United States
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Forest Service

Pacific
Northwest
Region

Muddy River Watershed Analysis

Gifford Pinchot National Forest

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Mount St. Helens National Volcanic Monument
Gifford Pinchot National Forest
Pacific Northwest Region
USDA, Forest Service

May, 1997

EXECUTIVE SUMMARY

The 86,913-acre Muddy River Watershed is comprised of National Forest (85,666 acres) and private (1,247 acres) ownership. The area has been divided into 36 sub-basins for analysis by an interdisciplinary team.

In this first iteration of analysis, the following eleven issues are analyzed: Mass Wasting; Surface Erosion from Roads and Upland Slopes; Fire History; Vegetation Structure and Composition; Stream Riparian Reserve Fragmentation and Riparian Habitat; TES and C-3 Plant Species; Habitat Condition for TES, C-3, and Cavity-Dependent Animal Species; Hydrologic Changes; Water Quality and Key Habitat Attributes for Salmonids; Conflict Between Trail Users; and Demand for and Resource Impacts from Dispersed Camping.

Characterization

The Muddy River and its tributaries drain the eastern slopes of Mount St. Helens and the immediately adjacent lands to the east.

The Muddy River watershed primarily developed from volcanic and glacial geologic processes and has been shaped by recent wind and rain erosional processes working on the surface deposits. Heavily influenced by the eruptive history of Mount St. Helens, the area is composed of Tertiary bedrock (30 to 20 million years of age) overlain by glacial tills, lahars, tephra, and alluvial deposits, many of which are highly subject to erosion. Management activities (primarily roading) have contributed to extensive debris flows and mass wasting during recent storms. Elevations range from 1,008 feet at Swift Reservoir to 8,298 feet at the crater rim of Mount St. Helens. Drained by the Muddy River, Clearwater Creek, Smith Creek, Bean Creek, Clear Creek, and their tributaries, the watershed is vegetated by coniferous forest plant associations which provide habitat for 239 wildlife species.

A pattern of large, although low-frequency, high-intensity, stand-replacement fires have occurred through time. Since 1920, very little of the watershed has burned from wildfire.

Current Conditions

Unstable and potentially unstable ground is mapped throughout the watershed, with one fourth of the sub-basins having greater than 50 percent of their area occupied by lands in these categories. Mass wasting and surface erosion from sensitive tephra deposits have contributed large amounts of sediment to streams particularly in the Smith, Bean, and Clearwater Creek drainages. Erosion rates have been especially high since the 1980 eruption of Mount St. Helens, with road construction playing a significant role as well.

During February, 1996 much of the Pacific Northwest experienced an unusually heavy storm in which relatively large amounts of warm rain fell on a significant snowpack. The resulting runoff caused severe damage at various elevations ranging from flooding in lowlands to landslides, road

Most visitors to the watershed (an average of 700,000 per year) come for recreation purposes: to view the Mount St. Helens devastated area, to use the trails, or to hunt big game. Situated near urban populations, trail use is heavy and mixed, posing conflicting expectations and some risk of injury for some users. Dispersed campsites are heavily used, particularly at favored hunting camp locations, and in two instances, the locations are causing resource damage.

Reference Conditions

Reference conditions explain how the existing conditions have changed over time as a result of human influence and natural disturbances. They describe the known or inferred history of the landscape. From this, we may understand what was sustainable in the past and what changes have occurred to affect sustainability in the future.

Volcanic processes and glaciers have created a landscape naturally prone to movement through mass wasting and surface erosion. Soil movement has been accelerated by roading and to a lesser degree by timber harvest.

Past vegetation patterns were shaped predominately by volcanic eruption and large, stand-replacement fires, changing thousands of acres at a time. Over the past 50 years timber harvest and related activities have altered stand structure, composition and distribution across the landscape by creating numerous small openings containing little if any standing multi-layered old trees and down woody material. Accordingly, plant and animal habitats have changed.

The distribution of fish within the watershed has been sharply altered by construction of roads and the three dams on the main stem of the Lewis River.

The extent and magnitude of human uses in the watershed has grown exponentially from the mid-1800's until present time, intensified by population growth and technological advancements accompanying the industrial era.

Interpretation

Eight dominant processes affecting the watershed's ecosystem are identified: volcanic and seismic activity, erosion, fire, timber management, roading, peak flow increases, flooding, and recreation activities.

In the interpretation section, current and reference conditions are compared by explaining significant differences, similarities, or trends and their causes. The comparisons, explanations, and discussions are presented in a similar series of tables and paragraphs that enable the reader to follow the logic of the analysis.

Information from earlier stages of the analysis is synthesized in order to further understand and discover interrelationships between elements of the ecosystem. The synthesis was conducted in three dimensions of the ecosystem: aquatic, terrestrial, and social/economic. Each is presented in

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INTRODUCTION

Management direction for the National Forest lands comprising the Muddy River watershed (Figure 1, Vicinity Map) is set forth in the Gifford Pinchot National Forest Land and Resource Management Plan, 1990 as amended (through amendment 11 Update No. 2, June 26, 1995), hereafter referred to as the 1990 GPNF Forest Plan (Figure 2, Land Allocations). On April 13, 1994, the 1990 GPNF Forest Plan was amended by the Secretary of Agriculture as documented in the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, hereafter referred to as the ROD. This Record of Decision is the culmination of a public land management effort initiated by President Clinton in April, 1993, and along with the accompanying Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl is frequently called the Northwest Forest Plan. The Northwest Forest Plan (NFP) provides extensive management direction, including land allocations, see Figure 3 Northwest Forest Plan Allocations, that comprise a comprehensive ecosystem management strategy. A major part of this strategy is the Aquatic Conservation Strategy (NFP, page B-9) which has four components (NFP, Page B-12)

- Riparian Reserves
- Key Watersheds
- Watershed Analysis and
- Watershed Restoration

The Muddy River Watershed was selected for analysis at this time because:

1. it is known to contain high priority watershed restoration needs, and
2. a watershed-scale analysis is needed to develop strategies for dealing with dispersed recreation use , trail development, various flood damage repair projects, research and science projects and access, and timber management activities such as young stand thinning and pruning and regeneration harvest in mature stands.

During February, 1996 much of the Pacific Northwest experienced an unusually heavy storm in which relatively large amounts of warm rain fell on a significant snowpack. The resulting runoff caused severe damage at various elevations ranging from flooding in lowlands to landslides, road washouts, debris torrents, and stream channel scouring and widening in the uplands. Mass wasting and erosion moved large amounts of sediment in short periods of time. Much of the damage to the affected areas in the Muddy River Watershed has been inventoried and color aerial photographs of the watershed were taken during the summer of 1996. This information was available to the team that conducted the watershed analysis reported in this document.

Muddy River
Vicinity Map

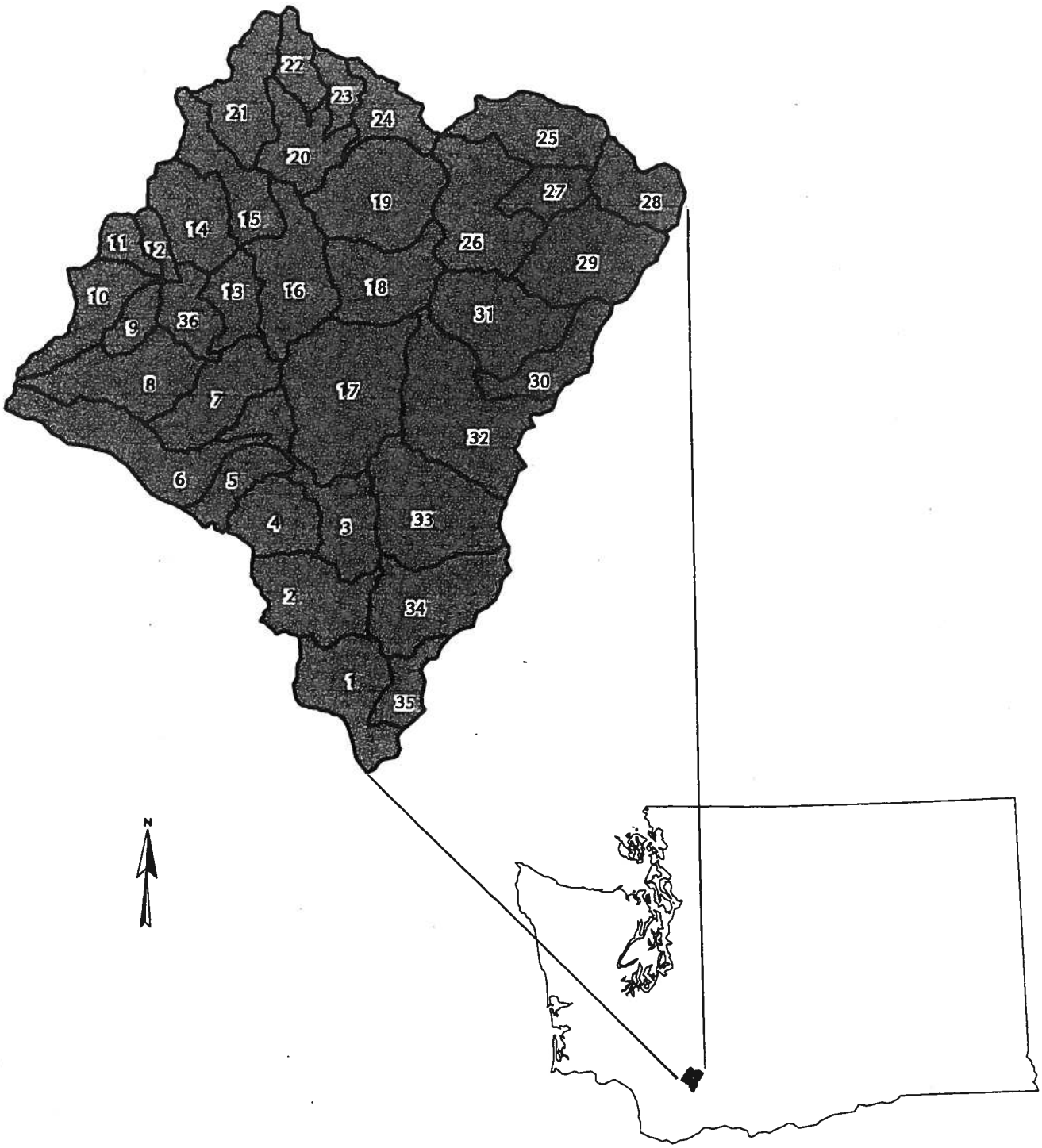

Figure 1. Vicinity Map. The Muddy River Watershed is located in the southwest corner of the State of Washington.

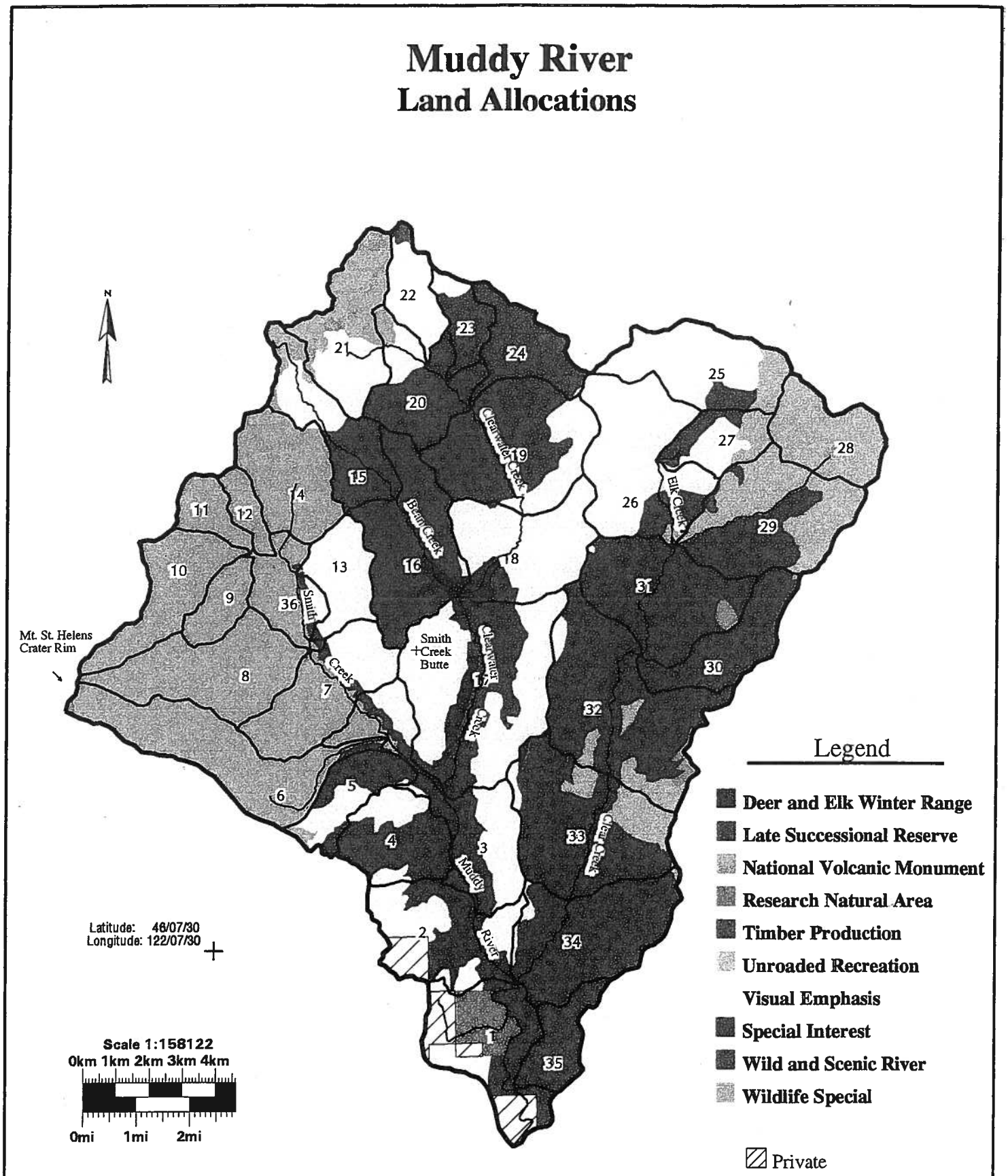

Figure 2. National Forest land within the Gifford Pinchot National Forest is assigned to various Management Area Categories (MACs). Each MAC has a goal or management emphasis.

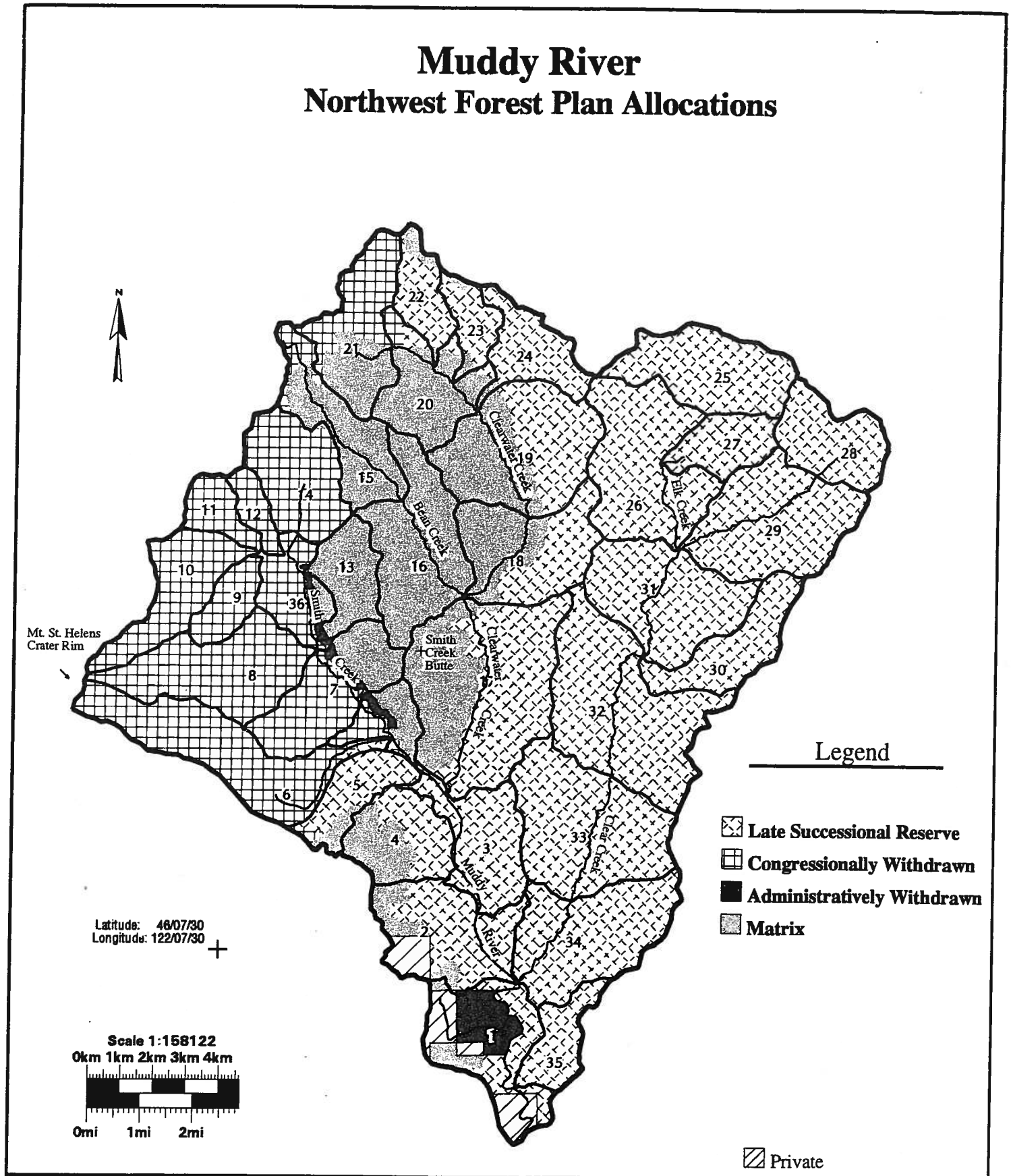

Figure 3. Under the Northwest Forest Plan, all federally administered lands within the range of the northern spotted owl are assigned to specific land allocations.

