnson	1987	6	4537	NA									NA
	1987	7	1864	NA									NA
	1987	8	3950	NA									NA
	1987	9	8192	NA									NA
	1987	10	2780	8-15	G	R	P	Cobble	S Boulder	3%	Early	3	B
	1987	11	685	8-15	G	R	P	Cobble	S Boulder	3%	Early	3	B
	1987	12	738	15-25	G	R	P	Cobble	S Boulder	3%	Late	3	B
	1987	13	703	15-25	G	R	P	S Boulder	Cobble	4%	Mid	3	B
	1987	14	521	15-25	G	R	P	Cobble	S Boulder	4%	Mid	3	B
	1987	15	931	15-25	G	R	P	S Boulder	Cobble	6%	Mid	3	A
	1987	16	765	8-15	G	R	P	S Boulder	Cobble	2%	Late	3	B
	1987	17	2122	8-15	G	R	P	S Boulder	Cobble	6%	Late	3	A
	1987	18	3121	15-25	G	R	F	Gravel	Cobble	2%	Early	3	B
	1987	19	781	8-15	G	R	F	Cobble	Cobble	4%	Early	3	B
	1987	20	761	8-15	G	R	F	Cobble	S Boulder	5%	Early	5	A
	1987	21	467	8-15	G	R	P	Cobble	Cobble	4%	Early	5	B
	1987	22	837	8-15	G	R	F	Cobble	Cobble	3%	Early	5	B
	1987	23	595	8-15	G	R	G	Cobble	Cobble	3%	Early	5	B
	1987	24	1531	15-25	G	R	F	Cobble	Cobble	3%	Late	3	B
	1987	25	683	8-15	G	R	G	Cobble	Cobble	4%	Late	3	A
	1987	26	1293	15-25	G	R	P	Cobble	Cobble	4%	Late	3	B

Johnson (WSU 3) Stream Survey Data													
Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
	1987	27	1510	8-15	G	R	P	Cobble	S Boulder	6%	Late	3	A
	1987	28	1560	8-15	G	R	F	Cobble	S Boulder	5%	Late	5	A
	1987	29	1001	<8	G	R	P	Het	Het	8%	Late	5	A
	1987	30	1572	<8	G	R	P	S Boulder	Cobble	10%	Late	4	A
Jordan	1983	J1	2904	8-15	G	R	G	NA	NA	19%	Mid	4	Aa+
	1983	J2	2376	8-15	G	R	G	NA	NA	8%	Mid	4	A
MF Johnson	1982	MFJ1	1980	NA	NA	R	NA	S Boulder	Cobble	5%	Early	2	A
	1982	MFJ2	2640	NA	NA	R	NA	NA	NA	15%	Late	4	A+
	1982	MFJ3	660	NA	NA	R	NA	NA	NA	11%	Early	4	A+
	1982	MFJ4	1320	NA	NA	R	NA	NA	NA	6%	Early	4	A+
	1982	MFJ5	2640	NA	NA	R	NA	NA	NA	5%	Early	7	A
Mission	1979	M1	660	15-25	NA	R	NA	Cobble	S Boulder	15%	Late	2	Aa+
	1979	M2	1980	15-25	NA	R	NA	Cobble	S Boulder	15%	Early	4	Aa+
	1979	M3	1320	8-15	NA	R	NA	S Boulder	Bedrock	NA	Early	4	NA

Lake (WSU 4) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Lower Lake	1993	L1	3696	11	G	A	P	S Boulder	Cobble	3%	Mid	NA	B
	1993	L2	3168	16	G	A	P	S Boulder	L Boulder	10%	Mid	NA	A
	1993	L3	4752	18	G	R	P	S Boulder	Gravel	8%	Early	NA	A
	1993	L4	4752	29	G	R	P	L Boulder	Cobble	8%	Late	NA	A
	1993	L5	9504	11	G	R	P	Cobble	Gravel	5%	Late	NA	A
	1993	L6	2640	24	G	R	P	Cobble	Cobble	8%	Late	NA	A

Coal (WSU 5) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Coal	1982	C1	1320	NA	G	A?	M	Cobble	S Boulder	2%	Early	2	B
	1982	C2	3960	NA	G	A?	M	Bedrock?		9%	Mid	4	A
	1982	C3	1320	NA	G	R	P	Cobble	S Boulder	7%	Late	3	A
	1982	C4/C5	6600	NA	G	R	P	Bedrock	Cobble	9%	Late	3	A
	1982	C6	1320	NA	G	R	M	Bedrock	Cobble	5%	Early	5	A
	1982	C7	1320	NA	G	R	G	NA	NA	8%	Late	5	A
	1982	C8	1980	NA	G	R	P	Cobble	S Boulder	5%	Early	5	A
	1982	C9	2640	NA	G	R	G	Cobble	Gravel	6%	Late	5	A
Lost Cr.	1984	L1	3960	NA	NA	R	G	Cobble	Gravel	12%	Late	3	Aa+
	1984	L2	634	NA	NA	No	P	L Boulder	Bedrock	38%	Early	4	Aa+
	1984	L3	2640	NA	NA	R	M	Gravel	Cobble	12%	Early	5	Aa+
	1984	L4	2218	NA	NA	R	M	Sand	Gravel	8%	Early	7	A

Hall (WSU 6) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Hager Cr.	1983-4	H1	1056	8-15	G	R	P	Cobble	Sand	4%	Early	2	B
	1983-4	H2	2587	8-15	G	R?	P	NA	NA	10%	Early	2	A
	1983-4	H3	528	<8	G	No	P	Bedrock		20%	Late	4	Aa+
Hager Lake	1983-4	H1	1320	15-25	G	R	G	Sand	Gravel	2%	Mid	1	B
	1983-4	H2	1056	>25	G	R	G	Gravel	Cobble	12%	Early	6	Aa+
	1983-4	H3	528	8-15	G	R?	P	Sand	Gravel	7%	Early	6	A
	1983-4	H4	528	8-15	G	No?	F	Cobble	Gravel	10%	Early	8	A
	1983-4	H5	3696	8-15	G	No	F	Gravel	Cobble	10%	Late	8	A
	1983-4	H6	1320	8-15	G	No	G	Cobble	Gravel	14%	Late	8	Aa+
Hall Cr.	1994	1	4224	NA	NA	A	P	Sand	Gravel	0%	Early	NA	NA
	1994	2	12144	15	NA	A	P	Sand	Gravel	0%	Early	NA	NA
Hinkle Tinkle	1983	HT1	2640	<8	NA	No	P	NA	NA	24%	Mid	8	Aa+
	1983	HT2	2640	8-15	NA	No	P	NA	NA	43%	Mid	8	Aa+
Snyder Cr.	1983	S1	264	>25	G	R?	P	Sand	NA	6%	Early	1	B
		S2	1320	8-15	G	R	F	Sand	NA	7%	Early	6	A
		S3	2112	8-15	G	No	F	Sand	Gravel	12%	Late	8	Aa+
		S4	1320	8-15	G	No	P	S Boulder	S Boulder	24%	Late	8	Aa+
		S5	264	<8	G	R	P	Sand	Sand	3%	Late	9	B