Other important material is included in the Appendices of the report as follows:

A: Glossary
B: References
C: Issues and Key Questions
D: Limitations of the Analysis, Confidence in the Analysis, Data Gaps, and Implications of Limitations for Management
E. Vegetation Stand Structure Definitions
F. Muddy River Watershed Research

Material is presented in the same general order in each chapter to follow a logical and parallel pattern as follows:

- Geology and physical processes,
- Fire
- Vegetation
- Riparian Reserve Habitats
- TES Plants and C-3 species
- Habitats for TES animal species
- Hydrology
- Water quality and key habitat attributes for fish
- Recreational Uses and Opportunities

CHAPTER I CHARACTERIZATION

A large portion of the Pacific Northwest lies within the Columbia River basin, which can in turn be divided along watershed boundaries into smaller component river basins such as the Lewis River basin. The Muddy River is a relatively small watershed that occupies a portion of the Lewis River basin. See Figure 1, Vicinity Map in the Introduction.

The Muddy River Watershed Analysis Area (hereafter referred to as the Muddy River) encompasses an area of National Forest and other ownership lands within the Muddy River watershed and some of its tributaries. The Muddy River includes lands drained by Smith Creek, Bean Creek, Clearwater Creek, Clear Creek, Elk Creek, Hungry Creek, Wright Creek, the reaches of the Muddy River, and several other smaller unnamed, interspersed drainages.

The analysis area is divided into 36 sub-basins (Figure 4).

The Muddy River covers 86,913 acres (85,666 of National Forest and 1,247 of private ownership), and ranges in elevation from 1,008 feet at Swift Reservoir to 8,298 feet at the crater rim of Mount St. Helens. All of the land, water, plants, animals, and people within this area make up the Muddy River ecosystem.

Geology, Soils, Erosion Processes

The Muddy River watershed primarily developed from volcanic and glacial geologic processes and has been shaped by recent wind and rain erosional processes working on the surficial deposits. The majority of the area is composed of Tertiary bedrock (30 to 20 million years of age) overlain by glacial tills, lahars, tephra and alluvial deposits. The Clear Creek drainage is somewhat younger ranging from 26 to 17 million years old. The Muddy, Smith, Bean and Clearwater drainages have been largely influenced by the eruptive history of Mount St. Helens.

The 1980 eruption of Mount St. Helens clearly demonstrated the effects of volcanism on shaping the landscape. The lahars (mudflows) that moved down the Muddy River and Smith Creek and the blast area in the north-western part of the watershed will have long-lasting effects on processes occurring in the watershed. The tephra deposits laid down in Clearwater, Bean and Smith Creeks have created a large area that is highly susceptible to surface erosion, shallow mantle failures and debris torrents in many of the steep sideslopes and drainages.

Tephra deposits from the many eruptions of Mount St. Helens has had an effect on vegetation growth in many ways. Figure 5 shows the extent of two of the larger tephra eruptions that affected the watersheds as well as how the 1980 event covered the area. The effects of tephra can impede growth as the fine ash accumulates on needles which can retard photosynthesis and transpiration. Deep deposits on the ground can kill or slow growth of the varying vegetation types. A depth of eight inches was used on Figure 5 as a thickness that would affect small vegetation as well as slow the growth of larger vegetation.

Muddy River
Sub-Basins

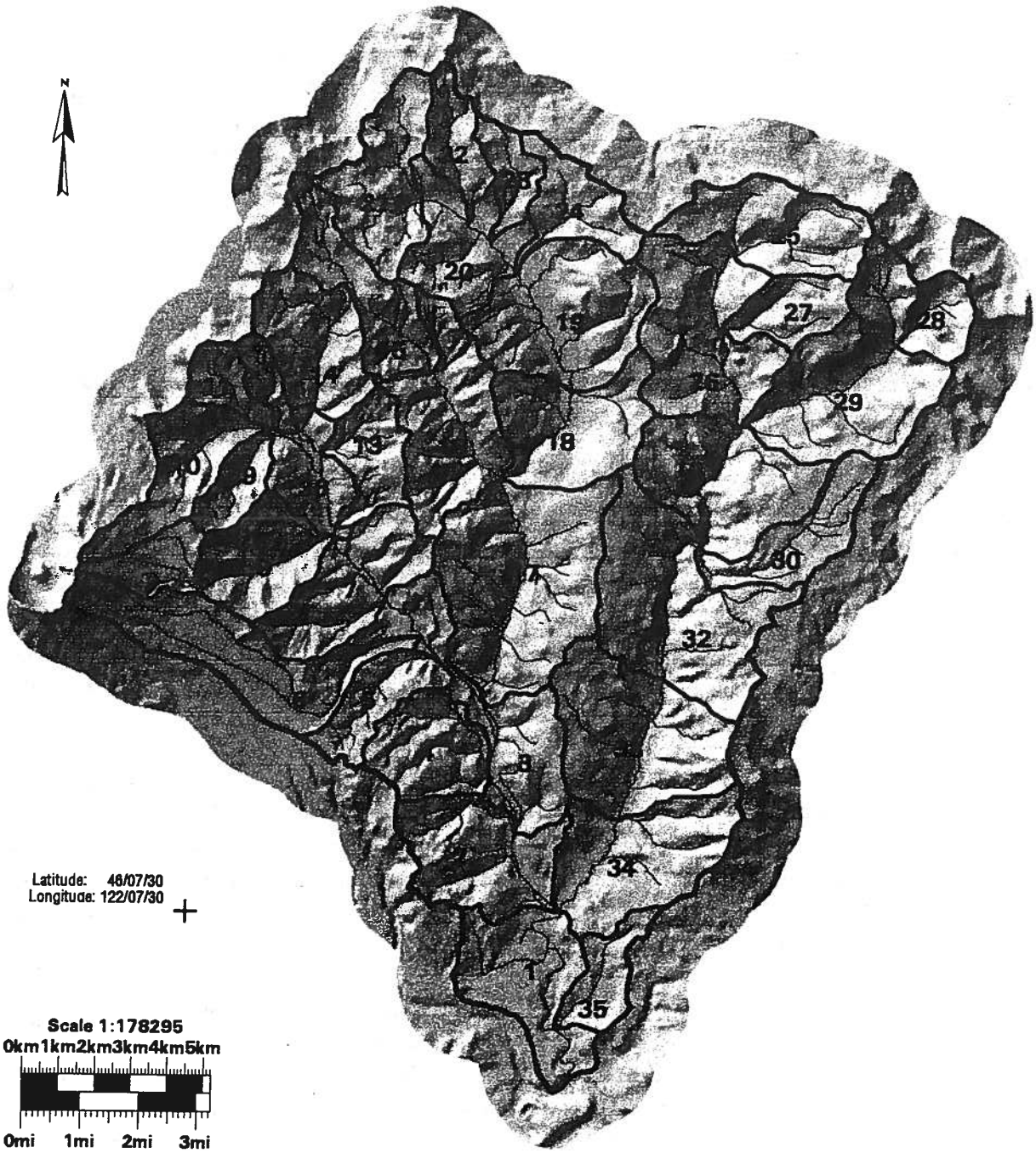

Figure 4. Sub-basins. For this analysis, the 86,913-acre Muddy River Watershed is divided into 36 sub-basins.

Muddy River Watershed Sub-Basins

Sub-Basin Number	Sub-Basin Name	Sub-basin Number	Sub-Basin Name
1	Cedar Flats	19	Clearwater Creek
2	Lower Muddy	20	Upper Clearwater Creek Tribs
3	Middle Muddy	21	Upper Clearwater Creek
4	Lower Muddy Tribs West	22	Upper Clearwater Tribs North
5	Lahar	23	Upper Clearwater Tribs Northeast
6	Upper Muddy	24	Upper Clearwater Tribs East
7	Lower Smith Creek	25	Upper Elk Creek
8	Ape Canyon	26	Lower Elk Creek
9	Upper Smith Tribs Southwest	27	Hungry Creek
10	Upper Smith Tribs West	28	Craggy Peak
11	Upper Smith Tribs Northwest	29	Snider Pasture
12	Upper Smith Tribs North	30	Wright Creek
13	Upper Smith Tribs East	31	Wright Meadow
14	Upper Smith Creek	32	Wildcat Trail
15	Upper Bean Creek	33	Spencer Butte
16	Lower Bean Creek	34	Lower Clear Creek
17	Lower Clearwater Cr	35	Muddy River Tribs East
18	Middle Clearwater Creek	36	Middle Smith Creek

Muddy River
Tephra Deposition

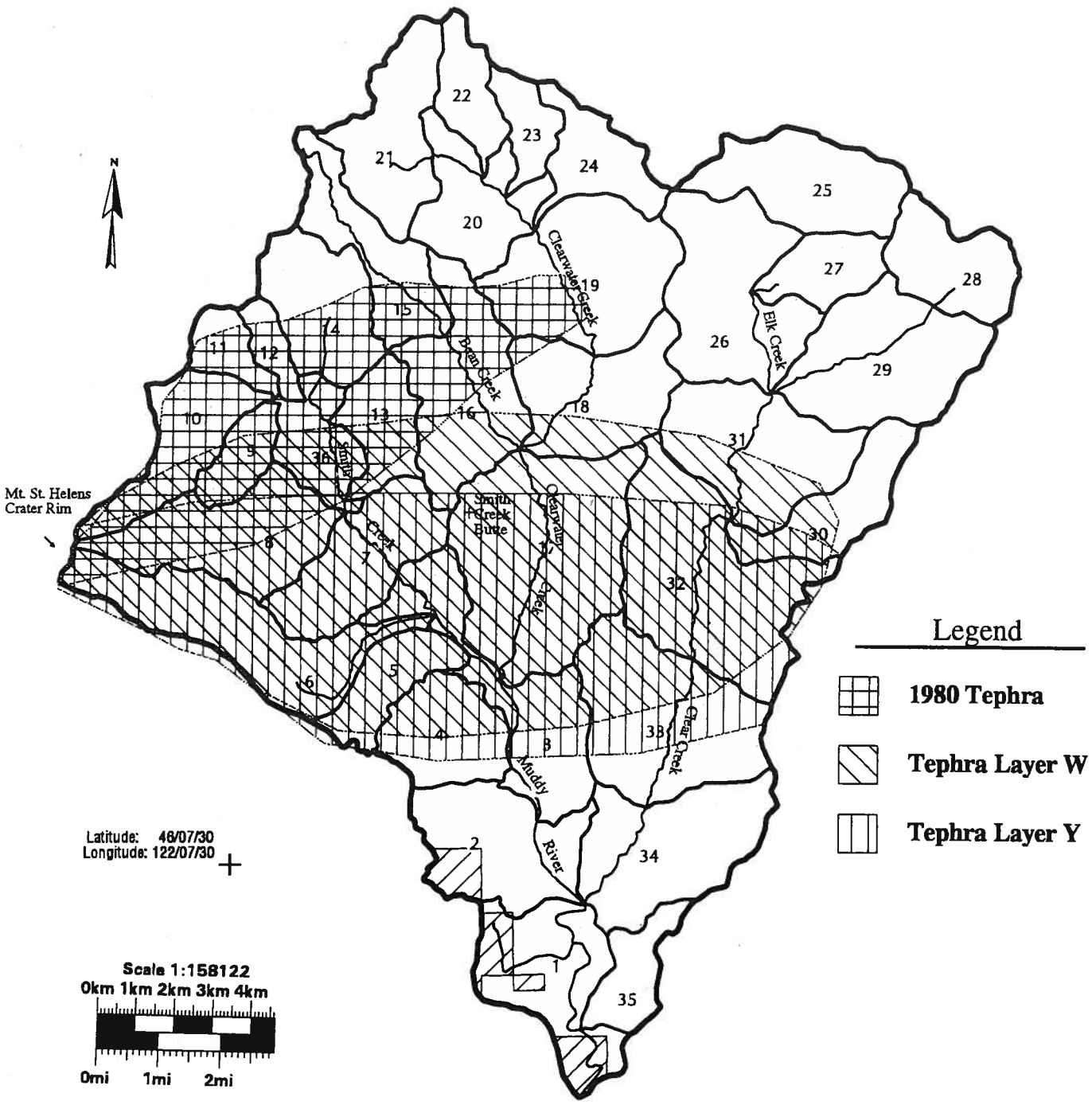

Figure 5. Examples of two of the largest tephra deposits that have affected the watershed. These depths are estimated at eight inches throughout the hatched area. Tephra Layer W erupted about 500 years in the past and Tephra Layer Y erupted about 3300 years in the past. Many other tephra deposits are recorded with varying depths. The 1980 tephra is estimated from US Geological Survey publications.

Pyroclastic flows and mudflows have also had a large effect on vegetation growth in the area. These types of large scale flows would have killed vegetation especially in their pathways. These pathways filled old drainage patterns and created new ones. A good example of this can be seen in the Muddy River drainage where there are prime examples of canyon filling flows.

Glacial activity is evident especially in the Clearwater where one can see the U-shaped valley that glaciers typically carve in the landscape. This is assumed to have occurred between 40,000 and 140,000 years ago. These valleys are characterized by steep upper slopes that have a strong tendency to initiate debris flows and mass wasting of loose material that may be subsequently deposited in the flatter troughs. Many of the debris torrents which have occurred during the last few years have been caused by the build-up of soil in the headwalls of many of the drainages.

The future stability of the tephra deposits will be affected by their proximity to Mount St. Helens and the associated earthquake potential. Low-level seismic events have continued to occur in the area surrounding the volcano since the 1980 eruption.

Fire

Large wildfires have been a major agent of natural change in the forest landscape of the Muddy River watershed. Fire has been an integral part of the forest ecosystem, affecting wildlife habitat, vegetation dynamics, soil properties and water hydrology.

The natural fire regime for the Muddy River Watershed is similar to other westside forest locations; major fires at any point are infrequent (50 to 400 year intervals) but catastrophic in their effects. Highly productive and long-lived tree species associated with the Douglas-fir zone accumulate great quantities of intermediate to large class size fuels. Fine fuels, the most readily ignitable, are present in a relatively small amounts. Fine fuels reach their maximum dryness in July and August, while the larger fuels do not usually dry out until September. The eruption of Mount St. Helens in 1980 modified the fuel characteristics of the watershed somewhat, especially the northern half, in that much of the fine fuels were covered with one to six inches of ash and/or pumice thus reducing both the potential rates of spread and intensity. Most of the fires in any given year occur in July and August, but the majority of these are less than one half acre in size. Most of the larger fires, and virtually all of the catastrophic fires, occur during September but range from late August to early October after long periods of drought.

It appears that large (although infrequent) high-intensity stand replacement fires occurred in the watershed up into the early 20th century (Figure 6). These include two large fires in 1902: (1) the 32,000 acre Lewis River Fire in the southeast portion of the watershed, and (2) the southern extent, (approximately 2,500 acres) of the large Cispus Fire to the north. A reburn of the 1902 Lewis River Fire, the Copper Creek Fire, consumed approximately 6,700 acres in 1920.

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Based on formal fire reports from 1970 through 1995, the current fire frequency of the watershed is approximately four fires per year. Thirty percent of the fire ignitions are due to lightning occurrence and the remaining 70 percent are attributed to miscellaneous human causes. During this period of time all fires were less than one half acre in size except for the Ape Canyon fire of 1973 which burned 114 acres on the eastern flanks of Mount St. Helens. The reduction in the number and size of catastrophic fires is related to suppression and prevention policies instituted by the Forest Service in the 1910's and the increase in road access due to logging operations. Catastrophic fires can be minimized or postponed, but inevitably some large, severe fires will continue to occur in the future.

Vegetation

About 90 percent of the National Forest lands within the watershed are in the Western Hemlock and Pacific Silver Fir vegetation zones (Figure 7, Vegetation Zones [Ecoclasses]). Nine percent are in non-forest, one percent is Mountain Hemlock and less than one percent is wetland. The vegetative patterns have historically been shaped by large-scale disturbances such as fire and volcanic activity (see Fire History and Geology and Physical Processes sections). The 1980 eruption of Mount St. Helens had a significant impact on the vegetation in the northwestern quarter of the watershed, where huge tracts of trees were blown over by the blast or incinerated. Recently, staggered-setting timber harvest has changed the distribution of vegetation, creating a mosaic of open patches across the landscape. *Carex interrupta*, a State Sensitive and Survey and Manage (C-3) Category 3 plant species, and *Pleuricospora fimbriolata,* a State Sensitive plant species, are present in the watershed. Four Botanical Special Interest Sites have been designated in the Forest Plan as Selected Species Management Areas for *Pleuricospora fimbriolata*.

Terrestrial Animals and Habitats

Based on the existing vegetation and vegetation structure, the Muddy River Watershed contains habitats that could support approximately 239 wildlife species; three of the species are introduced. Populations of approximately 49 species that may exist in the watershed are decreasing.

The watershed contains potentially suitable habitat for five Federally listed species, five Region 6 sensitive species, four C-3 species, and a number of species of interest.

Threatened and Endangered Species

Potential habitats exist for the following five Federally listed species: northern spotted owl, bald eagle, peregrine falcon, gray wolf and grizzly bear.