Butter (WSU 7) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Butter Cr.	1987	B1	3062	<8	NA	A	P	Cobble		2%	Early	2	E
	1987	B2	1584	8-15	G	A	P	Cobble	S Boulder	3%	Late	2	B
	1987	B3	475	8-15	G	A	P	Cobble	S Boulder	5%	Late	5	A
	1987	B4	1003	<8	G	R	P	L Boulder	Bedrock	12%	Early	5	Aa+
	1987	B5	1108	<8	G	R	P	L Boulder	Bedrock	9%	Late	4	A
	1987	B6	422	8-15	G	R	P	S Boulder	Cobble	11%	Late	4	Aa+
	1987	B7	1900	<8	G	R	P	S Boulder	Cobble	11%	Early	4	Aa+
	1987	B8	4752	<8	G	R	NA	S Boulder	Cobble	6%	Late	4	A
	1987	B9	1003	8-15	G	R	P	Cobble		2%	Late	5	E
	1987	B10	1214	8-15	G	R	P	Cobble	S Boulder	2%	Early	5	E
	1987	B11	1637	15-25	G	R	P	Cobble		4%	Late	5	B
	1987	B12	4224	15-25	G	R	P	Cobble		4%	Late	5	B
	1987	B13	2429	15-25	G	R	F	Cobble		4%	Late	5	B
	1987	B14	898	8-15	G	R	P	Cobble	S Boulder	4%	Late	5	B
	1987	B15	1637	8-15	G	R	P	Cobble	S Boulder	5%	Late	5	A
	1987	B16	581	8-15	G	R	P	Cobble	S Boulder	4%	Late	5	B
	1987	B17	317	<8	G	R	P	Bedrock	L Boulder	6%	Early	5	A
	1987	B18	845	8-15	G	R	F	Cobble	Cobble	3%	Late	5	B
	1987	B19	845	8-15	G	R	P	Cobble	S Boulder	5%	Late	5	A
	1987	B20	2006	>25	G	R	F	Cobble	Cobble	2%	Late	5	B
	1987	B21	1109	8-15	G	R	P	Cobble	S Boulder	4%	Early	5	B

Butter (WSU 7) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Butter	1987	B22	1320	8-15	G	R	P	Cobble	S Boulder	3%	Late	5	B
	1987	B23	1690	>25	G	R	G	Cobble	S Boulder	4%	Early	5	B
	1987	B24	1373	<8	G	R	P	L Boulder	S Boulder	4%	Early	10	A
	1987	B25	950	<8	G	R	P	Bedrock	S Boulder	5%	Late	5	A
	1987	B26	1003	15-25	G	R	F	Cobble	S Boulder	5%	Early	5	A
	1987	B27	1109	8-15	G	R	P	L Boulder	Bedrock	5%	Early	5	A
	1987	B28	2429	>25	G	R	G	Gravel	Cobble	7%	Late	10	B
	1987	B29	2323	8-15	G	R	P	L Boulder	Bedrock	7%	Early	5	A

Skate (WSU 8) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Skate Creek	1994	1	7708	15-25	P	A	P	Cobble	S Boulder	3%	Early	NA	B
	1994	2	7181	8-15	?	A	P	S Boulder	Cobble	5%	Late	NA	A
	1994	3	9926	8-15	G	A?	P	Cobble	S Boulder	3%	Late	NA	B
	1994	4	14256	8-15	G	A?	P	Cobble	S Boulder	3%	Late	NA	B
	1994	5	9108	15-25	G	R	P	Cobble	Gravel	2%	Late	NA	B
	1994	6	6151	<8	G	R	P	S Boulder	Cobble	9%	Late	NA	A
	1994	7	7286	8-15	G	No	P	Cobble	Gravel	6%	Late	NA	A
	1994	8	5966	8-15	G	No	P	S Boulder	Cobble	12%	Early	NA	Aa+
Little Johnson	1979	LJ1	5808	15-25	NA	A?	NA	S Boulder	Cobble	6%	Mid	5	A
	1979	LJ2	5280	15-25	NA	R	NA	S Boulder	Bedrock	11%	Mid	5	Aa+
	1979	LJ3	1848	15-25	NA	R	NA	S Boulder	Bedrock	3%	Early	7	B
	1979	LJ4	7392	8-15	NA	R	NA	Bedrock	Cobble	11%	Early	7	Aa+

Willame (WSU 9) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Lilian Cr.	1983	L1	264	<8	NA	No	F	NA	NA	5%	Early	6	A
	1983	L2	634	<8	NA	No	G	NA	NA	5%	Early	5	A
	1983	L3	1056	<8	NA	No	F	NA	NA	10%	Early	4	A
	1983	L4	1320	8-15	NA	No	P	NA	NA	8%	Early	4	A
	1983	L5	634	<8	NA	No	P	NA	NA	12%	Late	4	Aa+
	1983	L6	528	<8	NA	No	P	NA	NA	12%	Early	4	Aa+
	1983	L7	1056	<8	NA	No	P	NA	NA	15%	Late	4	Aa+
	1983	L8	1056	15-25	NA	No	P	NA	NA	5%	Early	2	B
	1983	L9	1056	<8	NA	No	P	NA	NA	10%	Mid	5	A
	1983	L10	528	8-15	NA	No	P	NA	NA	15%	Early	5	Aa+
	1983	L11	2112	15-25	NA	No	P	NA	NA	4%	Mid	5	B
	1983	L12	3168	8-15	NA	No	P	NA	NA	3%	Mid	6	B
NF Willame	1979	NFW1	3168	>25	P	R	F	Cobble	S Boulder	NA	Late	6	B?
	1979	NFW2	2006	15-25	P	R	P	Cobble	S Boulder	NA	L / E	5	B?
	1979	NFW3	1162	>25	M	R	F	Cobble	S Boulder	NA	L / E	3	B?
	1979	NFW4	3538	15-25	G	R	F	Cobble	Bedrock	NA	L / E	7	B?
	1979	NFW5	1214	8-15	G	R	F	Cobble	Bedrock	NA	Early	7	A?
	1979	NFW6	2112	8-15	G	R	P	Cobble	Bedrock	NA	L / E	3	A?
	1979	NFW7	3960	NA	G	R	P	Cobble	Gravel	NA	Late	8	NA
SF Willame	1983	SFW1	1056	8-15	G	A	P	Cobble	NA	6%	Mid	2	A
	1983	SFW2	2640	8-15	G	A	F	Cobble	Bedrock	7%	Late	3	A

Willame (WSU 9) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
SF Willame	1983	SFW3	1584	<8	G	R	P	Bedrock	BO	10%	Late	4	A
	1983	SFW4	2376	8-15	G	R	F	Bedrock	NA	5%	Mid	3	A
	1983	SFW5	1320	8-15	G	R	F	Cobble	NA	4%	Mid	5	B
	1983	SFW6	2640	<8	G	No	P	Bedrock	S Boulder	8%	Late	4	A
	1983	SFW7	2904	8-15	G	No	G	Cobble	NA	8%	Late	3	A
WF Willame	1979	WFW1	10032	NA	G	R	NA	NA	NA	NA	NA	NA	NA
	1979	WFW2	1320	NA	G	R	NA	Cobble	Bedrock	NA	NA	NA	NA
	1979	WFW3	3432	NA	G	R	NA	Cobble	S Boulder	NA	NA	NA	NA
	1979	WFW4	2112	NA	G	R	NA	Cobble	S Boulder	NA	NA	NA	NA
	1979	WFW5	1320	NA	G	No	NA	Bedrock	Cobble	NA	NA	NA	NA
	1979	WFW6	1584	NA	G	No	NA	Bedrock	Cobble	NA	NA	NA	NA
	1979	WFW7	2640	NA	G	No	NA	Cobble	Bedrock	NA	NA	NA	NA
Main Willame	1990	W1	6864	NA	NA	A	F	Cobble	S Boulder	3%	Late	3	B
	1990	W2	5016	NA	NA	A	P	Cobble	BO	3%	Mid	7	B
	1990	W3	3960	NA	NA	A	P	Cobble	S Boulder	7%	Mid	3	A
	1990	W4	5280	NA	NA	R	G	Cobble	S Boulder	3%	Mid	6	B
	1990	W5	6864	NA	NA	R	G	BO	S Boulder	13%	Mid	4	Aa+

Davis (WSU 10) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Davis	1984	D1	3564	>25	G	R	P	S Boulder	Cobble	7%	Late	4	A
	1984	D2	4224	8-5	G	R	P	S Boulder	Cobble	8%	Late	4	A
	1984	D3	9240	8-15	G	R	F	Bedrock	S Boulder	11%	Early	3	Aa+

Kilborn (WSU 11) Stream Survey Data

Stream	Date	Reach	Length (ft)	W:D	Temp	Fish[a]	LWD	Dominant Substrate	Subdom. Substrate	Gradient	Riparian Vegetation	VST[b]	RCT[c]
Kilborn Cr.	1993	1	4224	8-15	G	A	P	Cobble	Gravel	5%	Mid	NA	A
	1993	2	8448	15-25	G	No	P	Cobble	Gravel	18%	Late	NA	Aa+
	1993	3	5280	8-15	G	No	F	Cobble	Gravel	9%	Late	NA	A
	1993	4	2112	8-15	G	No	P	Cobble	Gravel	13%	Late	NA	Aa+

a Fish species present (A = anadromous, No = None, R = Rare)

b Valley Segment Type (from: USDA Forest Service. 1989. *Field Guide to Stream Survey Procedures*. 2500/2600. Gifford Pinchot National Forest. Vancouver, Washington.

1 = lower alluvial valley
2 = alluvial fan
3 = steeply incised valley / moderate channel gradient
4 = steeply incised valley / steep channel gradient
5 = incised glacial till or incised colluviam deposits
6 = moderate slope bound valley
7 = U-shaped glacial valley or trough
8 = valley wall / headwall tributary
9 = lava flow / spring-fed meadows
10 = alluviated mountain valley

c Rosgen Channel Type (from: Rosgen, D. 1996. *Applied River Morphology.* Wildland Hydrology, Pasoga Springs, Colorado.

Appendix C

ARP Levels on Private and National Forest Lands within the Upper Cowlitz Watershed

WSU	Weighted ARP	Total Acres	ARP (NF)	Acres (NF)	ARP (private)	Acres (private)
1	81.62767716	15,780	94.79825932	11,521	46	4,259
2	89.17119095	10,347	89.48017621	10,174	71	173
3	91.23181445	31,102	91.36952957	31,050	9	52
4	94.56528922	16,408	94.87189432	16,336	25	72
5	90.67609255	6,613	91	6,562	49	51
6	67.75028415	18,406	80.08741001	12,444	42	5,962
7	85.57749504	12,104	94	9,490	55	2,614
8	83.83760086	22,470	87.57426788	20,842	36	1,628
9	79.99483081	13,435	80.09364674	13,418	2	17
10	80.775	5,520	85	5,013	39	507
11	78.52176579	3,262	79	3,238	14	24

Appendix D

Road Density by 6th Field Subwatershed within WSU's

WSU	6th Field	Road Length (mi)	Acres	Road Density (mi/mi^2)
1	25B	15.30	6,369.4	1.54
1	25M	20.80	6,899.8	1.93
1	25O	0.00	2,511.4	3
2	25N	12.20	4,489.4	1.74
2	25P	11.20	5,857.9	1.22
3	25Q	16.80	3,778.1	2.85
3	25R	18.50	6,513.4	1.82
3	25S	18.00	9,590	1.20
3	25T	5.00	5,447.9	0.59
3	25U	1.20	5,774.6	0.13
4	25X	19.30	5,179.4	2.38
4	25Y	0.00	11,229.5	0
5	25Z	11.40	6,613	1.10
6	25E	7.60	1,400.8	3.47
6	25L	22.80	4,346.1	3.36
6	25V	32.70	5,518.7	3.79
6	25W	44.90	7,141.5	4.02
7	25K	14.10	12,103.5	0.75
8	25H	34.90	8,425.7	2.65
8	25I	25.70	9,313.8	1.77
8	25J	10.50	4,735.4	1.42
9	25C	6.10	3,417.6	1.14
9	25D	23.40	3,836.3	3.90
9	25F	12.10	2,506.1	3.09
9	25G	20.70	3,675.4	3.60
10	25A	21.80	5,519.7	2.53
11	02N	9.75	3,262	1.91

Appendix E

Water Quality

This appendix contains a summary of water quality data collected from historical stream surveys conducted on the Packwood and Randle Ranger Districts. No new data was collected for this analysis. 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.