Several northern spotted owl home ranges are known to exist in the watershed. Suitable habitat, primarily old-growth/late successional forest, used by spotted owl is highly fragmented and scattered

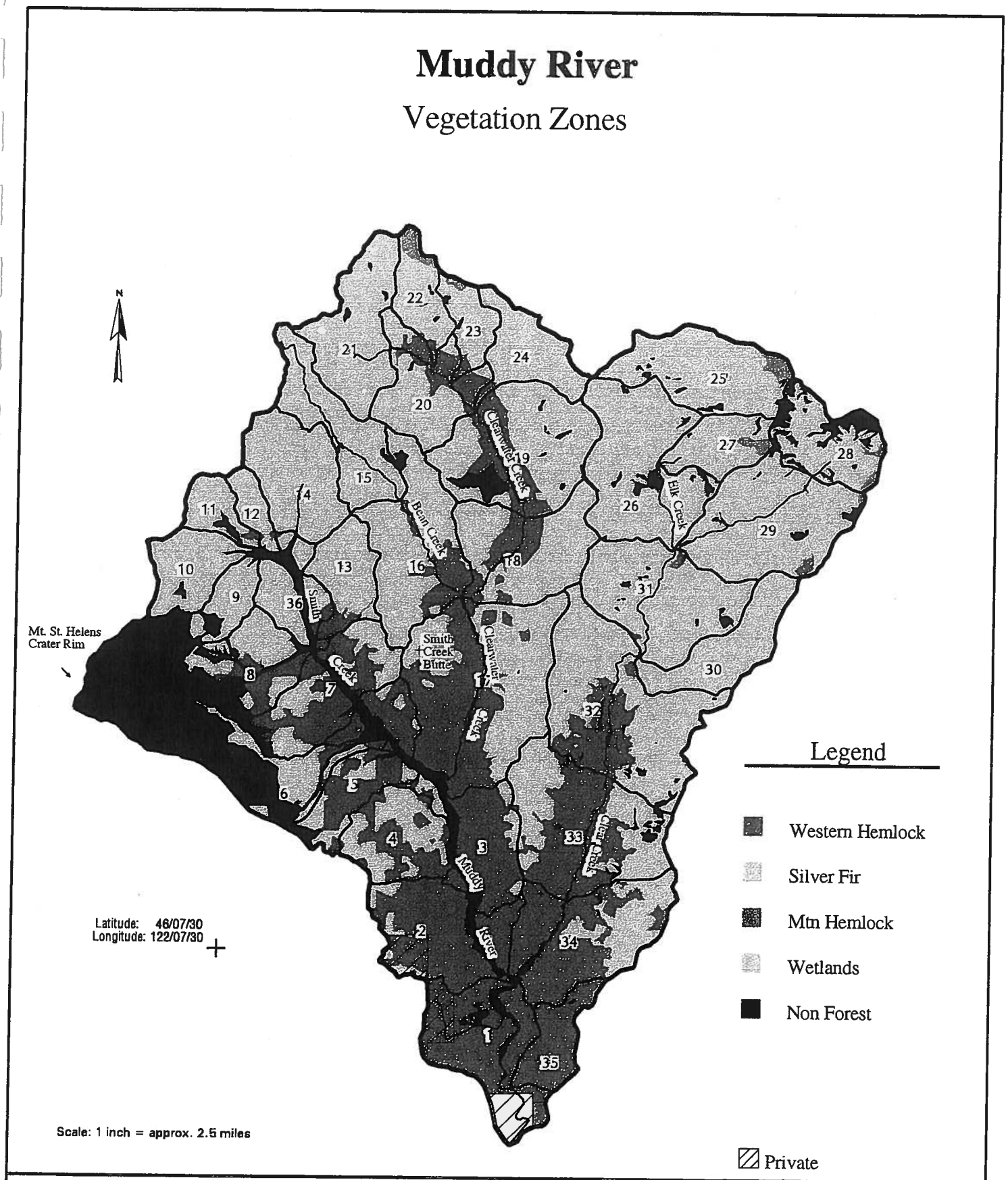

Figure 7. Vegetation Zones (Ecoclasses) of the Muddy River Watershed.

primarily in the eastern and southern portions of the watershed (Figure. 16). The watershed also contains a portion of the Lewis Late Successional Reserve RW-149 (LSR) (Figure. 17). The largest contiguous block of late successional/old growth forest is in LSR within the Elk Creek drainage.

Occasional sightings of bald eagles have occurred in the watershed. Between 1989 and 1990 a bald eagle nest was reported but never confirmed. Anderson and Ichisaka (1986) reported that the confluence of the Muddy River and Lewis River served as a primary foraging site for wintering bald eagles.

No sightings of peregrine falcons within the Muddy River watershed have been recorded. This may be due to the existence of very little cliff habitat. However, a large cliff face on Spencer Butte, adjacent to Clear Creek, may provide suitable nesting habitat.

No documented gray wolf sightings have been recorded. A grizzly bear sighting was reported in 1989. Because grizzly bear have very large home ranges, the occasional use of the watershed by an individual may be rare but probable. However, the likelihood of either a gray wolf or grizzly bear occupying the watershed is low because of the high level of human presence.

Sensitive Animal Species

Potential habitats exist for the two following Region 6 sensitive species: California wolverine and common loon.

An unconfirmed wolverine sighting was made in 1978. Similar to the gray wolf and grizzly bear, wolverines have large home ranges. Therefore, the occasional use of the watershed by an individual may be rare but is probable. However, the likelihood of an individual occupying the watershed is very low because of the high level of human presence.

There are no recorded sightings of the common loon in the watershed. Six lakes exist in the watershed and could provide adequate nesting habitat. But because of the shallowness of all six lakes, none are probably used by the common loon.

C-3 Animal Species (Survey and Manage)

Potentially suitable habitats exist for six C-3 species: silver-haired bat, long-eared myotis, fringed myotis, long-legged myotis, Larch Mountain and Van Dyke's salamanders.

No documented sightings of the above bats have been made in the watershed. In general, caves buildings and mines are used for winter roosts, while bark crevices, bridges, caves, mines and crevices are commonly used as summer roosts. No suitable caves, mines or buildings exist in the watershed, severely limiting the area's chances of serving a winter roost site. Several sub-basins contain a high percent of snags (Figure. 19). These sub-basins have a high probability of providing summer roost sites.

Riparian Reserves

As a key element of the Aquatic Conservation Strategy (ROD, B-9), the Riparian Reserves provide an area along all streams, wetlands, ponds, lakes and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Riparian Reserves are important to the terrestrial ecosystem as well, serving, for example, as dispersal habitat for certain terrestrial species. Figure 8 shows the Riparian Reserves in the Muddy River Watershed in two categories, those associated with streams and wetlands, and those lying on unstable ground.

Water Quality

Two 303 (d) water quality impaired stream segments (Muddy River and Clearwater Creek) are presently identified on the Washington State 303 (d) list. Both segments exceeded State water temperature standards and lost nearly all riparian vegetation as a result of the May 1980 eruption of Mount St. Helens.

Prior to the 1980 eruption, the Muddy River baseline station had three years of temperature observations and exceeded State water quality stream temperature standards an average of sixteen times per year. After the eruption, with six years of observation, Muddy River stream temperatures exceeded State water quality standards an average of fifty-two times per year. Prior to the eruption, the Clearwater Creek baseline station had one year of temperature observations and exceeded State water quality stream temperature standards three times. After the eruption, with nine years of observations, Clearwater Creek stream temperatures exceeded State water quality standards forty-nine times per year, on average. After the eruption, with eight years of observations, Clear Creek baseline station stream temperatures exceeded State water quality standards six times per year, on average.

There are 19 water quality monitoring stations within the Muddy River Watershed active for varying lengths of time since 1975. Seventeen recorded temperature. Three measured discharge and two were for extensive chemical analyses after the May 1980 eruption.

Water Quantity

About 70 percent of the Muddy River Watershed is in the transient snow zone and subject to rain-on-snow storm events.

Aquatic Animals and Habitat

The Muddy River Watershed (a Tier 1 Key watershed) has approximately 742 miles of stream; 7.0 miles are Class I, 75 miles are Class II, 187 are Class III, and 473 are Class IV (Figure 9). Rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*), mountain whitefish (*Prosopium williamsoni*), largescale suckers (*Catastomus macrocheilus*), and sculpins (*Cottus* sp.) are the most common fishes found in the streams. Bull trout (*Salvelinus confluentus*) are found below the watershed boundary. The Muddy River Watershed area is managed by the Washington Department of Fish and Wildlife for wild fish management. No stocking of fish in streams occurs above Swift Reservoir (J. Weinheimer, per. comm.). Stream survey data exists for 46.6 miles within this watershed; however, only 36.1 miles of this data was suitable for analysis using standards developed by the Columbia River Bansin Policy Implementaion Guide (CRBPIG) (USDA FS 1993). Following are the current conditions for those 36.1 miles:

Table 1. Current Conditions for Stream Segments Compared to the Desired Future Condition in the Muddy River Watershed.

	Desired Future Conditions (DFC)		
	Good	Fair	Poor
Percent of Total Miles and Miles of Stream in DFC			
Large Woody Debris (LWD)	12% (4.48 mi)	28% (10.19 mi)	60% (21.43 mi)
Primary Pools per Mile	3% (1.0 mi)	20% (7.26 mi)	77% (27.84 mi)

Survey data for Ape Canyon and Bean Creeks (10 miles) could not be assessed in this table due to the lack of quantitative data; however, the surveyor did note that fish habitat was poor in all reaches of both streams due to: high temperatures (58 and 59 degrees F, respectively), lack of LWD, little pool habitat, minimal spawning gravel, and little to no vegetative cover.

Mean stream water temperatures meet the State Water Quality standard of 16 degrees Celsius (60.8 degrees Fahrenheit); however, maximum temperatures exceed this standard for short periods of time. This could affect optimum spawning and rearing behavior for salmonids.

Culverts and road crossings can fragment aquatic habitat by interfering with fish migration, as well

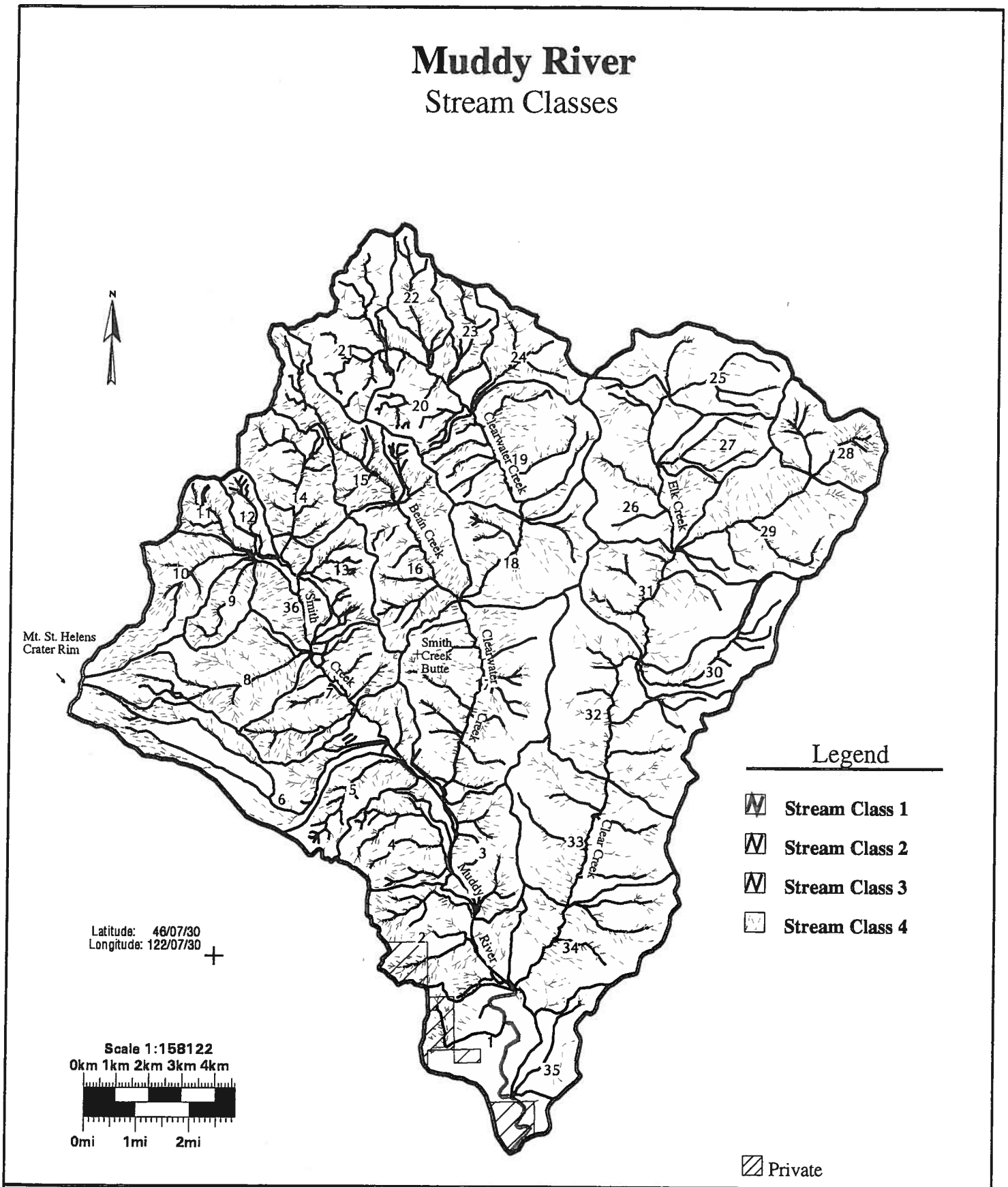

Figure 9. Stream segments have been grouped according to their size and presence of beneficial uses. These groups, referred to as stream classes, range from Class 1, which is a large perennial stream, to Class 4, which is a small intermittent stream.

as the flow pattern of LWD and sediment through the system. The watershed contains 565 road/stream crossings, which, when divided by 738 stream miles equates to 0.77 crossings per mile of stream.

Thirty percent of the riparian reserves along streams have undergone timber harvest in the past 50 years. Some resource damage is occurring from dispersed campsites within the wtaershed.

Historical sightings of bull trout, which is proposed for listing as threatened, have occurred in the Muddy River.

There are two large reservoirs created by the dams on the Lewis River that are very popular recreation areas. These are Yale Lake and Swift Reservoir, which are approximately 3,800 and 4,580 acres, respectively. No anadromous fish currently access the Muddy River watershed because upstream fish passage is blocked by the dams at both Yale Lake and Swift Reservoir. Both reservoirs contain rainbow trout, cutthroat trout, bull trout, mountain whitefish, and largescale suckers.

Six lakes are located within the Muddy River watershed analysis area: Curtis, Badger, St. Charles, Ghost, Meta, and Crane (Figure 21). Stocking of fish is not allowed in St. Charles, Ghost, Meta or Crane due to the natural recovery processes being studied within the area. Curtis and Badger Lakes are too shallow to support fish populations, therefore, they are not stocked. Lake surveys have not been completed to identify fish habitat condition.

Aquatic habitat and organisms in the lakes and streams near Mount St. Helens were severely affected by the May 18, 1980 eruption The Muddy River, Smith Creek, Pine Creek, Bean Creek and Clearwater Creek had extreme channel changes occur by volcanic mudflows and pumiceous pyroclastic flows. Streams within the Monument continue to be affected by sedimentation due to the mudflows, and deposition of ash. Revegetation of mudflows and ash depositional areas has been slow, aiding to increased stream temperatures, decreased nutrient levels from allochthanous materials, and decreased primary production. As a result of the eruption, populations of aquatic organisms dropped to very lows levels or were decimated all together depending upon what elevation the stream or lake was located (USFS 1989).

		Fish Populations	
Smith Creek	I/O	Unknown	II-IV
Wright Creek	O	ONMY	II-IV

*Fish Species Codes:

TLC=Twin Lakes Cutthroat Trout
ONMY= *Oncorhnychus mykiss* (Rainbow Trout)
ONCL= *Oncorhynchus clarki* (Cutthroat Trout)
SAFO= *Salvelinus fontinalis* (Brook Trout)
PRWI= *Prosopium williamsoni* (Mountain Whitefish)
CAMA= *Catostomus macrocheilus* (Largescale Sucker)

Human Uses

The Muddy River area has been occupied by, and its environment modified by humans, for at least six thousand years. American Indians established seasonal villages along the Lewis River where they fished for salmon, collected edible plants such as huckleberries, and hunted game in the surrounding mountains. Peeled cedar trees still exhibit scars where Indians removed bark used for making baskets to store and transport berries.

Ridge tops provided relatively open travel routes, a preferred area for berry collecting, and perhaps vision questing. Outcrops of jasper and agate were a source of raw material used to manufacture cutting tools and projectile points. The relative abundance of these materials in stream beds provided a ready source of material to early inhabitants. Historic records document the intentional setting of fires in the fall for the control of underbrush, rejuvenation of berry fields, and to enhance hunting. In the early 1800's European immigrants encountered a human-affected landscape.

American Indian populations rapidly decreased during the 1800's with the introduction of European diseases to which they had almost no resistance. During this same period, land was made available for homesteading, while land grants encouraged the railroad development. Settlers hunted game, cleared land in the valleys, and engaged in subsistence farming. Near the end of the century, gold was discovered in the watershed which led to the attempted development of several mineral properties. The largest of these, the Commonwealth Mine, is located near the headwaters of Clearwater Creek. Several short drifts and shallow shafts explored vein deposits. None of the prospects produced commercial quantities of gold or silver, but did result in the construction of many mining cabins, and some trail development. Fur trapping was contemporaneous with mining activity. Many of

later became travel routes for curious visitors. Recreational use is concentrated along the Road 25, 99, and 83 corridors. Windy Ridge viewpoint, at the end of Road 99 receives, an average of 330,000 visitors per year, 250,000 travel Road 25, and 108,000 visit the Lahar Recreation Area.

Road 99 receives visitors during the non-snow season, from the end of May through October. Viewpoints, interpretive sites, trails, and a restaurant are found along this northern fringe of the watershed. The Lahar Recreation Area, and Lava Canyon Trail are popular destinations along the upper Muddy River. Smith Creek Trailhead provides access to the Smith Creek Drainage and the Smith Creek Butte Trail, a popular equestrian hunting area. Other relatively long trails include Ape Canyon, Loowit, Truman, Boundary, Smith Creek, Wright Meadow, and Craggy Peak. These popular trails are featured in a variety of guidebooks and with their spectacular scenery attract thousands of visitors each year.

CHAPTER II ISSUES AND KEY QUESTIONS

Having characterized the watershed, the ID team assembled the issues to be studied. For this watershed analysis, "Issues" are topics of concern about key elements of the ecosystem that are related to:

management goals and objectives,

human values, or

resource conditions within the Muddy River Watershed.

Each issue generates Key Questions to be investigated. These questions:

1. address the issues by focusing on the elements that influence and are influenced by humans, and which can be measured at the watershed scale; and

2. are expected to be answered by the analysis.