Stream temperature data was collected using continuous gauges, max- min thermometers, and instantaneous readings. Stream widths and depths are observational and are not necessarily measured at bankfull.

Dry Creek (WSU 1)

Temperature readings for Burton Creek in 1949 was between 13.9° and 15° C (Bryant 1949). The main Dry Creek water temperatures recorded in May 1995 was 11.1° C (USDA Forest Service, 1995e).

Smith Creek (WSU 2)

Temperature readings by Roth (1938) were below the threshold in Smith Creek and were 5.6° C. Water temperatures measured at RM 4.7 in 1986 were 7.2° C and 13.3° C in 1994.

Table E-1: Smith Creek Water Flow and Temperature Data Collected at River Mile 4.7

Stream Name	Fish Species Present	Water Year	Max. Temp.	Max. 7 Day Avg. High	Spring Discharge	Fall Discharge
Smith Creek	Salmon spp.	1986	13.0 C	12.6 C	NA	NA
	Steelhead	1994	13.3 C	12.3 C	35.6 CFS	NA
	Rainbow	1995	12.6 C	12.4 C	33.4 CFS	1.5 CFS
	Cutthroat	1996	12.0 C	11.6 C	18.2 CFS	6.1 CFS

Johnson Creek (WSU 3)

Readings by Bryant (1949) found water temperatures to range between 8.8° and 11.7° C. On October 2, 1945 a water temperature of 9.4° C was recorded while in 1962 the Washington Department of Fisheries recorded a temperature of 3.9° C. Measurements in 1995 produced an average water temperature of 11.1° C.

Table E-2: Johnson Creek Water Flow and Temperature Data Collected at River Mile 0.8						
Stream Name	**Fish Species Present**	**Water Year**	**Max. Temp**	**Max. 7 Day Average High**	**Spring Discharge**	**Fall Discharge**
Johnson Cr.	Salmon spp.	1975	11.1 C	10.4 C	NA	NA
	Steelhead	1977	12.8 C	12.6 C	NA	NA
	Rainbow	1978	12.8 C	12.3 C	NA	45 CFS
	Cutthroat	1981	12.0 C	10.4 C	135 CFS	NA
		1982	13.5 C	13.0 C	NA	NA
		1983	11.5 C	9.7 C	NA	NA
		1984	13.0 C	12.3 C	NA	NA
		1985	14.0 C	13.1 C	NA	NA
		1986	13.0 C	12.5 C	NA	NA
		1987	12.0 C	11.5 C	NA	25 CFS
		1988	12.0 C	11.4 C	NA	NA
		1994	13.9 C	13.7 C	125 CFS	25 CFS
		1995	13.7 C	13.1 C	138 CFS	32 CFS
		1996	13.9 C	13.5 C	170 CFS	42 CFS

Glacier Lake is a deep mountain lake, 104 feet. The temperatures range is 5.0° and 11.1° C (measured at 100 foot and 3 foot intervals), dissolved oxygen range is 3.8 mg/l to 8.8 mg/l and pH is 5.12 to 6.54.

Wright Lake has a bottom of aquatic vegetation and silt/ash. Temperature measurements were 14.4° C, dissolved oxygen - 7.4 mg/l and pH of 6.3.

Heart Lake - No Data

Lake Creek (WSU 4)

The water temperature measurements by Roth (1938) was 4.4° C while Bryant (1949) found temperature readings of 17.2° C. Lake Creek exceeds Washington State water temperature standards with a water temperature of 18° C in reach 6 (USDA Forest Service, 1993d). This is possibly due to influence of surface water from Packwood Lake.

E-3: Lake Creek Water Flow and Temperature Data collected at Lake Creek River Mile 0.3						
Stream Name	**Fish Species Present**	**Water Year**	**Max. Temp**	**Max. 7 Day Average High**	**Spring Discharge**	**Fall Discharge**
Lake Creek	Salmon spp., Steelhead, Rainbow	1995	13.9 C	13.4 C	16.8 CFS	7.5 CFS

The discharge of Lake Creek is modulated by the dam at Packwood Lake.

Art Lake has water temperature of 16.7° C, dissolved oxygen of 7.9 mg/l, and pH of 7.1 (USDA Forest Service, 1995a).

The pH level for Packwood Lake is 7.8. (Lucas 1989) Other characteristics (temperature and dissolved oxygen) are not known.

Mosquito Lakes - No Data

Coal Creek (WSU 5)

Water temperature measurements in 1938 recorded 4.4° C (Roth 1938) while temperature measurements in 1949 were recorded to be 6.1° C (Bryant 1949).

Lost Lake has a pH level of 7.5.

Beaver Lake has a pH level of 7.5.

Hall Creek (WSU 6)

Water temperature measurements in 1938 recorded 4.4° C (Roth 1938) while temperature readings of 14.4° C were reported by Bryant (1949).

A water temperature of 11.1° C was recorded in Reach #2 (USDA Forest Service, 1994d).

Table E-4: 1995 Hager Creek Water Flow and Temperature Data Collected at River Mile 2.4						
Stream Name	**Fish Species Present**	**Water Year**	**Max. Temp**	**Max. 7 Day Average High**	**Spring Discharge**	**Fall Discharge**
Hager Creek	None	1995	9.5 C	9.1 C	8.4 CFS	7.4 CFS

Hager Lake has an depth of 40 feet, water temperature of 7.8° C, dissolved oxygen of 8.9 mg/l, and pH level of 7.5.

Snyder Lake has a depth of 8 feet, water temperature of 10.6° C, dissolved oxygen of 12.5 m/l, and pH level of 7.7.

Butter Creek (WSU 7)

Water temperature measurements in 1938 recorded 5.6° C (Roth 1938) while stream survey measurements completed by Bryant (1949) recorded temperatures of 14.4° C.

Table E-6: Butter Creek Water Flow and Temperature Data Collected at River Mile 5.5

Stream Name	Fish Species Present	Water Year	Max. Temp.	Max. 7 Day Average High	Spring Discharge	Fall Discharge
Butter Creek	Salmon spp., Steelhead, Rainbow	1995	13.4 C	12.5 C	56 CFS	9.8 CFS

Skate Creek (WSU 8)

Water temperature measurements in 1938 recorded 4.4° C (Roth 1938). In 1949 Bryant recorded temperatures of 10.0° and 16.1° C in the lower 8.75 miles which were surveyed (Bryant 1949). Stream survey measurements completed in 1995 recorded temperatures of 10.6° to 17.8° C (USDA Forest Service, 1995i).