A general letter announcing the beginning of the watershed analysis and soliciting ideas about topics that should be investigated was mailed to 84 addressees which included individuals interested in watershed analysis in general and other agencies. Neal Darby, US Fish and Wildlife Service, provided input.

From the characterization (Chapter I of this report) and from verbal and written input, a list of Issues and Key Questions was compiled. See Appendix C, List of Issues and Key Questions.

In order to proceed, the total list was narrowed to concentrate the team specialists' limited time and resources on those issues of greatest importance.

Being prepared to answer watershed-scale questions about anticipated future land management project decisions is the driving force behind this iteration of the Muddy River Watershed Analysis. Accordingly, the types of future projects needing a watershed-scale perspective include:

1. Watershed Restoration
   - Road decommissioning/weatherization
   - Placement of in-stream structures
   - Riparian Reserves - planting, vegetation manipulation

2. Small tree thinning and underplanting diverse tree species
3. Flood repair to roads, facilities, other (slides, etc.)
4. Management of dispersed recreation camping
5. Developing and reconstructing trails, trailheads, and associated access
6. Research and science projects and associated access
7. Timber harvest

A total of eleven issues will be addressed in the Muddy River Watershed Analysis. These issues are

- **Mass Wasting:** The Muddy River has numerous landslides and debris flows within its boundaries. Management activities along with the 1980 eruption of Mount St. Helens have activated or worsened a number of these features, sometimes impacting streams.

- **Surface Erosion From Roads and from Upland Slopes:** Surface erosion from roads has been a major contributor of sedimentation to streams in the past. Most of the sediment is transported during new construction and within the first two to three years thereafter. After this time, vegetative growth on the fill slopes and cut slopes help alleviate this problem, but in areas near stream crossings the problem can continue to influence stream habitat for many years. Poor construction practices in the past have created numerous problems recently from fill slope failures that directly and indirectly move sediment into many streams. This is especially evident since the storm event of February, 1996.

  The tephra deposits and blast area created by the eruption in 1980 has left varying amounts of loose unconsolidated material on the entire watershed. This material is highly erosive especially on the steeper slopes and where the vegetation was destroyed. Recent storm events have given a good picture of the erosive properties of these deposits.

- **Fire History:** In the past, large catastrophic fire has been a change agent at the landscape (watershed) scale.

- **Vegetation Structure and Composition:** Historically, the Muddy River Watershed was probably comprised of large contiguous stands which were shaped by episodic wildfire or the eruption of Mount St. Helens. The species composition and structure of these stands varied considerably depending on the nature and size of the disturbance. Because disturbance events were infrequent, it is likely that through time a large proportion of the vegetation was late-successional. Within the last 60 years, timber harvest and regeneration activities have changed this historic successional pattern by increasing the number of young, small, uniform openings with single storied structure and reducing species diversity. These younger stands are distributed across the watershed fragmenting the larger contiguous stands historically present. The structure, composition, and distribution of these patches has diminished the diversity and distribution of some plants, lichens, fungi, bryophyte and animal species and their habitat.

- **Stream Riparian Reserve Fragmentation and Riparian Habitat:** Stream riparian areas provide habitat for bryophytes, fungi, lichens, plants, and wildlife and provide corridors for wildlife migration and plant dispersal. Some critical components of terrestrial habitat within Stream Riparian Reserves have been altered by fragmentation due to wildfire, the 1980 eruption of Mount St. Helens, and timber management activities. This has influenced the capacity of these ecosystems to provide effective habitat for riparian dependent species and other species that may use Stream Riparian Reserves as corridors between larger habitat blocks. Disruption of connectivity between these areas can potentially result in species isolation. This can lead to undesirable changes in species composition, use, and ecosystem functions within Riparian Reserves and the watershed.

- **TES and C-3 Plant Species:** Numerous populations of *Pleuricospora fimbriolata,* a State Sensitive plant, are present in the watershed. Four Forest Plan Botanical Special Interest Sites have been designated as Selected Species Management Areas for *Pleuricospora fimbriolata. Carex interrupta*, a state Sensitive and Survey and Manage (C-3) Category 3 plant species is also present in the watershed. An additional 33 threatened, endangered or sensitive (TES) plant species are suspected to occur within the watershed, based on suitable habitat. A small portion of the watershed has been surveyed for TES species.

  Lobaria oregana, L. scrobiculata, Nephroma bellum, N. resupinatum, Pannaria saubinetti, Pseudocyphellaria anomala, P. anthraspis and *P. crocata,* C-3 Category 4 lichens are present in Cedar Flats Research Natural Area. It is highly likely that these and other C-3 lichens are present in other parts of the watershed. *Tetraphis geniculata*, a C-3 Category 1and 3 bryophyte, and *Ulota meglospora*, a protection buffer bryophyte species are also present in Cedar Flats. None of the rest of the watershed has been surveyed for C-3 bryophytes, lichens or fungi.

- **Habitat Condition for TES, C-3, and Cavity-Dependent Animal Species:** The watershed contains suitable, or potentially suitable habitats for threatened, endangered, and sensitive species including the northern spotted owl, peregrine falcon, gray wolf, grizzly bear, bald eagle, Townsend's big-eared bat, and Larch Mountain salamander.

  The watershed contains suitable, or potentially suitable habitat for C-3 species (North American lynx, forest bats, Van Dyke's salamander) and cavity-dependent species.

- **Hydrologic Changes:** Past disturbances such as wildfire and volcanic eruption in the analysis area may have influenced basin hydrology by increasing peak flows during fall and winter storms, and decreasing summer low flows. Human activities have occurred throughout the watershed and may influence the timing and quantity of runoff as well.

- **Water Quality and Key Habitat Attributes for Salmonids:** Current aquatic habitat conditions are a result of past natural and human induced processes that have occurred in the watershed. Road building, dams, volcanic eruption and fire regimes, combined with timber harvest and increased human populations in the watershed have through time altered stream habitats and aquatic communities. Degraded water quality from sediment and high water temperatures may be affecting habitats for bull trout, rainbow trout, sculpins, suckers and cutthroat trout. State water quality regulations are in place to protect existing and designated uses of water (i.e., beneficial uses). Due to time and analysis information limitations the focus will be on fish spawning and rearing.

- **Conflict Between Trail Users:** Use of trails in the watershed is increasing. When different uses are mixed, such as hikers and mountain bike riders, or motorized use, an interference between non-mechanized and faster moving mechanized users may develop. These conflicts can degrade the recreational experience of users, and in some instances produce danger of collision and injury.

- **Demand For and Resource Impacts From Dispersed Camping:** Road decommissioning within this and adjacent watersheds is removing access from dispersed camp sites, making them no longer available. Demand is particularly high during hunting season in the fall. This may influence the number of hunters able to use the area, and the appearance of new camps. In some cases, dispersed camping may impact other resource values, such as wildlife or water quality. These impacts will be identified.

CHAPTER III CURRENT CONDITIONS

Chapter III consists of brief presentations (illustrated by maps, tables, and charts) which describe current conditions and trends of relevant ecosystem elements and processes within the watershed.

Geology and Physical Processes

Mass Wasting

Mass wasting within the Muddy River Watershed is characterized by three main processes: large, slow-moving, deep-seated landslides, debris torrents/flows, and shallow rapid mantle failures. These have occurred both in managed and natural areas. Since the 1980 eruption of Mount St. Helens, the number of debris torrents and shallow mantle failures have increased significantly in the blast area. The loose tephra deposits on the steep slopes lack sufficient cohesiveness to remain in place during heavy storm events. As this loose tephra fails it can (and in many instances has) caused failure into the underlying mantle

Much of the area has been mapped as unstable and potentially unstable as can be seen in Figure 10. Table 3 displays a breakdown of unstable and potentially unstable acres by sub-basin and percent of unstable and potentially unstable land by sub-basin. As shown, one fourth of the sub-basins within the watershed have greater than 50 percent of their area mapped as unstable or potentially unstable. Sub-basin 36 is the highest at 84.5 percent.

Table 3. Unstable and Potentially Unstable Land in Sub-basins of the Muddy River Watershed

Sub-basin	Acres in Sub-basin	Acres Unstable	Acres Potentially Unstable	Percent of Sub-basin
1	2835	104	47	5.3%
2	2826	171	1036	42.7%
3	3036	682	1256	63.8%
4	1908	27	1156	62.0%
5	1331	194	696	66.9%
6	3475	963	130	31.5%
7	2528	362	1610	78.0%
8	3009	166	638	26.7%
9	837	57	114	20.4%

Sub-basin	Acres in Sub-basin	Acres Unstable	Acres Potentially Unstable	Percent of Sub-basin
10	1993	22	552	28.8%
11	749	10	238	33.1%
12	533	145	110	47.8%
13	1332	154	961	83.7%
14	2290	81	610	30.2%
15	2136	189	514	32.9%
16	3186	433	1198	51.2%
17	5536	145	1505	29.8%
18	2817	142	780	32.7%
19	3808	102	61	4.3%
20	2086	204	96	14.4%
21	2455	41	0	1.7%
22	1076	49	75	11.5%
23	828	111	51	19.6%
24	1464	52	291	23.4%
25	2631	0	162	6.2%
26	3697	124	1847	53.3%
27	1189	0	154	13.0%
28	1861	4	0	0.2%
29	3584	56	604	18.4%
30	1778	0	142	8.0%
31	3287	24	1690	52.1%
32	4855	31	1587	33.3%
33	4125	193	1899	50.7%
34	3366	175	1252	42.4%
35	1105	0	44	4.0%
36	1358	438	710	84.5%
Totals	86910	5651	23816	33.9%

Muddy River

Unstable and Potentially Unstable Land

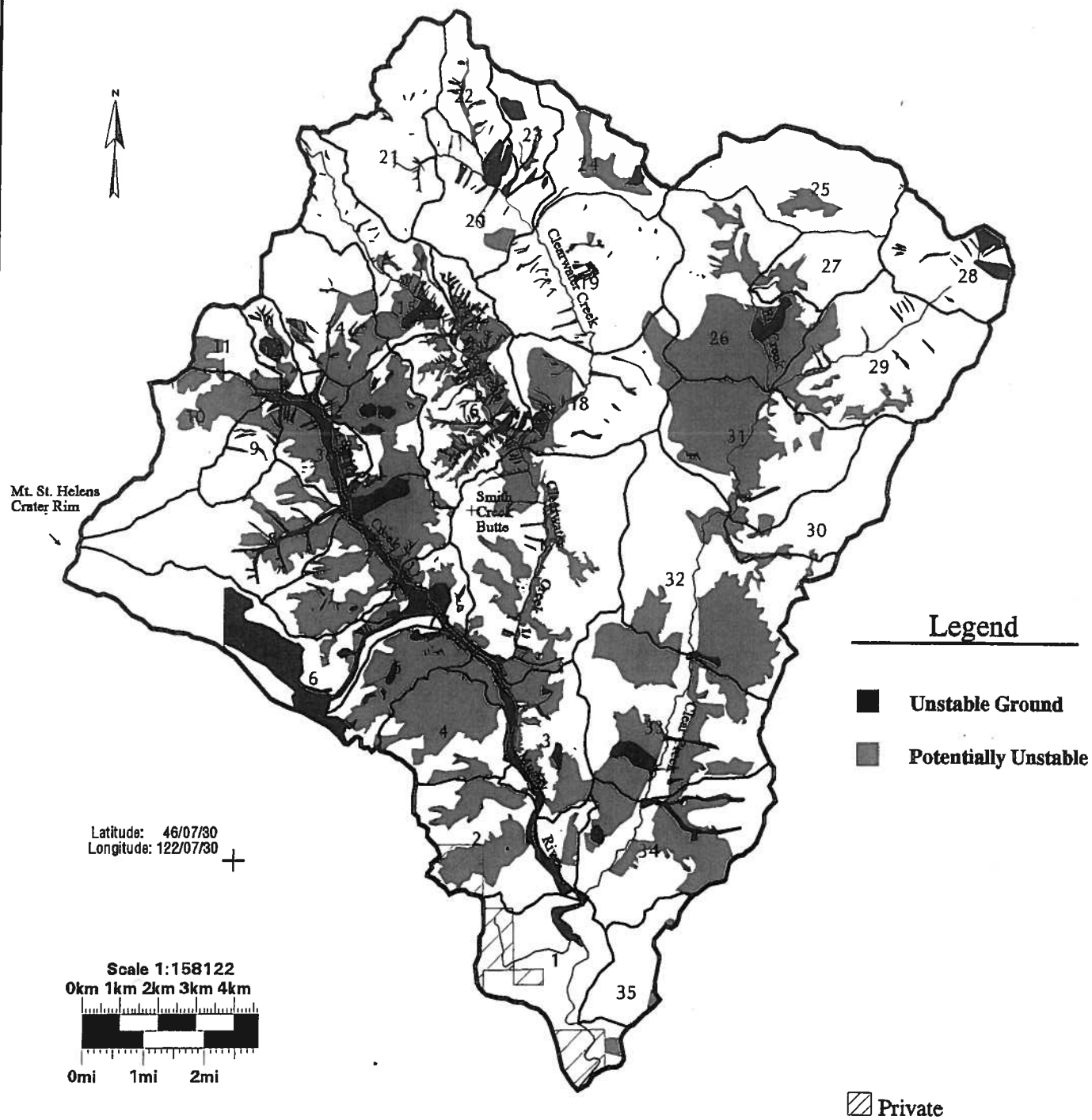

Figure 10. Areas mapped as unstable and potentially unstable ground. Areas of overlap should be considered as unstable.

Erosional Processes

Erosional processes have been a major contributor to sediment routing since the 1980 eruption of Mount St. Helens. Loose ash and tephra on the steep slopes of the watershed have continually been influenced by precipitation and wind. As new vegetation gains a foothold these erosional processes will ease until the next eruptive event adds more ash and tephra to the landscape. The amount of ash and tephra from eruptive events also influences the vegetation in place at the time. In areas where these deposits are greater than eight inches in depth vegetative growth is diminished or killed. This is an approximate figure as all the vegetation types will be affected differently under these circumstances. Shallow ground vegetation will be buried and may be killed, or in time, it might work its new growth to the new surface. Larger shrubs and trees can be killed or experience a slowing of growth. These effects are not starkly evident from the 1980 eruption because the effects of the lateral blast destroyed almost all vegetation. If the blast had been vertical the effects of ash and tephra deposits would have shown up clearly. Today the loose ash and tephra are continually being eroded by precipitation and wind. The effects are most pronounced during large storm events or spring runoff. Many rills and gullies are noticeable in the northern part of the watershed, especially in Smith, Bean and Clearwater Creek drainages.

The other major erosional contributor to sediment routing is the effect of roads in the watershed. The modeling used to determine areas of concern is based mostly on road densities and amounts of traffic. Other factors are used but these two have the most effect on where sediment routing is of concern. Figure 11 shows the sub-basins of concern, i.e. those with the highest sediment rates in tons per year per square mile. This is the sediment that is routed to the stream system which may influence the stream habitat conditions. Most of the routed sediment from roads is "fines" that could fill in habitat typically used by fish as spawning areas. This model may give misleading results in that it does not appear to take into account that asphalt roads would probably have lower sediment production than gravel or native surfaced roads. Water runoff would only have minimal amounts of sediment to pick up and transport. Also, this model does not account for construction practices that could lead to fill failures or other road related failures that could contribute large amounts of sediment to the system over short periods of time.

The tephra deposits from the 1980 eruption have been a much larger contributor of sediment to the aquatic system than erosion from roads. This is more noticeable in the blast area than in the southern portions or Clear Creek areas of the watershed. The southern portions and Clear Creek did not receive a relatively large volume of tephra, and the vegetation tended to hold and work this material into the soil. However, the sediment production from this area was still considerable, especially during the first few years after the eruption.

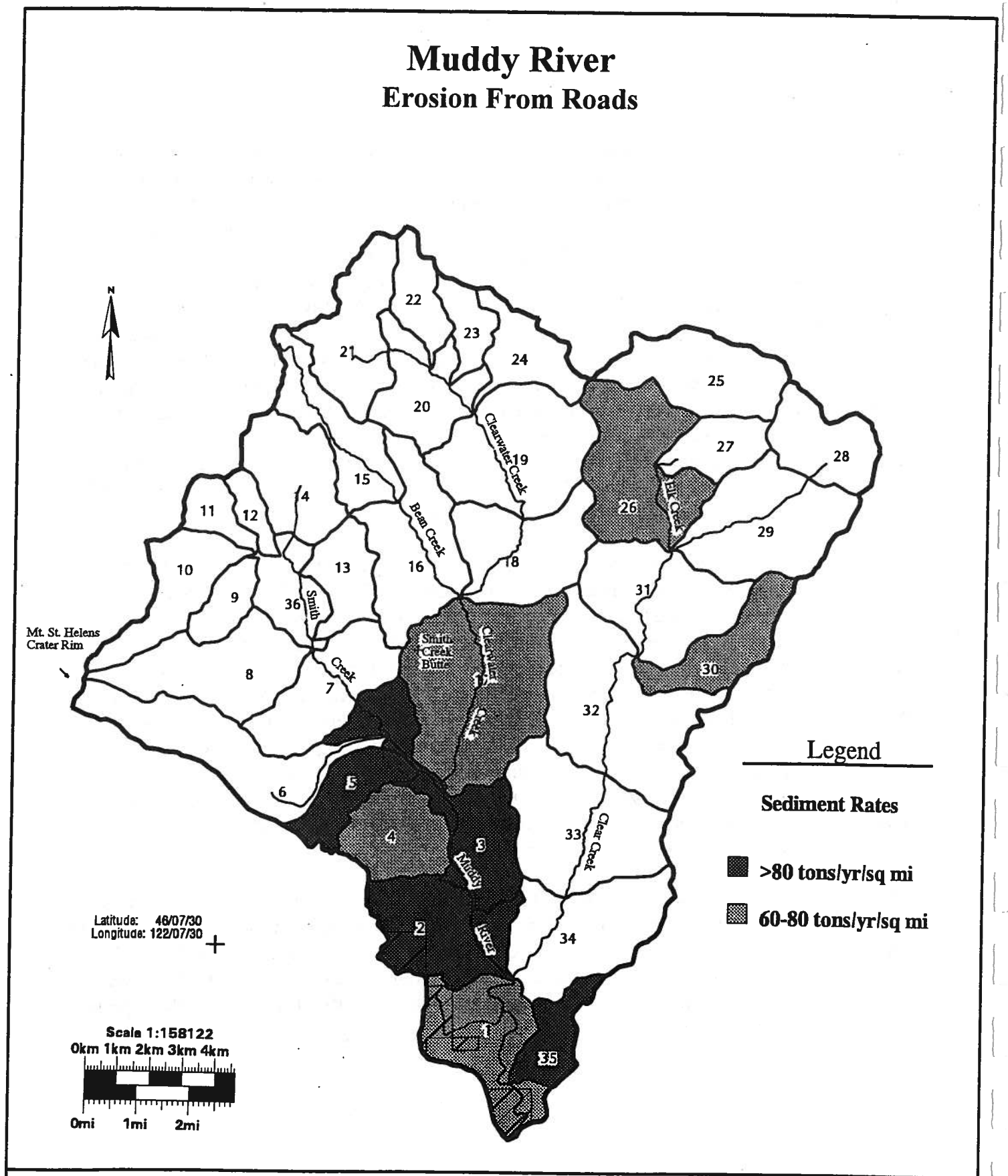

Figure 11. Sub-basins with the highest potential for moving sediment from roads to streams.