Table E-7: Skate Creek Water Flow and Temperature Data Collected at River Mile 3.2

Stream Name	Fish Species Present	Water Year	Max. Temp	Max. 7 Day Average High	Spring Discharge	Fall Discharge
Skate Creek	Salmon spp.,	1975	14.2 C	12.3 C	NA	NA
	Steelhead,	1977	11.1 C	10.2 C	NA	NA
	Rainbow,	1993	13.0 C	12.7 C	55 CFS	14 CFS
	Cutthroat	1994	14.2 C	13.6 C	50 CFS	10 CFS
		1995	14.2 C	13.6 C	98 CFS	12 CFS
		1996	13.7 C	13.3 C	45 CFS	18 CFS

Johnson Lake has a depth of 6 feet and pH level of 6.5.

Willame Creek (WSU 9)

Stream channel temperatures recorded by Bryant (1949) were 17.2° C in Willame Creek. Stream survey measurements (USDA Forest Service, 1994g) recorded temperatures of 15.0° C.

Willame Lake has a water temperature of 17.5° C, dissolved oxygen of 8.1 mg/l, and pH of 7.3 (USDA Forest Service, 1995k).

Table E-8: North Fork Willame Creek Water Flow and Temperature Data Collected at River Mile 1.1

Stream Name	Fish Species Present	Water Year	Max. Temp	Max. 7 Day Average High	Spring Discharge	Fall Discharge
N. Fork Willame	Rainbow	1978	12.8 C	11.7 C	NA	NA
		1982	16.0 C	14.7 C	NA	NA
		1983	13.5 C	13.4 C	NA	NA
		1984	15.0 C	13.7 C	NA	NA
		1985	15.0 C	14.5 C	NA	NA
		1987	15.5 C	14.4 C	NA	NA
		1988	15.5 C	14.9 C	NA	NA
		1996	16.3 C	15.9 C	3.4 CFS	2.0 CFS

Table E-9: South Fork Willame Creek Water Flow and Temperature Data Collected at River Mile 1.0

Stream Name	Fish Species Present	Water Year	Max. Temp	Max. 7 Day Average High	Spring Discharge	Fall Discharge
S. Fork Willame	Rainbow	1977	12.8 C	12.6 C	NA	NA
		1978	12.8 C	12.3 C	NA	1.8 CFS
		1980	12.5 C	11.9 C	NA	3.5 CFS
		1981	13.0 C	13.0 C	NA	NA
		1982	14.0 C	13.0 C	NA	NA
		1984	11.5 C	11.1 C	NA	NA
		1985	12.0 C	11.8 C	NA	NA

Table E-9: South Fork Willame Creek Water Flow and Temperature Data Collected at River Mile 1.0						
Stream Name	**Fish Species Present**	**Water Year**	**Max. Temp**	**Max. 7 Day Average High**	**Spring Discharge**	**Fall Discharge**
		1986	13.0 C	12.4 C	NA	NA
		1987	12.0 C	11.1 C	NA	NA
		1988	11.0 C	10.7 C	NA	NA
		1994	14.4 C	14.2 C	4.7 CFS	1.7 CFS

Long Lake has a water temperature of 18.1 ° C, dissolved oxygen of 8.5 mg/l, and pH of 6.9 (USDA Forest Service, 1995f).

Davis Creek (WSU 10)

Stream channel temperatures recorded by Bryant (1949) were 10.6° C in the lower Davis Creek River Mile. 1963 measurements also taken in the lower reaches recorded 4.4° C temperatures. The maximum recorded temperatures for Davis Creek was 16.1° C (USDA Forest Service, 1984).

Kilborn Creek (WSU 11)

Stream channel temperatures recorded by Bryant (1949) were 8.3° C.

Appendix F

Riparian and Stream Channel Conditions

This appendix contains information regarding riparian and stream channel conditions. Both historic and present source materials for riparian condition are limited in scope. The following information was gathered from watershed analyses conducted on National Forest and private timber company lands, stream surveys collected by the Forest Service, and from Forest Service SMART, Aquarun, and IVEG databases.

A riparian inventory was completed of stand age and concentrations of existing species for WSU's 1-11. Refer to Map 18 for a display of current vegetation structure in riparian areas within the analysis area.

Cowlitz River WSU 1

The Cowlitz River leaves the Upper Cowlitz Watershed Analysis Area at River Mile (RM) 115. RM is a measure of the distance along the Cowlitz from its confluence with the Columbia River. From RM 115 to RM 116.5, the Cowlitz flows mainly through pasture land, with some mixed stands of hardwoods (alder, cottonwood, maple) and conifers (Douglas-fir, western red cedar, western hemlock) in the riparian area. From RM 116.5 to RM 117.5 the river has a narrow strip of early-seral, mixed hardwood and conifer vegetation, separating it from pasture land and a private campground on the south bank. The north bank is forested with mixed hardwood and conifer early seral vegetation. From RM 117.5 to RM 120, the river flows through mixed hardwood and conifer early-seral vegetation. From RM 120 to RM 120.5, the Cowlitz north bank is National Forest land, with mid to late (100 to 150 year old) seral stands. The south bank continues as mixed hardwood and conifer early seral vegetation. From RM 120.5 to RM 122, the north bank is again private land and reverts to mixed hardwood and conifer early-seral vegetation. The south bank is pasture with a narrow strip of mixed hardwood and conifer early-seral vegetation. From RM 122 to RM 122.5, the river has mid-seral stage vegetation on the south bank. The north bank is mixed hardwood and conifer early seral vegetation.

Garrett WSU 1

From the Cowlitz River, Garrett Creek flows through private land for 1.3 miles. The first 0.8 miles pasture is pasture land; the next 0.5 miles mixed hardwood and conifer early-seral vegetation. Within the National Forest, the stream flows through mid-seral (90 year old) Douglas-fir forest for 0.3 miles before the riparian vegetation becomes late seral stage (+200 year old) forest for 1.0 miles to the headwaters. In the summer months Garrett Creek goes subsurface on the valley bottom.