Fire

Large wildfires have been a major agent of natural change in the forest landscape of the Muddy River watershed. Fire has been an integral part of the forest ecosystem, affecting wildlife habitat, vegetation dynamics, soil properties and water hydrology.

The natural fire regime for the Muddy River Watershed is similar to other westside forest locations; major fires at any point are infrequent (50 to 400 year intervals) but catastrophic in their effects. Highly productive and long-lived tree species associated with the Douglas-fir zone accumulate great quantities of intermediate to large class size fuels. Fine fuels, the most readily ignitable, are present in a relatively small amounts. Fine fuels reach their maximum dryness in July and August, while the larger fuels do not usually dry out until September. The eruption of Mount St. Helens in 1980 modified the fuel characteristics of the watershed somewhat, especially the northern half, in that much of the fine fuels were covered with one to six inches of ash and/or pumice thus reducing both the potential rates of spread and intensity. Most of the fires in any given year occur in July and August, but the majority of these are less than one half acre in size. Most of the larger fires, and virtually all of the catastrophic fires, occur during September but range from late August to early October after long periods of drought.

It appears that large (although infrequent) high-intensity stand replacement fires occurred in the watershed up into the early 20th century. These include two large fires in 1902: (1) the 32,000 acre Lewis River Fire in the southeast portion of the watershed, and (2) the southern extent, (approximately 2,500 acres) of the large Cispus Fire to the north. A reburn of the 1902 Lewis River Fire, the Copper Creek Fire, consumed approximately 6,700 acres in 1920.

Based on formal fire reports from 1970 through 1995, the current fire frequency of the watershed is approximately four fires per year. Thirty percent of the fire ignitions are due to lightning occurrence and the remaining 70 percent are attributed to miscellaneous human causes. During this period of time all fires were less than one half acre in size except for the Ape Canyon fire of 1973 which burned 114 acres on the eastern flanks of Mount St. Helens. The reduction in the number and size of catastrophic fires is related to suppression and prevention policies instituted by the Forest Service in the 1910's and the increase in road access due to logging operations. Catastrophic fires can be minimized or postponed, but inevitably some large, severe fires will continue to occur in the future.

Vegetation

Stand Composition

The vegetation of the Muddy River watershed has been categorized into six vegetation zones (or ecoclasses; Figure 7. Vegetation Zones) based on plant species present, their proportions, and potential vegetation (Brockway et al. 1983; Topic et al. 1986; Topic 1989). The Western Hemlock

zone is generally the most productive for timber, followed by the Pacific Silver Fir zone. Table 4 shows the amounts of each vegetation zone in the watershed, and Table 5 shows the breakdown of these zones by sub-basin.

Table 4. Vegetation Zones in the Muddy River Watershed. Calculations exclude non-National Forest lands.

Vegetation Zone	Acres	Percent of Watershed
Western Hemlock	22,912	27
Pacific Silver Fir	54,339	63
Mountain Hemlock	497	1
Wetland	79	<1
Water	33	<1
Non-Forest	8658	9

Table 5. Vegetation Zones in the Muddy River Watershed by Sub-basin. Calculations include non-National Forest lands.

Sub-Basin	Acres	Western Hemlock	Pacific Silver Fir	Mountain Hemlock	Wetlands	Water	Non-Forest
01*	1987	1753	0	0	0	0	234
02*	2428	2087	149	0	0	0	192
03	3036	2135	375	0	0	3	523
04	1908	863	1021	0	0	0	25
05	1331	784	420	0	0	0	126
06	3475	113	809	0	0	0	2553
07	2528	1308	950	0	0	3	267
08	3009	417	884	0	65	0	1643
09	837	0	726	0	0	0	111
10	1993	0	1298	0	0	0	696
11	749	34	643	0	0	0	72
12	533	23	486	0	0	0	24
13	1332	176	1151	0	0	0	5

Sub-Basin	Acres	Western Hemlock	Pacific Silver Fir	Mountain Hemlock	Wetlands	Water	Non-Forest
14	2290	6	2280	0	0	0	4
15	2136	0	2100	0	0	2	34
16	3186	612	2521	0	0	1	52
17	5536	2628	2751	0	0	0	158
18	2817	689	2120	0	0	0	8
19	3808	978	2551	0	0	0	279
20	2086	595	1485	0	0	0	7
21	2455	0	2402	0	0	22	31
22	1076	46	861	153	3	0	14
23	828	63	707	36	3	0	18
24	1464	50	1413	1	0	0	0
25	2631	0	2420	127	3	2	79
26	3697	0	3521	0	0	0	176
27	1189	0	1095	79	0	0	15
28	1861	0	1310	82	0	0	468
29	3584	55	3405	19	0	0	105
30	1778	2	1776	0	0	0	0
31	3287	55	3162	0	5	0	65
32	4855	1107	3611	0	0	0	137
33	4125	2104	1876	0	0	0	145
34	3366	2182	1074	0	0	0	110
35	1105	1101	0	0	0	0	4
36	1358	167	912	0	0	0	279
Totals:	86911	22912	54339	497	79	33	8658

* Sub-basin with non-National Forest land ownership.

Stand Structure

From an ecological/functional perspective, stand structure is often more informative than stand age or seral (successional) stage. Stand structure definitions have been developed based on a number of different criteria (Hall et al. 1985), and were recently expanded to include a total of 16 categories (Appendix D, Structure Stage Definitions).

For ease of interpretation, structure stages are combined into seven groups based on ecological functions at a more coarse scale (Table 6, Vegetation Structure Stages). Table 7 lists the percent grouped vegetation structure stages, and percent harvested, for each sub-basin. Harvested acres listed in the table are for National Forest lands only, as are the structure stages. Approximately 1.5 percent of the watershed, in Sub-basins 1 and 2, is in non-National Forest ownership. All of the acreage in non-National Forest lands has been harvested, and is in either grass/forb/seedling, open sapling/pole/small tree or closed sapling/pole/small tree structure stages. The total percentage of harvested lands for both non-National Forest and National Forest lands in Sub-basins 1 and 2 is 57 and 64 percent, respectively.

Figure 12 depicts the distribution of structure stages throughout the watershed. Large contiguous areas of shrub/forb, open sapling/pole, and closed sapling/pole are obvious where past fires and the 1980 eruption of Mount St. Helens occurred. Most lands within the Monument itself were not planted after the 1980 eruption and are now in the grass/forb structure stage. Adjacent to the Monument, where planting did occur, the vegetation is now primarily an open sapling/pole/small tree structure stage. The large contiguous blocks of closed and open sapling/pole in the vicinity of Smith Creek Butte and east of the Muddy River originated from the wildfires which occurred at the turn of the century (Figure 6, Large Historical Fires).

The vegetation pattern created by recent harvest operations is also obvious, especially on lands historically managed by the Forest Service for timber (Figure 13). Small patches which range in size from one-half to 336 acres (38 acres average) are scattered throughout larger stands of contiguous forest, creating a mosaic of seral stages distinctly different than what would have occurred through natural disturbances. This pattern of different aged stands has resulted in the fragmentation of larger forest stands. Because harvested lands were managed for timber growth and output, these areas were planted and subsequently managed through time to maintain young, single-storied stands with reduced species and structure diversity. The variety of layers, species, age classes and structure which exist on lands regenerated naturally after a wildfire or volcanic eruption generally do not exist on these managed stands. On non-federal lands, where plantations are generally larger than those created by the Forest Service, this pattern is less obvious.

Since about 1940, approximately 42 percent of the National Forest lands within the watershed have been harvested (Figure 13). This acreage includes lands within the Monument which were harvested prior to the eruption of Mount St. Helens. Most of these harvest units were subsequently lost when the mountain erupted and were not planted thereafter. Harvest acres represent approximately 64 percent of the seedling, sapling, pole and small tree components within the

watershed. The remaining 36 percent of the young stands are the result of natural disturbance, primarily wildfire and volcanic activity.

Table 6. Vegetation Structure Stages. Calculations exclude non-National Forest lands.

Structure Stage	Percent	Grouped Structure Stage	Percent
Grass/Forb	15	Grass/Forb/Seedling	15
Shrub/Seedling	<1		
Remnant Forest	<1		
Open Sapling/Pole	27	Open Sapling/Pole/Small Tree	32
Open Small Tree	5		
Closed Sapling/Pole	7	Closed Sapling/Pole/Small Tree	21
Closed Small Tree	14		
Large Tree Single-Layer	1	Large Tree Single-Layer	1
Large Tree Multi-Layer	21	Large Tree Multi-Layer	21
Hardwood Sapling/Pole	<1	Hardwoods	<1
Hardwood Shrub/Seedling	<1		
Hardwood Trees	<1		
Wetlands	1	Non-Forest	10
Water	<1		
Rock	9		
Totals:	100%		100%

Table 7. Percent Grouped Vegetation Structure Stages, and Percent Harvested, by Sub-Basin, Muddy River Watershed. Calculations exclude non-National Forest lands.

Sub-Basin	Acres National Forest	Acres Non-Federal Lands	Percent Har-vested	Grass/ Forb/ Seedling	Open Sap/Pole/ Sm Tree	Closed Sap/Pole /Sm Tree	Lg Tree Single Layer	Lg Tree Multi Layer	Hard-wood	Non-Forest
01*	1987	849	38%	2%	25%	15%	0%	46%	0%	234
02*	2428	399	58%	7%	24%	36%	0%	20%	5%	192
03	3038	0	30%	4%	15%	55%	5%	4%	0%	526
04	1908	0	60%	4%	37%	53%	0%	6%	0%	25
05	1331	0	75%	4%	47%	38%	0%	1%	0%	126
06	3475	0	17%	5%	12%	5%	0%	2%	3%	2553
07	2529	0	53%	1%	28%	43%	7%	10%	0%	270
08	3009	0	10%	24%	9%	4%	0%	4%	1%	1708
09	837	0	100%	85%	0%	0%	0%	0%	2%	111
10	1993	0	100%	65%	0%	0%	0%	0%	0%	696
11	749	0	100%	90%	0%	0%	0%	0%	0%	72
12	533	0	100%	95%	0%	0%	0%	0%	0%	24
13	1333	0	90%	3%	96%	1%	0%	0%	0%	5
14	2289	0	1%	78%	21%	0%	0%	0%	0%	4
15	2137	0	69%	17%	81%	0%	0%	0%	0%	36
16	3186	0	73%	24%	71%	4%	0%	0%	0%	53
17	5535	0	27%	6%	21%	25%	3%	42%	0%	158
18	2816	0	57%	4%	54%	3%	0%	38%	0%	7
19	3808	0	73%	6%	58%	6%	0%	22%	0%	279
20	2086	0	91%	2%	95%	2%	0%	0%	0%	7
21	2454	0	39%	5%	91%	2%	0%	0%	0%	52
22	1078	0	24%	2%	23%	6%	0%	67%	0%	17
23	827	0	42%	1%	37%	4%	0%	55%	0%	21
24	1464	0	41%	7%	34%	0%	0%	59%	0%	0
25	2631	0	33%	8%	13%	23%	5%	47%	1%	84

Sub-Basin	Acres National Forest	Acres Non-Federal Lands	Percent Har-vested	Grass/ Forb/ Seedling	Open Sap/Pole/ Sm Tree	Closed Sap/Pole /Sm Tree	Lg Tree Single Layer	Lg Tree Multi Layer	Hard-wood	Non-Forest
26	3699	0	45%	13%	12%	27%	0%	43%	0%	176
27	1187	0	34%	13%	21%	13%	7%	45%	0%	15
28	1861	0	<1%	1%	4%	27%	0%	43%	0%	453
29	3584	0	16%	10%	7%	30%	0%	49%	1%	105
30	1778	0	54%	22%	12%	25%	10%	31%	0%	0
31	3287	0	34%	14%	18%	13%	1%	51%	0%	70
32	4855	0	24%	11%	34%	40%	0%	11%	0%	137
33	4124	0	24%	5%	32%	47%	1%	10%	1%	145
34	3366	0	27%	9%	32%	47%	0%	8%	0%	110
35	1105	0	44%	5%	29%	22%	0%	43%	0%	4
36	1357	0	19%	58%	20%	0%	0%	0%	1%	279
Total %	**98.5%**	**1.5%**	-	**15%**	**32%**	**21%**	**1%**	**21%**	**<1%**	10%

* Sub-basin with non-National Forest land ownership.

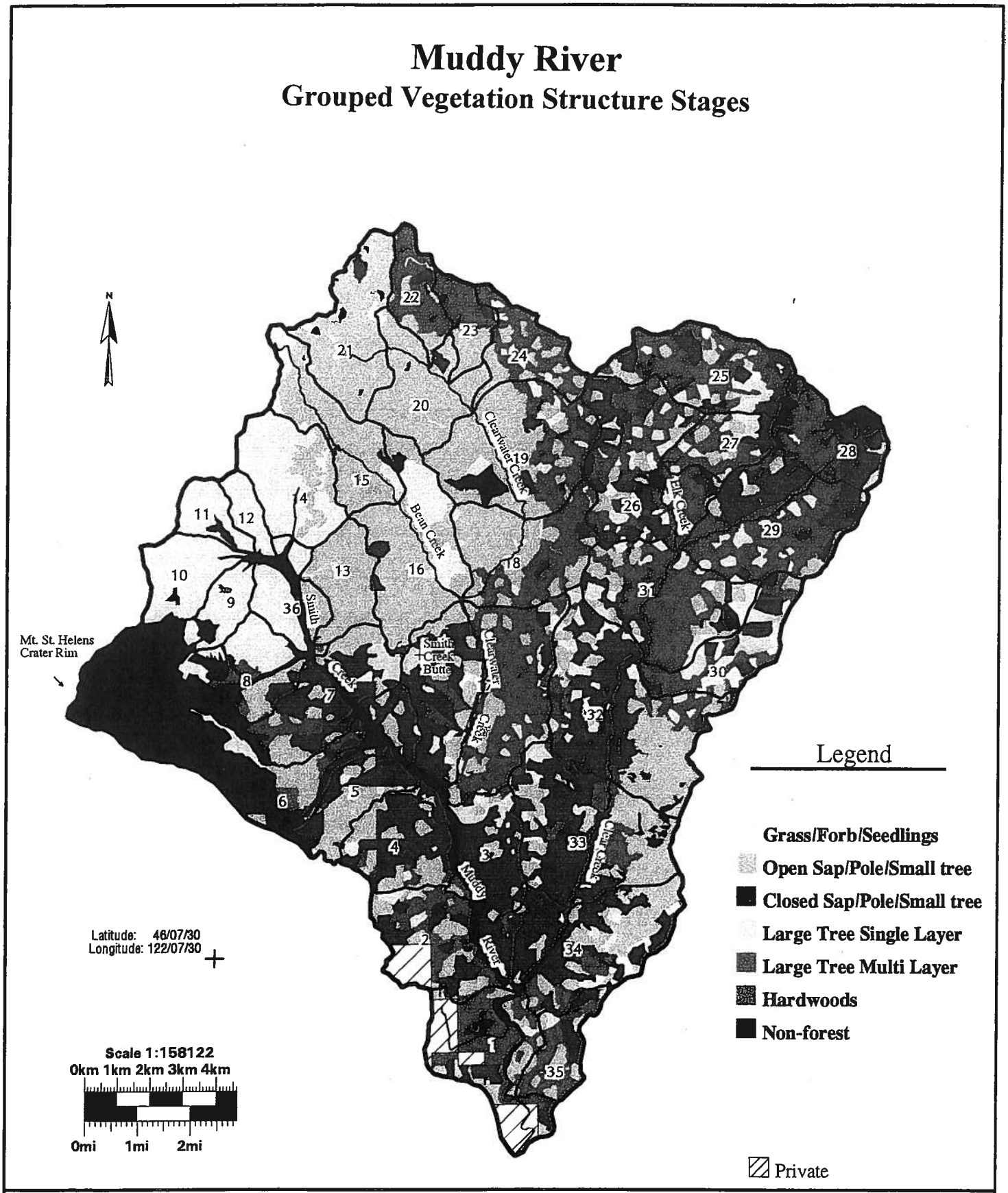

Figure 12. Grouped Vegetation Structure Stages in the Muddy River Watershed. Privately-owned lands (cross-hatched) are not classified into Structure Stages.