Burton WSU 1

Burton Creek flows through private land for 1.9 miles from its confluence with the Cowlitz. The first 0.9 miles is mixed hardwood and conifer early-seral vegetation, the next 0.4 miles is pasture land, and reverts to mixed hardwood and conifer early seral vegetation for 0.6 miles. Within the National Forest, the stream flows through mid seral stage (90 year old) Douglas-fir forest for 0.7 miles before the riparian vegetation becomes late seral stage (+200 year old) forest for 1.5 miles up to the headwaters. In the summer months Burton Creek goes subsurface on the valley bottom.

Dry WSU 1

The first 0.8 miles of Dry Creek are either privately or state owned. From the Cowlitz River, the stream first flows through 0.4 miles of 50% mixed hardwood and conifer early-seral vegetation and 50% mid-seral stage vegetation, and then through 0.4 miles of mid seral stage vegetation. Within the National Forest, the riparian vegetation is mid-seral (90 year old) Douglas-fir for 1.6 miles, then late-seral for the remaining 1.6 miles to its source. In the summer months Dry Creek goes subsurface on the valley bottom.

Smith WSU 2

From its confluence with the Cowlitz River, Smith Creek flows for 1 mile through private land, with mixed hardwood and conifer mid-seral vegetation. The riparian seral class is mid seral stage Douglas-fir (90 years old) for 3 miles, then mixed hardwood and conifer mid-seral plantation (40 years old) for 0.5 miles. The stream meanders through an old harvest unit/swamp for approximately 1 mile, before the riparian vegetation changes to early-seral (40 years old) for 0.5 miles in a plantation. A 0.4 mile segment of the stream is continuous late-seral stage (+200 years old), and the last stream mile is 50% early seral stage (<30 years old) and 50% late-seral stage (+200 years old).

Johnson WSU 3

The first 0.5 mile reach of Johnson Creek flows through mixed hardwood and conifer early-seral vegetation (approximately 40 years old), interspersed with homes. The next 2 miles are in a steep walled canyon with 80% of the riparian reserve consisting of Douglas-fir late-seral vegetation (+200 years old), 10% in Douglas-fir mid-seral vegetation (90 years old) and 10% exposed rock, followed by a 0.7 mile stretch of canyon supporting all Douglas-fir late-seral vegetation (+200 years old). Above this reach, there is a 1.1 mile segment that is 60% early-seral vegetation (<35 years old) and 40% Douglas-fir late-seral vegetation (+200 years old), then a 1.0 mile segment of Douglas-fir late-seral vegetation (+200 years old) on the east bank, and the west bank is 50% Douglas-fir mid-seral vegetation (150 years old) and 50% Douglas-fir late-seral vegetation (+200 years old), with the Glacier Creek confluence in the reach. Following this, there is a 0.5 mile segment of Douglas-fir mid-seral vegetation (150 years old), then a 0.6 mile stretch of Douglas-fir late-seral vegetation (+200 years old), Deception Creek joins Johnson Creek in this reach. Above these reaches is a 1.0 mile stretch of early-seral vegetation (50 years old), followed by a 3.0 mile segment late-seral vegetation buffer strip (150-200 years old), 60% of the riparian area is early-seral vegetation (30-50 years old) regeneration harvest. The last 2.0 miles is a mix of 60% early-seral vegetation (30-50 years old) regeneration harvest, 25% swamp, and 15% Pacific silver fir, western hemlock late-seral vegetation (+200 years old).

Glacier Creek WSU 3

Beginning from the confluence with Johnson Creek, Glacier Creek flows through a 1.5 mile riparian block of 90% Douglas-fir late-seral vegetation (+200 years old) and 10% mid-seral vegetation (+200 years old) with a short stretch of early-seral vegetation (<35 years old). Above that, the stream flows subsurface through the natural rock field dam from Glacier Lake for 0.5 miles. Above the lake, the stream flows through a 0.7 mile segment of late-seral vegetation (+200 years old), then 0.7 miles composed of 80% mid-seral vegetation (100-150 years old), 10% late-seral vegetation (+200 years old), and 10% non-forest area. The top 0.9 miles flow through 60% late-seral vegetation (+200 years old), 20% mid-seral vegetation (100-150 years old), and 20% non-forest.

Deception Creek WSU 3

From its confluence with Johnson Creek, 1.3 miles Deception Creeks riparian area is 70% Douglas-fir late-seral vegetation (+200 years old) and 30% early-seral vegetation (30-50 years old), followed by a 0.8 mile segment of early-seral vegetation (<35 years old), a 0.8 mile stretch of Douglas-fir/western hemlock late-seral vegetation (+200 years old), a 0.7 mile reach of 80% early-seral vegetation (<35 years old) and 20% late-seral vegetation (+200 years old). Above this is a 0.4 mile segment of late-seral vegetation (+200 years old), a 1.2 mile reach comprised of 60% early-seral vegetation (<35 years old), 20% mid-seral vegetation (100-150 years old) and 20% late-seral vegetation (+200 years old), and a 0.2 mile stretch to the headwaters of Pacific silver fir late-seral vegetation (150-200 years old).

Middle Fork Johnson Creek WSU 3

From its confluence with Johnson Creek, the Middle Fork flows for 0.4 mile through early-seral vegetation (30-50 years old), then a 0.6 mile segment of Douglas-fir late-seral vegetation (+200 years old), another 0.5 miles of early-seral vegetation (<35 years old), then 0.4 miles of 80% mid-seral vegetation (+200 years old) and 20% early-seral vegetation (<35 years old). After entering the Goat Rocks Wilderness, the stream is 80% late-seral vegetation and 20% mid-seral vegetation (both +200 years old) for 1.0 miles, then a 1.1 mile segment of 70% mid-seral vegetation (150-200 years old), 25% late-seral vegetation (+200 years old), and 5% non-forest. The last 1.6 miles to the headwaters is 90% alpine meadows and 10% mid-seral vegetation (150-200 years old).

Mission Creek WSU 3

From its confluence with Johnson Creek, Mission Creek flows through a 0.9 mile segment of 50% late-seral vegetation (150-200 years old), 25% non-forest, 20% early-seral vegetation (<35 years old) and 5% mid-seral vegetation (150-200 years old). Above this, the riparian area for 1.0 miles is 50% avalanche tailout and avalanche chutes, 25% late-seral vegetation (+200 years old) and 25% mid-seral vegetation (150-200 years old).

Jordan Creek WSU 3

From the confluence with Johnson Creek, Jordan Creek has a 2.5 mile segment of riparian area that is 90% mid-seral vegetation (150-200 years old) and 10% late-seral vegetation (+200 years old). The top 0.7 miles of the stream are 90% avalanche chute tailout, 5% mid-seral vegetation (150-200 years old) and early-seral vegetation (80 years old).

Large Lakes within WSU 3

Glacier Lake lies entirely within the Goat Rocks Wilderness. 80% of the riparian area is composed of late-seral vegetation (+200 years old), with 20% non-forested, either rock fields or stream delta.

Wright Lake is entirely surrounded by early-seral vegetation. Forest Road 21 restricts the outflow of the lake.

Hugo Lake is bounded on two sides by forest roads and on two sides by early-seral vegetation There is very little shading and the roads have impacted the lake shore vegetation.

Lower Lake Creek WSU 4

From its confluence with the Cowlitz River, Lower Lake Creek flows for 1.0 miles through private land. 90% of the riparian area is mixed hardwood/conifer early-seral vegetation (50 years old) and 10% mixed hardwood and conifer mid-seral vegetation. The next 4.0 miles to Packwood Lake is 90% Douglas-fir late-seral vegetation (+200 years old) and 10% early-seral vegetation (<35 years old).

Packwood Lake is surrounded by late-seral Douglas-fir forests.

From Packwood Lake, Upper Lake Creek flows through a 1.0 mile reach of 75% mid-seral vegetation (70-80 years old), 20% late-seral Douglas-fir vegetation (+200 years old) and 5% swamp, then a 1.4 mile segment of Douglas-fir late-seral vegetation 100-150 years old), then a 1.2 mile stretch of 70% avalanche chute tailout, 15% late-seral vegetation (100-150 years old) and 15% mid-seral vegetation (100-150 years old). Above this, a 0.6 mile segment of riparian area is 50% late-seral vegetation (150-200 years old), 30% avalanche chute tailout, and 20% mid-seral vegetation (150-200 years old). The next 0.6 miles of riparian area is avalanche chute tailout, and the last 0.6 miles to the headwaters are 50% avalanche chute tailout and 50% early-seral vegetation (70-80 years old).

Coal Creek WSU 5

From its confluence with the Cowlitz River, Coal Creek flows through 0.5 miles of private land supporting mixed hardwood/conifer early-seral vegetation (50 years old) and homes. It then flows through a 0.6 mile block of late-seral Douglas-fir vegetation (+200 years old), a 0.9 mile rocky canyon segment of 40% non-forest, 30% late-seral Douglas-fir vegetation (+200 years old), 20% early-seral vegetation (<35 years old) and 10% mid-seral Douglas-fir vegetation (100 years old). For the next 1.0 miles, the riparian area is 50% late-seral Douglas-fir vegetation and 50% mid-seral Douglas-fir vegetation (both +200 years old), followed by a 0.5 mile stretch of 90% early-seral vegetation (<35 years old) and 10% mid-seral Douglas-fir vegetation (+200 years old). Above this, 1.5 miles is 90% late-seral western hemlock/Pacific silver fir vegetation (+200 years old) and 10% early-seral vegetation (<35 years old), 1.5 miles is 95% late-seral vegetation (+200 years old) and 5% non-forest, the last 1.0 miles are 65% mid-seral vegetation (100-150 years old), 30% non-forest, and 5% late-seral vegetation (+200 years old).

From its confluence with Coal Creek, Lost Creek flows through a 0.5 mile reach of 55% late-seral Douglas-fir vegetation (+200 years old) and 45% early-seral vegetation (<35 years old), a 0.6 mile segment of 95% late-seral western hemlock and Douglas-fir vegetation (+200 years old) and 5% avalanche chutes, a 0.9 mile stretch of 50% late-seral vegetation (+200 years old) and 50% early-seral vegetation (<35 years old). The last 1.6 miles of stream to Lost Lake is 90% late-seral Pacific silver fir vegetation (+200 years old) and 10% mid-seral Pacific Silver fir vegetation (100-150 years old).

Cowlitz River WSU 6

From RM 122.5 to 123, the north bank of the Cowlitz is late-seral Douglas-fir vegetation (100-150 years old), and the south bank is mixed hardwood and conifer early-seral vegetation. From RM 123 to RM 126, near the Franklin Bridge in Packwood, the riparian area has mixed hardwood / conifer early-seral vegetation on both banks. From RM 126 to RM 127, the south bank is mixed hardwood/conifer early-seral vegetation with homes interspersed, the north bank continues mixed hardwood/conifer early-seral vegetation. From RM 127 to RM 127.5, both banks are mixed hardwood/conifer early-seral vegetation, then from RM 127.5 to RM 128, near the mouth of Butter Creek, the north bank is mixed hardwood/conifer early-seral vegetation with a number of homes. From RM 128 to RM 130.5, where the river enters the National Forest, the riparian area is mixed hardwood/conifer early-seral vegetation, there are homes from RM 130 to RM 130.5 on the north bank. From RM 130.5 to RM 131, the north bank is late-seral Douglas-fir vegetation, the south bank mixed hardwood/conifer early-seral vegetation. From RM 131 to RM 132, the south bank is late-seral Douglas-fir vegetation, and the north bank is mainly mid-seral Douglas-fir forest with some large overstory trees. From RM 132 to RM 133, where the river enters the Watershed Analysis Area, both banks are late-seral Douglas-fir vegetation.

Hall Creek WSU 6

From its confluence with the Cowlitz River, Hall Creek flows on private land for 0.4 miles through mixed hardwood/conifer early-seral vegetation (<50 years old), then through National Forest for 0.2 miles of late-seral Douglas-fir vegetation (+200 years old), then once again on private land for 3.0 miles to its source. 65% of the final segment is mixed hardwood/conifer early-seral vegetation and 35% is pasture.

Hager Creek WSU 6

Hager Creek is a tributary to Hall Creek. It has an unknown end on the valley bottom, probably flowing subsurface to join Hall Creek. From its terminus shown on the map, Hager Creek flows on private land for 0.6 miles through early-seral, mixed hardwood/conifer vegetation (<50 years old). Above that, it flows through National Forest land, through a 1.1 mile segment of 80% mid-seral Douglas-fir vegetation (+200 years old), 15% early-seral vegetation (<35 years old) and 5% late-seral Douglas-fir vegetation (+200 years old). Above this, it flows through 0.7 miles of the ancient landslide that formed Hager Lake. Above Hager Lake, the stream flows through a 0.7 mile reach of 50% late-seral Douglas-fir/western hemlock vegetation (+200 years old) and 50% early-seral vegetation (<35 years old), 1.0 miles of 50% mid-seral vegetation (+200 years old) and 50% early-seral vegetation (<35 years old), and a last 1.6 miles to the headwaters of 70% late-seral vegetation (+200 years old) and 30% early-seral vegetation (<35 years old).