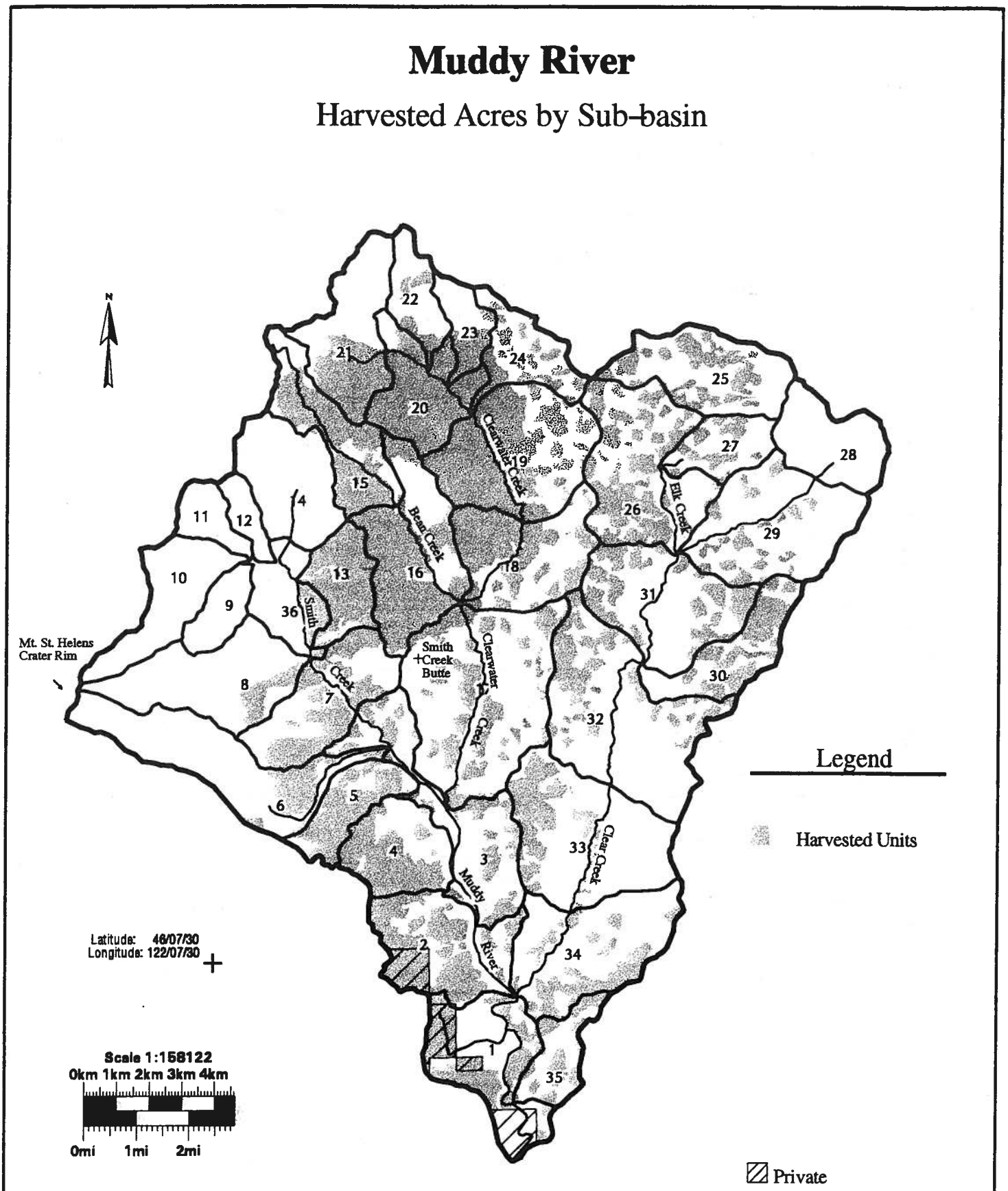

Figure 13. Harvested areas within the Muddy River Watershed.

Stream Riparian Reserves

Stand structure and composition within stream Riparian Reserves have been altered by fire, volcanism, and harvest activities within the watershed. Sixty-eight percent of the Stream Riparian Reserves are in early- to mid-successional structure stages, 19 percent are in late-successional structure stages, less than one percent are in hardwoods and 12 percent are in non-forest. The fragmentation of this habitat has probably influenced the capacity of these ecosystems to provide effective habitat and dispersal corridors for terrestrial plant and animal species between large habitat blocks. It has also influenced the capacity to provide large woody debris recruitment for aquatic habitats. Table 8 lists grouped structure stages within stream Riparian Reserves, and Table 9 shows structure stages by sub-basin.

Table 8. Grouped Stream Riparian Reserve Vegetation Structure Stages. Calculations exclude non-National Forest lands.

Total Riparian Reserve Grouped Structure Stages	Acres	Percent
Grass/Forbs/Seedling	3698	12%
Open Sapling/Pole/Small Tree	10297	33%
Closed Sapling/Pole/Small Tree	7042	23%
Large Tree Single Layer	5376	17%
Large Tree Multi-Layer	504	2%
Hardwoods	105	0%
Non-Forest	3774	12%
Riparian Reserve Totals:	**30796**	**100%**

Table 9. Percent Grouped Vegetation Structure Stages of Stream Riparian Reserves by Sub-basins. Calculations are based upon Stream Riparian Reserves on National Forest lands only.

Sub-Basin	Stream Riparian Reserve	Percent Harvested Stream Riparian Reserve	Percent Grass/ Forb/ Seedling	Percent Open Sap/Pole /Sm Tree	Percent Closed Sap/Pole /Sm Tree	Percent Lg Tree Single Layer	Percent Lg Tree Multi Layer	Percent hard-wood	Percent Non-Forest
01*	457	64%	0%	11%	7%	0%	46%	0%	35%
02*	1222	55%	5%	23%	33%	0%	21%	4%	14%
03	1722	17%	2%	15%	54%	4%	2%	0%	23%
04	755	54%	3%	35%	52%	0%	8%	0%	3%
05	472	72%	2%	42%	45%	0%	0%	0%	11%
06	1109	15%	3%	12%	4%	0%	3%	1%	77%
07	1648	33%	2%	27%	42%	11%	7%	0%	11%
08	1046	11%	25%	11%	3%	0%	2%	1%	58%
09	327	0%	0%	0%	80%	0%	0%	2%	18%
10	649	0%	71%	0%	0%	0%	0%	0%	29%
11	278	0%	85%	0%	0%	0%	0%	0%	15%
12	221	0%	90%	0%	0%	0%	0%	0%	10%
13	1115	34%	3%	96%	1%	0%	0%	0%	0%
14	830	0%	79%	20%	0%	0%	0%	0%	0%
15	847	70%	15%	83%	0%	0%	0%	0%	1%
16	2131	36%	16%	76%	5%	0%	0%	0%	2%
17	3260	14%	5%	25%	37%	4%	24%	0%	5%
18	800	59%	5%	62%	2%	0%	31%	0%	0%
19	1263	77%	6%	66%	3%	0%	18%	0%	7%
20	613	92%	2%	96%	2%	0%	0%	0%	0%
21	628	43%	4%	88%	4%	0%	0%	0%	4%
22	324	32%	1%	30%	4%	0%	63%	0%	2%
23	300	52%	0%	52%	1%	0%	47%	0%	1%
24	409	44%	4%	40%	0%	0%	56%	0%	0%
25	414	28%	5%	10%	21%	4%	54%	0%	5%

Sub-Basin	Stream Riparian Reserve	Percent Harvested Stream Riparian Reserve	Percent Grass/ Forb/ Seedling	Percent Open Sap/Pole /Sm Tree	Percent Closed Sap/Pole /Sm Tree	Percent Lg Tree Single Layer	Percent Lg Tree Multi Layer	Percent hard-wood	Percent Non-Forest
26	853	25%	9%	6%	15%	0%	62%	0%	7%
27	306	22%	12%	14%	3%	10%	60%	0%	0%
28	582	0%	1%	2%	35%	0%	40%	0%	22%
29	923	8%	6%	5%	29%	0%	58%	0%	2%
30	435	43%	20%	5%	23%	15%	37%	0%	0%
31	778	22%	9%	11%	12%	0%	67%	0%	1%
32	1034	8%	5%	29%	52%	0%	11%	0%	4%
33	1056	16%	2%	18%	61%	1%	12%	1%	6%
34	942	18%	5%	25%	53%	0%	7%	0%	10%
35	166	34%	9%	14%	17%	0%	58%	0%	1%
36	881	10%	39%	31%	0%	0%	0%	1%	29%

* Sub-basin with non-National Forest land ownership.

Muddy River

Grouped Vegetation Structure Stages in Stream Riparian Reserves

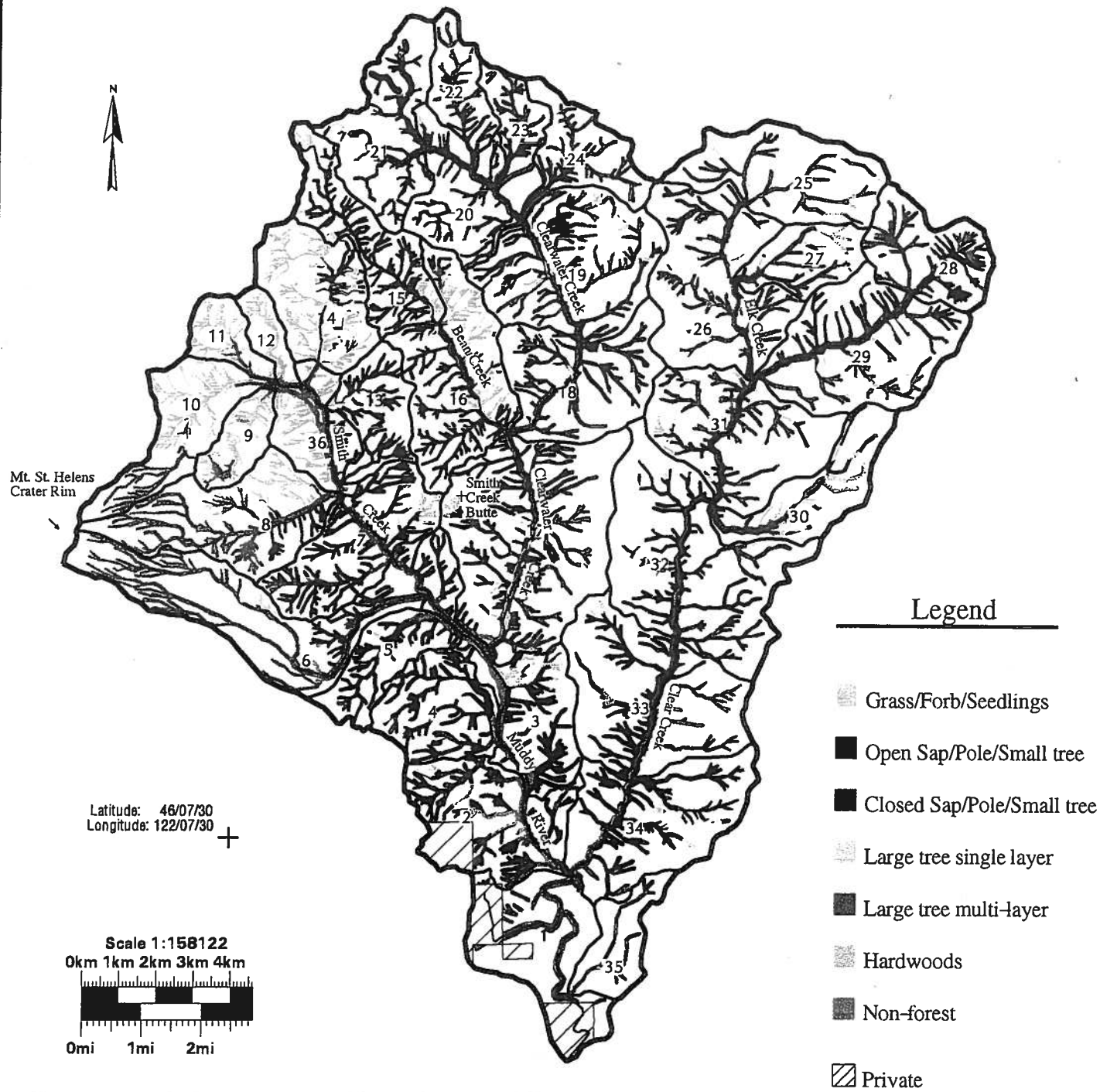

Figure 14. Stand structure and composition within the Stream Riparian Reserves have been influenced by volcanism, wildfire, and harvest activities.

Cedar Flats Research Natural Area

The Cedar Flats Research Natural Area (RNA) was established in 1946 to exemplify the western red cedar stands found on valley bottom habitats in the Cascade Range of Washington (Franklin et al. 1972). It occupies a 275 hectare (680 acre) tract on the west side of the Muddy River in Sub-basin 1 (the RNA designated in Figure 2, Land Allocations). It represents four components of the Western Hemlock Zone of the Western Slopes and Crest Physiographic Province: (1) old-growth Douglas-fir/western hemlock forest; (2) old-growth western red cedar forest; (3) marsh and swamp ecosystem; and (4) western red cedar swamp (Dyrness et al. 1975). The guiding principle in management of this and other RNAs is to prevent unnatural encroachments, activities which directly or indirectly modify ecological processes on the tracts (Franklin et al. 1972). One state Sensitive plant *Carex interrupta* (Cornelius & Schuller 1982), eight Category 4 Survey and Manage (C-3) lichens (Table 12), one Categories 1 and 3 C-3 bryophyte and one Protection Buffer bryophyte species are present in the RNA (See C-3 Lichen and Bryophyte section).

TES Plants

Of the 35 TES vascular plant species either documented or suspected to occur in the Mount St. Helens Administrative Unit, two State listed Sensitive species, *Carex interrupta* and *Pleuricospora fimbriolata,* have been found within the Muddy River watershed (Table 10). Four Forest Plan Botanical Special Interest Sites have been designated as Selected Species Management Areas for *Pleuricospora fimbriolata* (Table 11; Figure 15). *Carex interrupta* is also a C-3 Category 3 species.

Table 10. Documented and Suspected TES Plant Species

Species	Federal Status	State Status	C-3 Status	Muddy River	MSH Unit	Sub-Basins
Agoseris elata	-	S	-	-	Sus	
Botrychium lanceolatum	-	S	-	-	D	
B. lunaria	-	S	-	-	D	
B. minganense	-	S	-	-	Sus	
B. montanum	-	S	-	-	Sus	
B. pinnatum	-	S	-	-	D	
Carex atrata var. erecta	-	S	-	-	D	
C. densa	-	S	-	-	Sus	
C. interrupta	-	**D**	**3**	-	**D**	**1, 33, 34**
C. scopulorum v prionophylla	-	S	-	-	Sus	
Chrysolepis chrysophylla	-	S	-	-	D	

Species	Federal Status	State Status	C-3 Status	Muddy River	MSH Unit	Sub-Basins
Cicuta bulbifera	-	S	-	-	Sus	
Cimicifuga elata	-	T	2	-	Sus	
Corydalis aquae-gelidae	-	T	2	-	D	
Cypripedium fasciculatum	-	T	2	-	Sus	
Epipactus gigantea	-	S	-	-	Sus	
Githopsis specularioides	-	S	-	-	Sus	
Liparis loeselii	-	E	-	-	Sus	
Luzula arcuata	-	S	-	-	Sus	
Microseris borealis	-	S	-	-	Sus	
Mimulus suksdorfii	-	S	-	-	Sus	
Montia diffusa	-	S	-	-	D	
Ophioglossum vulgatum	-	T	-	-	Sus	
Orobanche pinorum	-	S	-	-	Sus	
Parnassia fimbriata v	-	S	-	-	Sus	
Pedicularis rainierensis	-	S	-	-	Sus	
Platanthera sparsiflora	-	S	-	-	Sus	
Pleuricospora fimbriolata	-	**S**	-	**D**	**D**	**1,2,17,31-35**
Poa nervosa v nervosa	-	S	-	-	Sus	
Polemonium carneum	-	T	-	-	Sus	
Polystichum californicum	-	S	-	-	Sus	
Saxifraga debilis	-	S	-	-	Sus	
Sisyrinchium sarmentosum	-	T	2	-	D	
Utricularia intermedia	-	S	-	-	Sus	
Veratrium insolitum	-	S	-	-	Sus	

State/Federal Status: T = Threatened E = Endangered S = Sensitive

Occurrence: D = Documented
Sus = Suspected

C-3 Status: 1 = Manage known sites
2 = Survey prior to activities & manage sites
3 = Conduct extensive surveys and manage sites
4 = Conduct general regional surveys

Table 11. Selected Species Management Areas for *Pleuricospora fimbriolata*

Species	Forest Plan Special Site #	Management Area Name	Sub-Basin	Land Allocation	Acres
Pleuricospora fimbriolata	1109	East Face	17	LSR	20
Pleuricospora fimbriolata	1110	East Vista	32	LSR	20
Pleuricospora fimbriolata	1111	Clearview	34	LSR	20
Pleuricospora fimbriolata	1112	Basil	35	LRS	20

Carex interrupta (green-fruited sedge)

Found along sandy or rocky riverbanks, in streambeds, and open wet places at lower elevations. It ranges from the lower reaches of the Columbia River east as far as western Klickitat County, Washington, and south to Douglas County, Oregon, where it occurs west of the Cascade summits.

Pleuricospora fimbriolata (fringed pinesap)

Found in the duff and humus layer in shaded coniferous forests from southern Washington to California. Typically occurs in late-successional stands.

C-3 Lichens and Bryophytes

At least eight species of C-3 lichens are present in the watershed (Table 12). These are all present in Cedar Flats Research Natural Area, the only area that has been surveyed. It is almost certain that these and other C-3 lichens are present elsewhere in the watershed. *Tetraphis geniculata*, a C-3 Category 1 and 3 bryophyte, and *Alate meglospora*, a protection buffer bryophyte species are also present in Cedar Flats. None of the rest of the watershed has been surveyed for C-3 bryophytes, lichens or fungi.

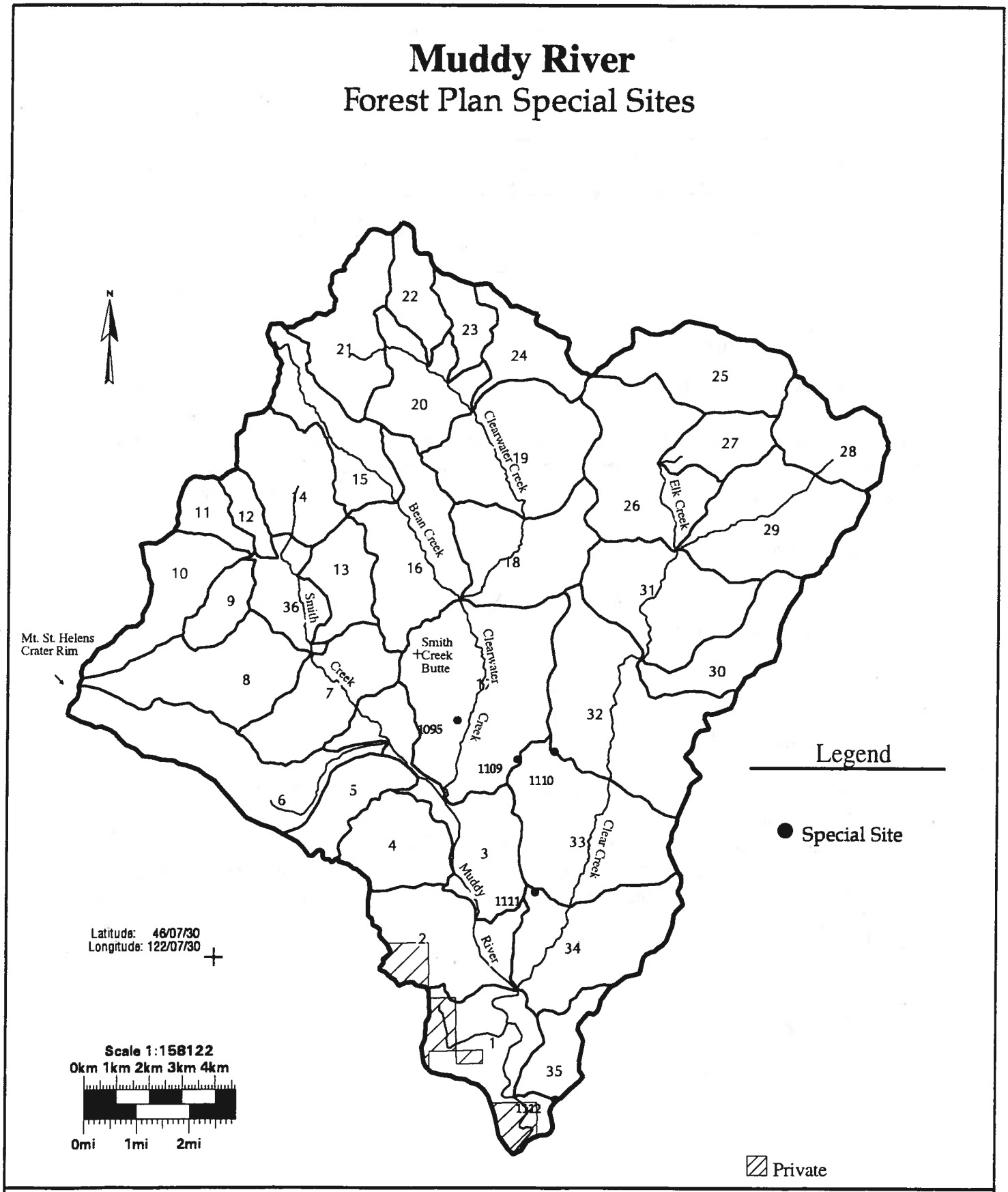

Figure 15. Forest Plan Special Sites in the Muddy River Watershed. Four digit number designates the special site number.

Table 12. C-3 Lichens Present or Suspected to Occur in the Muddy River Watershed

Lichen Species	Survey Category	MSH Unit	Muddy River
Dermatocarpon luridum	1,3	Sus	Sus
Hydrothyria venosa	1,3	D	Sus
Hypogymnia duplicata	1,2,3	Sus	Sus
Hypogymnia oceanica	1,3	Sus	Sus
Leptogium rivale	1,3	D	Sus
Loxosporopsis corallifera	1,3	D	Sus
Nephroma occultum	1,3	D	Sus
Lobaria hallii	1,3	D	Sus
Lobaria linita	1,2,3	Sus	Sus
Lobaria oregana	4	D	D
Lobaria scrobiculata	4	D	D
Nephroma bellum	4	D	D
Nephroma resupinatum	4	D	D
Pannaria saubinetti	4	D	D
Pilophorous nigricaulis	1,3	Sus	Sus
Pseudocyphellaria anomala	4	D	D
Pseudocyphellaria anthraspis	4	D	D
Pseudocyphellaria crocata	4	D	D
Pseudocyphellaria rainierensis	1,2,3	D	Sus
Sticta sp. nov. (formerly *Dendriscocaulon intricatulum*)	1,3	D	Sus
Tholurna dissimilis	1,3	Sus	Sus

C-3 Survey Strategies: 1 = manage known sites; 2 = survey prior to activities and manage sites; 3 = conduct extensive surveys and manage sites; 4 = conduct general regional surveys

Habitat Conditions for Terrestrial Animals

Based on the existing vegetation and vegetation structure, the Muddy River Watershed contains habitats that could support approximately 239 wildlife species. There are potential habitats for five Federally listed species, two sensitive species, six C-3 species and several species of interest.

Federally Listed Animal Species

Habitats which are potentially suitable exist in the Muddy River Watershed for five Federally listed species. Federally listed species are those which are threatened with becoming endangered or endangered of becoming extinction. Actions carried out by the agency must not jeopardize the continued existence or adversely modify critical habitats. The five Federally listed species are shown in the table below.

Table 13. Federally Listed Species which are Known or Suspected to Occupy the Watershed.

Common Name	Species Name	Federal Listing	Documented Sighting in Watershed	Probability of occurrence in watershed[1]
northern spotted owl	*Strix occidentals caurina*	threatened	yes	high
bald eagle	*Haliaeetus leucocephalus*	threatened	yes	high
peregrine falcon	*Falco peregrinus*	endangered	no	low
gray wolf	*Canis lupus*	endangered	no	low
grizzly bear	*Ursus arctos horribilis*	threatened	yes	low

Northern spotted owl - There are seventeen northern spotted owl activity centers located within the Muddy River Watershed. Table 14. displays the acres of suitable habitat within owl home ranges. The home range of an activity center is considered viable if at least 40 percent of the area is in suitable habitat. Functional northern spotted owl habitat is divided into two categories: suitable and dispersal habitats. Suitable habitat provides all of the owl's life needs (that is nesting, roosting, foraging and dispersal) while dispersal habitat is used by owls moving from one area of suitable habitat to another (USDA 1993). The amount of suitable habitat in all but three spotted owl home ranges are above the "take" viability threshold. A minimum of 550 acres within 0.7 miles and 2,663

[1] High - Suitable habitat present. Confirmed sighting.
Moderate - Suitable habitat present. Species presence suspected but not confirmed.
Low - Habitat conditions marginal. Species presence not confirmed.

acres within 1.82 miles of a site center is needed to maintain viability. All site centers are located in forest allocations that restrict timber harvest: sixteen of the sites are in the Lewis Late Successional Reserve (LSR) and one site in the Cedar Flats Research Natural Area (RNA) which is administratively withdrawn (AWA) from scheduled timber harvest.

Table 14. Acres of Suitable Habitat Within 0.7 and 1.82 Miles of a Home Range Center[2].

Activity Center	Allocation	Suitable Acres within 0.7 mi	Suitable Acres within 1.82 mi
105	LSR	832	3,356
106	AWA	607	**2,125**
108	LSR	713	4,483
109[3]	LSR	776	4,156
116	LSR	662	3,558
117	LSR	596	3,658
121	LSR	**349**	**2,224**
123	LSR	623	2,769
130	LSR	507	2,918
131	LSR	541	2,752
1003	LSR	603	4,109
1011	LSR	**339**	4,014
1106	LSR	864	4,018
1201	LSR	540	2,725
1209	LSR	788	4,302
1216	LSR	711	3,792
1217	LSR	635	4,050

Table 15 displays the acres of nesting, foraging, and dispersal habitat for spotted owls and the percentage within each sub-basin. For the most part owl habitat in the watershed is highly fragmented with only 40 percent of the watershed functioning as "usable" spotted owl habitat (Figure 16). A cluster of sub-basins in the western portion of the watershed is completely lacking or contains trace amounts of suitable and dispersal habitat (Figure 16 and Table 15). These sub-basins may act somewhat as a barrier for owl movement. Sub-basins 28, 29, 31, 32, and 33 contain the largest contiguous block of suitable spotted owl habitat (Map 16).

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[2] Numbers in bold indict acres within the home range is below the minimum viability threshold.

[3] The only site within the watershed where owl presence has been verified within the past five years.

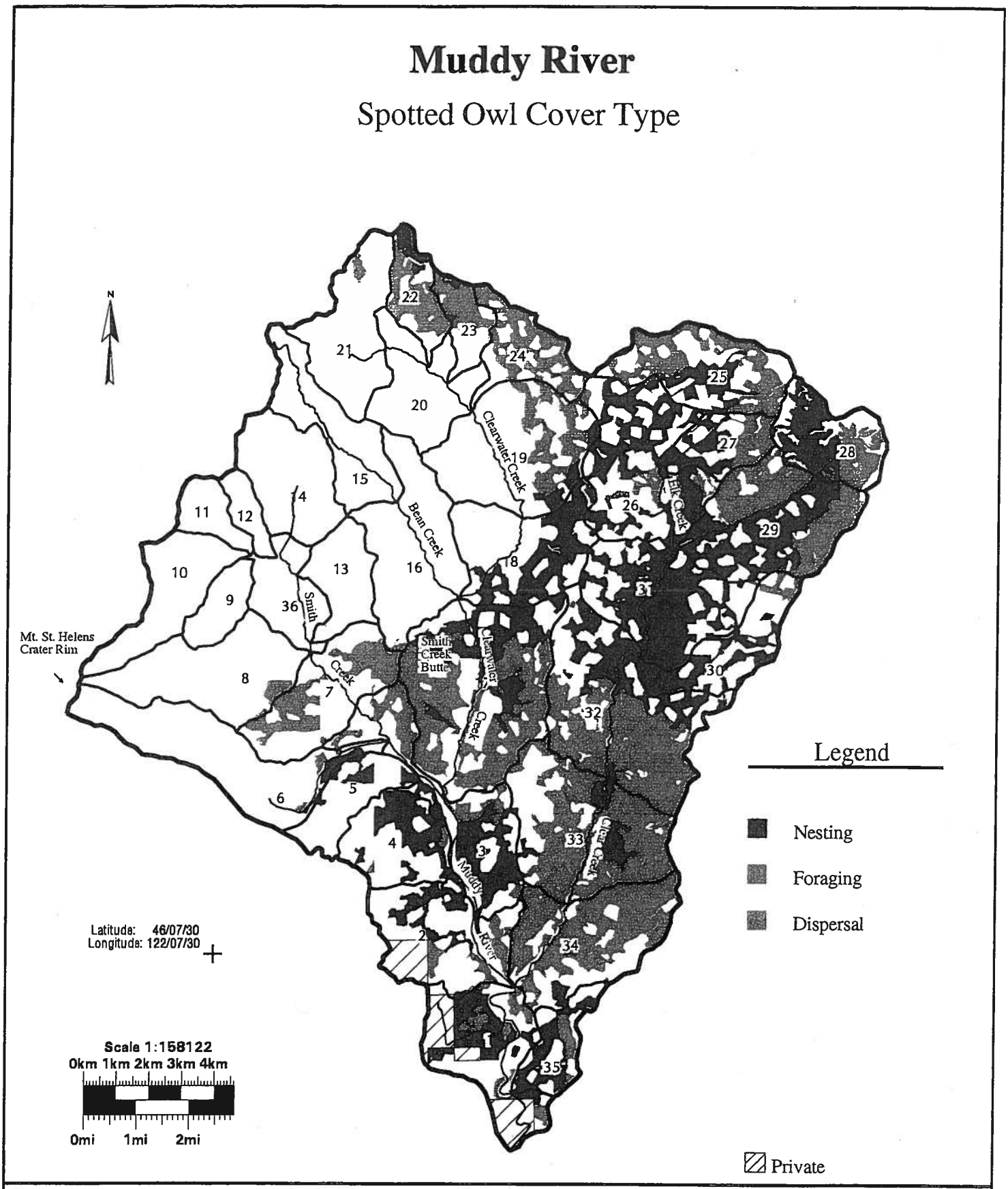

Figure 16. Distribution of northern spotted owl habitats within the Muddy River Watershed. Suitable habitats (nesting and foraging) in the watershed are highly fragmented. The lack of "usable" habitats in the western portion of the watershed may act as a barrier for dispersing owls.

Table 15. Abundance of Owl Habitat in Each Sub-basin[4].

Sub-basin (acres)	Nesting Habitat acres / percent	Foraging Habitat acres / percent	Dispersal Habitat acres / percent	Unsuitable Habitat acres / percent
1 (2,835)	731 26%	180 6%	126 4%	1,798 50%
2 (2,827)	446 15%	326 12%	21 <1%	2,034 72%
3 (3,036)	**980 32%**	**591 19%**	**1 <1%**	1,464 48%
4 (1,908)	695 36%	48 <1%	0 0%	1,165 61%
5 (1,330)	202 15%	0 0%	0 0%	1,128 84%
6 (3,475)	102 3%	5 <1%	46 1%	3,322 95%
7 (2,528)	0 0%	899 35%	6 <1%	1,623 64%
8 (3,010)	0 0%	107 4%	0 0%	2,903 96%
9 (837)	0 0%	0 0%	0 0%	837 100%
10 (1,993)	0 0%	0 0%	0 0%	1,993 100%
11 (749)	0 0%	0 0 %	0 0%	749 100%
12 (533)	0 0%	0 0%	0 0%	533 100%
13 (1,322)	0 0%	0 0%	0 0 %	1,322 100%
14 (2,290)	0 0%	0 0%	0 0%	2,290 100%
15 (2,136)	0 0%	0 0%	0 0%	2,136 100%
16 (3,186)	0 0%	30 1 %	1 <1%	3,155 99%
17 (5,536)	**1,298 23%**	**2,331 42 %**	**125 2%**	1,782 32%
18 (2816)	1,075 38%	0 0%	0 0%	1,741 62%
19 (3,809)	214 6%	721 19%	2 <1%	2,872 75%
20 (2,086)	0 0%	1 <1%	0 0%	2,085 99%
21 (2,455)	0 0%	11 <1%	52 2%	2,392 92%
22 (1,076)	**174 16%**	**548 50%**	**22 2%**	332 31%
23 (828)	**55 7%**	**400 48%**	**11 1%**	362 44%
24 (1,465)	**10 <1%**	**851 58%**	**3 <1%**	601 41%
25 (2,630)	**479 18%**	**952 36%**	**118 4%**	1,081 41%
26 (3,696)	**1,608 44%**	**319 9 %**	**6 <1%**	1,763 48%
27 (1,190)	**418 35%**	**196 16%**	**153 13%**	423 36%

[4] Sub-basins in bold have morethan 50 percent dispersing habitat for spotted owls. Both nesting and foraging habitats serve as dispersal habitat.

28 (1,862)	**803 43%**	**499 27%**	**24 1%**	536 28%
29 (3,584)	**1,482 41%**	**1,249 35%**	**191 6%**	662 18%
30 (1,777)	**694 39%**	**100 6%**	**18 1%**	965 54%
31 (3,287)	**2,092 64%**	**9 1%**	**0 0%**	1,186 36 %
32 (4,855)	**1,057 22%**	**1,853 38%**	**637 13%**	1,308 27%
33 (4,125)	**435 11%**	**1,716 42%**	**886 21%**	1,088 26%
34 (3,366)	**75 2%**	**1,621 48%**	**660 20%**	1,010 30%
35 (1,105)	**459 41%**	**146 13%**	**6 <1%**	494 45%
36 (1,358)	0 0%	0 0%	0 0%	1,358 100%
Total 86,901	15,584 18%	15,709 18%	3,115 4%	52,493 60%

Not including Riparian Reserves, there are four Northwest Forest Plan management allocations in the watershed and suitable spotted habitat is found in all four. The four allocations are Matrix, Late Successional Reserve (LSR), Administratively Withdrawn (AWA) and Congressionally Withdrawn (CWA). Table 16 displays the acres and percentage of the spotted owl habitat within each allocation. Figure 17 shows the distribution of spotted owl habitats within the management allocation.

Table 16. Distribution of Spotted Owl Habitat within Northwest Forest Plan Allocations.

Allocation[5]	Nesting		Foraging		Dispersal		Non-habitat		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Matrix	737	4%	1,678	9%	126	<1%	15,341	86%	17,882	20%
LSR[6]	14,228	29%	13,344	27%	2,789	6%	18,407	38%	48,768	56%
CWA	60	<1%	649	4%	104	1%	17,071	95%	17,884	20%
AWA	556	49%	35	3%	96	8%	441	39%	1,128	1%
Private	3	<1%	3	<1%	0	0%	1,243	99%	1,249	1%
Total	15,584	18%	15,709	18%	3,115	4%	52,503	60%	86,911	

As shown in Table 16, 78 percent (67,780 acres) of the watershed is within management allocations that restrict schedule timber harvest. Matrix lands make up a relatively small percent of the watershed, only 20 percent (17,882 acres). However, Riparian Reserves in the Matrix play an important role in providing conductivity for late successional / old growth species between LSR

[5] Scheduled timber harvest is restricted in allocations in bold.

[6] LSR overlaps spotted owl critical habitat WA-38.