Snyder Creek WSU 6

Snyder Creek is a tributary Hall Creek. From the confluence it flows for 1.1 miles through 90% National Forest mid-seral vegetation (+200 years old) and 10% private land mixed hardwood/conifer early-seral vegetation, then 0.8 miles 80% mid-seral vegetation (150-200 years old), 10% late-seral vegetation (+200 years old), and 10% early-seral vegetation (<35 years old) to its headwaters.

Hinkle Tinkle Creek WSU 6

The first 1.2 mile reach of the stream is in early-seral vegetation on private land, the next 1.1 mile reach is in Douglas-fir mid-seral vegetation (100-150 years old), and the last 0.3 miles to the headwaters are in avalanche chutes and alpine meadow.

Butter WSU 7

From the confluence of Butter Creek with the Cowlitz River, Butter Creek flows for 0.7 miles through an area of homes with scattered trees, then 0.2 miles of early-seral vegetation before entering the National Forest. It flows through a 1.0 mile section of 70% Douglas-fir mid-seral vegetation (90 years old) and 30% Late-seral Douglas-fir vegetation (+200 years old), a 0.6 mile reach of 80% rock canyon and 20% mid-seral Douglas-fir vegetation (100-150 years old), a 3.4 mile stretch of 90% mid-seral Douglas-fir vegetation (100-150 years old) and 10% early-seral vegetation (<30 years old), then a 2.4 mile stretch of 50% late-seral Douglas-fir/western hemlock vegetation (+200 years old), 45% early-seral vegetation (<30 years old), and 5% mid-seral vegetation (60 years old). At this point the stream flows from Mount Rainier National Park, where it is 2.3 miles of 40% early-seral vegetation (80 years old), 30% mid-seral vegetation (100-150 years old), and 30% western hemlock/Pacific silver fir late-seral vegetation (+200 years old).

Skate WSU 8

From the mouth of Skate Creek on the Cowlitz River, Skate Creek flows through 2.4 miles of private and state land, 90% early-seral vegetation, and 10% late-seral vegetation (100-150 years old). On the National Forest, Skate Creek flows through a 7.7 mile reach of 50% mid-seral Douglas-fir vegetation (150 years old) and 50% Late-seral Douglas-fir vegetation (150 years old), a 1.2 mile segment of mid-seral Douglas-fir vegetation (150 years old), a 1.1 mile stretch of 75% late-seral western hemlock/Douglas-fir/Pacific silver fir vegetation (+200 years old) and 25% early-seral vegetation (<30 years old). The last 1.1 miles to the headwaters is 75% early-seral vegetation and 25% late-seral western hemlock/Pacific silver fir vegetation (+200 years old).

Forest Road # 52 is within the floodplain for approximately 4 miles and influencing the channel development.

Willame Creek WSU 9

From its confluence with the Cowlitz River, Willame Creek flows through 0.3 miles of private land and is 70% hardwood and conifer early-seral vegetation and 30% mid-seral vegetation. Entering the National Forest, the stream flows through a 1.0 mile segment of 95% late-seral Douglas-fir vegetation (+200 years old) and 5% mid-seral vegetation (<30 years old), then 1.8 miles of mid-seral Douglas-fir vegetation (100-150 years old), 0.8 miles of late-seral Douglas-fir vegetation (+200 years old), then a 1.0 mile reach of 50% mid-seral vegetation (100-150 years old), 35% late-seral vegetation (+200 years old), and 15% early-seral vegetation (<30 years old). The last 0.5 miles to the confluence of North Fork and West Fork Willame Creeks, where the mainstem Willame Creek begins is 50% late-seral Douglas-fir/western hemlock vegetation (+200 years old) and 50% early-seral vegetation (<50 years old).

South Fork Willame Creek WSU 9

From the confluence with Willame Creek, the South Fork flows through a 1.1 mile stretch of 95% mid-seral Douglas-fir vegetation (100-150 years old) and 5% early-seral vegetation (<30 years old), then a 1.7 mile segment of Douglas-fir 55% mid-seral vegetation (100-150 years old) and 45% late-seral vegetation (100-150 years old), then a 0.9 mile reach of 50% western hemlock/Pacific silver fir late-seral vegetation (+200 years old), 25% early-seral vegetation (<30 years old), 15% avalanche chute tailout, and 10% mid-seral vegetation (100-150 years old).

West Fork Willame Creek WSU 9

From the confluence with Willame Creek, the West Fork flows for 0.5 miles through late-seral Douglas-fir vegetation (+200 years old), and then a 3.2 mile segment of 50% late-seral Douglas-fir/western hemlock vegetation (+200 years old) and 50% early-seral vegetation (<40 years old).

North Fork Willame Creek WSU 9

From the confluence with Willame Creek, the North Fork flows through 0.5 miles through Late-seral Douglas-fir vegetation (+200 years old), then a 0.5 mile segment of early-seral vegetation (<30 years old), followed by a 0.7 mile reach of mid-seral Douglas-fir vegetation (100-150 years old), then a 2.5 mile stretch composed of 60% early-seral vegetation (<30 years old), 30% western hemlock/Late-seral Douglas-fir vegetation (+200 years old), and 10% mid-seral Douglas-fir vegetation (100-150 years old).

Davis Creek WSU 10

From the confluence with the Cowlitz River, Davis Creek flows through a 1.2 mile reach of hardwood and conifer early-seral vegetation, 0.6 miles of pasture, then another 0.7 miles of hardwood and conifer early-seral vegetation on private land. On the National Forest, Davis Creek flows through 2.0 miles of 70% mid-seral Douglas-fir vegetation (100-150 years old), 25% late-seral Douglas-fir vegetation (100-150 years old), and 5% early-seral vegetation (<30 years old). Above this is a 1.1 mile stretch of 60% late-seral vegetation (+200 years old) and 40% early-seral vegetation (50 years old), followed by a 0.7 mile segment to the headwaters which is

85% early-seral vegetation (<30 years old) and 15% late-seral vegetation (+200 years old).

Kilborn Creek WSU 11

From its confluence with the Cowlitz River, Kilborn Creek flows through 0.3 miles of early-seral vegetation on private land. On the National Forest, the stream flows through 2.1 miles of 65% late-seral vegetation (+200 years old) and 35% mid-seral vegetation (80 years old), then a 1.1 mile reach of 55% late-seral vegetation (+200 years old), 25% mid-seral vegetation (100-150 years old), and 20% early-seral vegetation (<30 years old). The last 0.8 miles to the headwaters is late-seral vegetation (150-200 years old).