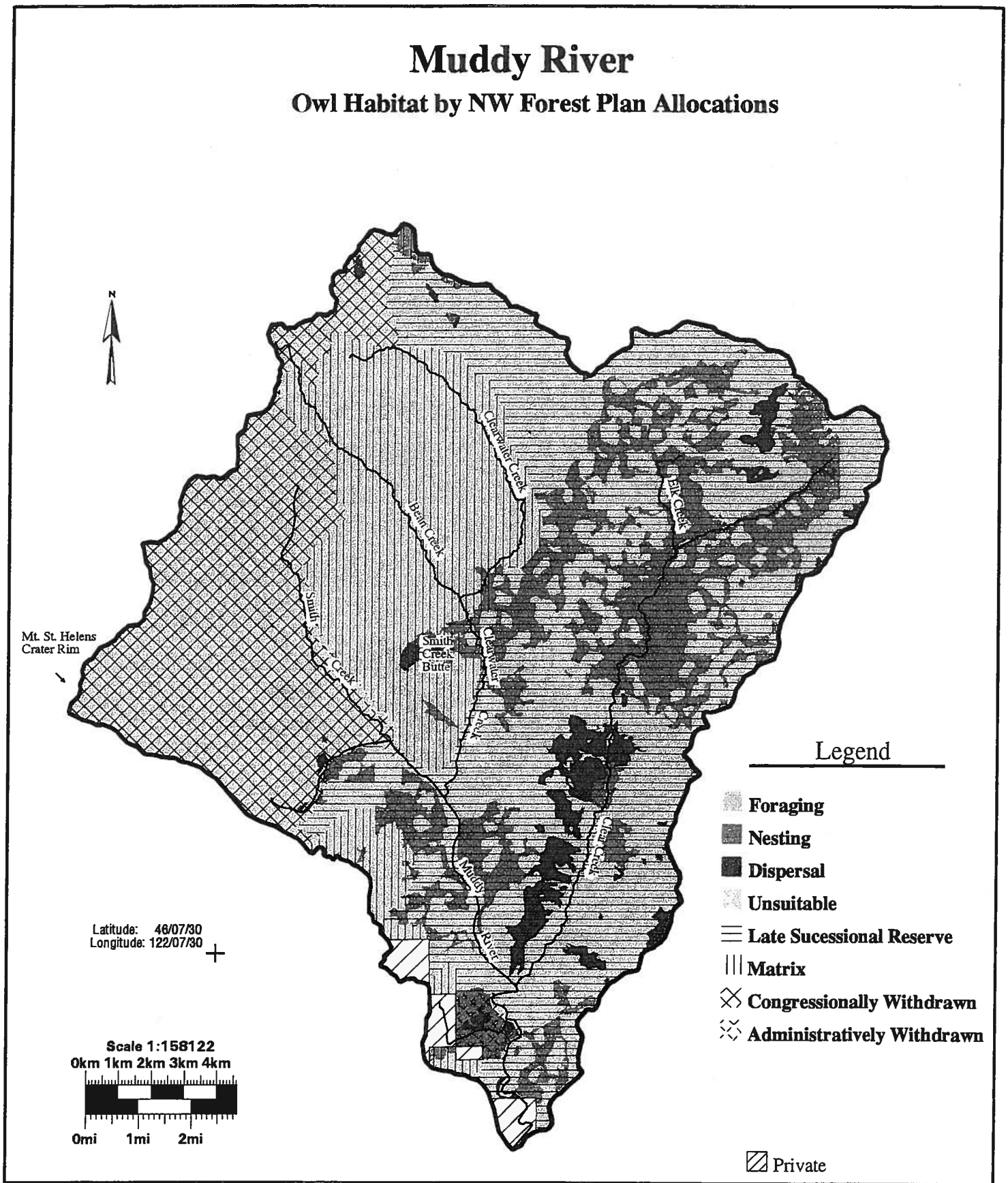

Figure 17. Distribution of the northern spotted owl habitats by Northwest Forest Plan management allocations within the Muddy River Watershed. The largest blocks of suitable habitats are located in the LSR.

reserves. Currently, the stream Riparian Reserves contain only 19 percent of the large tree structure stage and 68 percent of the small tree or younger stages (Figure 14). This lack of mature forest in the stream Riparian Reserves may retard their ability to serve as dispersal "corridors."

Bald Eagle -Chance sightings of bald eagles have occurred within the watershed, although no formal surveys have been conducted. An unconfirmed bald eagle nest was reported some time between 1989 and 1990 in Sub-basin 3. The bald eagle is an opportunistic scavenger/predator. The key to their occupying an area is the presence of a large body of water, large trees for nesting, roosting, feeding and freedom from excessive human disturbance (USDI 1986). Andersen and Ichisaka (1986) reported that the confluence of the Muddy and Lewis, which is located in sub-basin 1, served as a primary foraging site for wintering bald eagles.

Peregrine Falcon - There are no known documented sightings or active or historical eyries in the watershed. However, no formal surveys have been conducted either. The peregrine falcon is almost exclusively dependent on high sheer cliffs for nest sites and their diets consist primarily of birds (USDI 1982). Maps and aerial photos were used to identify potential sites. One cliff, Spencer Butte, located in sub-basin 32/33 could possibly provide suitably nesting habitat. It was also identified as a marginal nesting site in the Middle Lewis Watershed Analysis.

Gray Wolf and Grizzly Bear - No gray wolf sightings have been recorded in the watershed. There has, however, been one highly reliable grizzly bear sighting in 1989. The degree of confidence in the sighting is based on two grizzly bear diagnostic characteristics seen: a large shoulder-hump and long claws (per. Comm. Tom Owens WDFW). The key elements of providing adequate habitat for both species include a sufficient year-round prey base (ungulates and alternate prey), suitable den and rendezvous sites (wolf) and sufficient space with minimal human disturbance (seclusion) (IGBC 1987). However, no formal surveys have been conducted for either species. The likelihood of a wolf pack or grizzly bear permanently occupying the watershed is very low because of high levels of human influence (see section on human dimensions). But because both species have large home ranges, part of a home range could overlap into the watershed.

Prey base - Fundamental to wolf survival is a healthy ungulate population. Amendment 11 predicts the goal of managing Roosevelt elk (*Cervus elaphus*) at the 1990 habitat capacity level with and increasing black-tailed deer (*Odoccoileus hemionus*) by 10 percent can be achieved by maintaining 44 percent optimal thermal cover in deer and elk winter range. Optimal thermal cover conditions are generally found in stands with multi-layering and at least 70 percent canopy cover (Brown 1985).

Within the Muddy River Watershed deer and elk (ungulate) biological winter range covers approximately 34 percent (29,463 acres) (Figure 18). Generally, ungulate biological winter range is located at lower elevations (<2,200 ft) and is very closely associated with the western hemlock zone. Table 17 displays the amount of forage and cover within ungulate winter range.

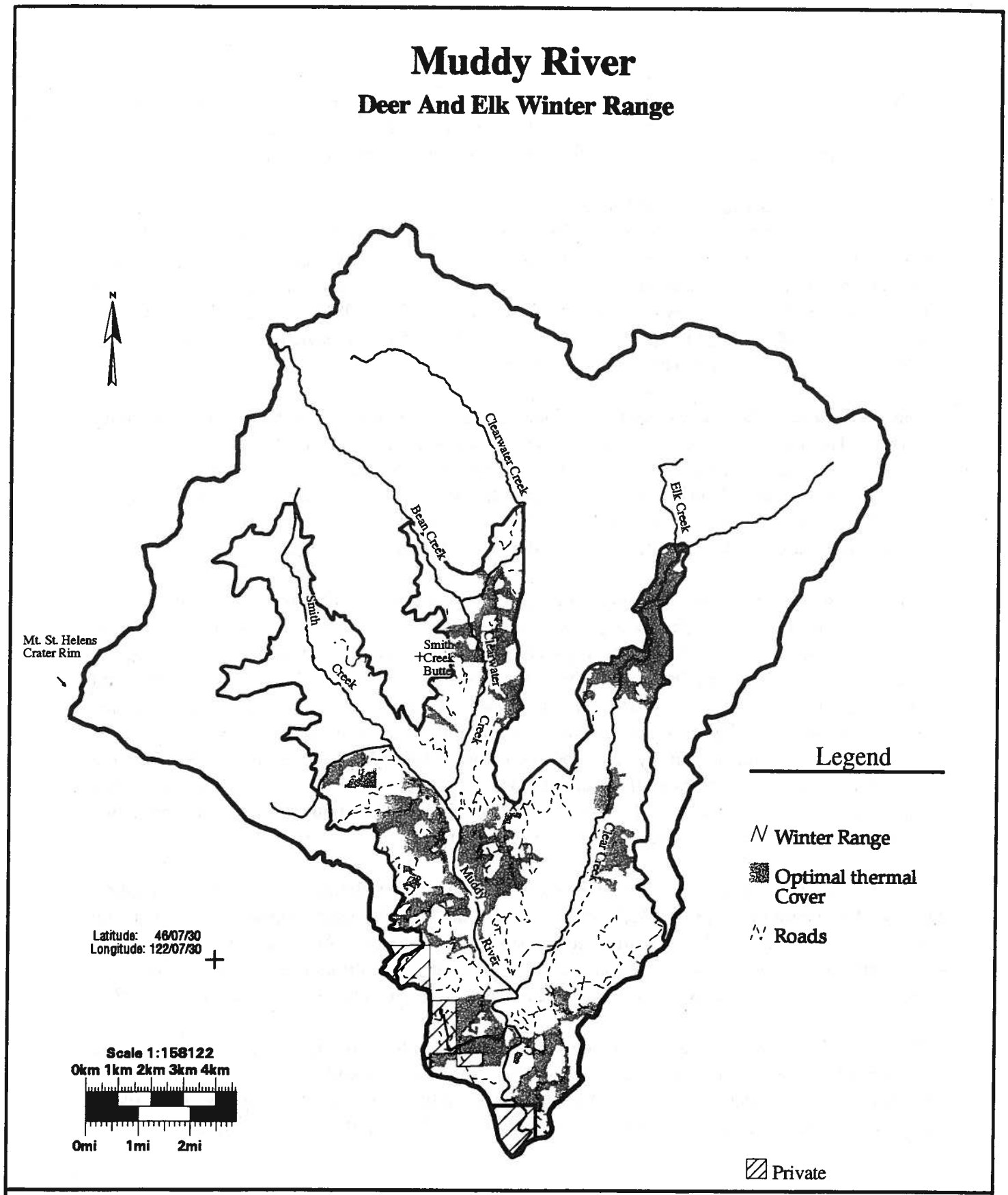

Figure 18. Optimal thermal cover distribution and road locations within biological winter range. Only 22 percent of biological winter range contains optimal thermal cover. Road densities within winter range are 2.1 miles/square miles.

Table 17. Abundances of Forage and Cover in Biological Deer and Elk Winter Range.

Cover Type	Acres	Percentage
Forage	6,485	22%
Hiding Cover	9,315	32%
Thermal Cover	6,374	22%
Optimal Thermal Cover	6,446	22%
Total	29,463	

Currently, biological winter range contains approximately half (22 percent) of the desired percent of optimal thermal cover. Until optimal thermal cover reaches the 44 percent level, deer and elk populations may be below the desired population goals. This less than optimal level could mean less prey availability for wolf and grizzly bear.

Furthermore, the Clearwater Valley (Sub-basins 19, 20, and 21) are inhabited by a high concentration of elk and may serve as an elk calving area.

In addition, Amendment 11 predicts that ungulates can be moved in the direction of the population goals by reducing road densities in deer and elk winter range. These goals require that road densities in ungulate winter range be reduced to 1.7 miles per square mile to minimize harassment. Currently, within the watershed's winter range, there are 84 miles of road covering 29,463 acres. This averages to approximately 2.1 miles per square mile. Road densities are especially high, greater than 2 miles per square mile, in sub-basins 1, 2, 3, 4, 5, 18, 19, and 35.

Seclusion (Road Densities) - Ruediger and Mealey (1978) suggested those road densities greater than 1 mile per square mile were detrimental to grizzly bear. Frederick (1991) reported that wolf populations ceased to breed and were rapidly extirpated when road densities exceed 0.94 miles per mile. Table 25 displays the breakdown of miles of road per sub-basins. There are eleven sub-basins where the road densities are relatively low, less than one mile per square mile; seven sub-basins where the road densities are relatively moderate, exceeding one mile per square mile but less than two miles per square mile; and sixteen sub-basins where that the densities are relatively high, greater than two miles per square mile. The average road density for the watershed is two miles per square mile (Table 26). Road damage resulting from floods in the winter of 1995 and the spring of 1996 has blocked access to a number of roads in the watershed. This has resulted in a reduction in the overall open road density.

Den and Rendezvous sites - No current or historical den or rendezvous sites are known to exist in the watershed. The degree of seclusion (lack of human presence) affects the likelihood of a suitable site serving as a den and/or rendezvous site. Chapman and Feldhamer (1982) reported that wolf dens are usually located on slopes, ridges, or other high ground and near a source of

water. Wolves may also use abandoned beaver lodges, hollow logs, rock crevices or surface depressions. Rendezvous sites are used after den use ceases. Once pups are old enough to hunt with adults rendezvous sites are abandoned. Grizzly bear dens are located in areas that will be well covered with a blanket of snow to minimize the loss of warmed air and that will provide security for winter (IGBC 1993). These sites are normally at high elevations away from development or human activity. The eleven sub-basins where the road densities are less than one mile per square mile could provide future opportunities for wolf dens or rendezvous sites. However, much of the watershed is below the 5000-foot level which may not offer many grizzly bear den site opportunities. Badger Peak and Kirk Rock located in Sub-basins 25 and 28 are the exceptions.

Sensitive Animal Species

Habitats which are potentially suitable exist in the Muddy River Watershed for three sensitive species. Table 18 below lists the two sensitive species in the analysis. Actions carried out by the agency must not contribute to a trend toward Federal listing or cause a loss of viability to sensitive species (USDA 1995). See the section on C-3 species for the discussion on Larch Mountain salamanders.

Table 18. Sensitive Animal Species which are Known or Suspected to Occur in the Watershed.

Common Name	Species Name	Documented sighting in watershed	Probability of occurrence in watershed[7]
Wolverine	*Gulo gulo*	yes	low
Common Loon	*Gavia immer*	no	low

Wolverine - The wolverine is the only sensitive species that has been documented in the watershed; however, this sighting was not confirmed. The wolverine is similar to the gray wolf and grizzly bear in that the wolverine has a very large home range and uses a variety of habitats. The wolverine too is highly sensitive to human disturbance. A general trait of areas occupied by wolverines is their remoteness from humans and human developments (USDA 1994). With the current high level of human use occurring in the watershed, wolverine occupation is unlikely. However, because they have such large home ranges (250 square miles to more than 1200 square miles) part of the home range could very possibly overlap the watershed (Chapman and Feldhamer 1987).

Common Loon - No common loon sightings have been reported in the Muddy River Watershed. Sightings of a loon have occurred in Spirit Lake which is located in the adjacent watershed (per.

[7] See footnote number one.

comm. C. Crisafulli). The common loon nests and rears its young in close proximity to a lake or large body of water that are deep enough to allow the bird to escape predators and long enough for an adequate take off for flight (USDA 1991). Six lakes are located in the watershed. They include Badger, Ghost, St. Charles, Meta, Curtis, and Crane Lakes (Figure 21). Because of the shallow depth of all six lakes, none probably serve as suitable nesting areas.

C-3 Animal Species (Survey and Manage)

Habitats which are potentially suitable exist in the Muddy River Watershed for six vertebrate C-3 species. C-3 or survey and manage species receive additional management considerations because habitat assessments predicted low viability under Alternative 9 of the Northwest Forest Plan. Table 19 shows these six species. Habitats for two other vertebrate C-3 species, great gray owl and lynx were initially considered but later eliminated from this analysis. Suitable habitat was believed not to be present for the great gray owl. Even though the lynx occupies a variety of boreal forest habitats, its distribution and abundance appears to be closely associated to that of the snowshoe hare (WDFW 1995, USDA 1994). Currently there is no evidence indicting that Muddy River Watershed supports an abundant population of snowshoe hares.

Table 19. C-3 Animal Species which are Known or Suspected to Occur in the Watershed.

Common Name	Species Name	Documented sighting in watershed	Probability of occurrence in watershed[8]
Silver-haired bat	*Lasionyteris noctivagans*	No	Moderate
Long-eared myotis	*Myotis evotis*	No	Moderate
Fringed myotis	*Myotis thysanodes*	No	Moderate
Long-legged myotis	*Myotis volans*	No	Moderate
Larch Mountain salamander	*Plethodon larselli*	No	Moderate
Van Dyke's salamander	*Pethodon vandykei*	Yes	High

Forest Bats - There are no recorded sightings of the four forest bats currently in the watershed. Three of the bats use a wide variety of habitats including caves, forests, cliffs, and man-made structures such as wooden bridges and roofs (USDA 1997). The silver haired bat is the only species primarily associated with forest structures. Table 20 outlines the various foraging zones exploited and roost structures used by the each species.

[8] See footnote number one.

Table 20. Habitat Selection for the Four Forest Bats.

Common Name	Foraging Zone[9]	Winter Roosts	Day and Night Roosts
Silver-haired bat	forest and meadow openings	Unknown	loose bark, bark crevices, woodpecker holes, limbs against trees and building sides
Long-eared myotis	gleans; forest and meadow openings	caves, buildings and mines	under bark, stumps, houses, mines, caves, bridges and talus piles
Fringed myotis	gleans; forest and meadow openings; riparian zones	buildings, rock crevices and mines	bridges, mines, caves, buildings and snags
Long-legged myotis	forest and meadow openings; riparian zone	caves, tree cracks, crevices and holes in boles	caves, tree cracks and crevices

The watershed lacks any known significant caves, mines or man made structures that may serve as winter roost for bats. In some areas of the watershed summer roosts are readily available in the form of dead and dying trees. The areas that have the highest probability of providing suitable summer roosting structures are those sub-basins with the greatest abundance of late successional / old growth forest. For this analysis the assumption was made that sub-basins having a potentially high carrying capacity for cavity excavators also had potentially high carrying capacity for forest bats.

Larch Mountain Salamander - No Larch Mountain salamander sightings have been documented in the watershed. The Larch Mountain salamander is typically associated with steep wooded talus slopes that include large amounts of decaying plant material and little soil. Overstory trees are often Douglas-fir, Oregon ash and big leaf maple. However, they have also been found in late-seral forest in the western hemlock zone where there is no talus. In virtually all cases where this species was found, a few very large Douglas-fir trees and snags were in the stand too (C. Crisafulli 1995). Sub-basins within the Muddy River Watershed that contain late successional and old growth forest such as 3, 4, and 17-35 have a moderate chance of providing suitable habitat for Larch Mountain salamanders.

Van Dyke's Salamander - Four Van Dyke's salamander sites were located in the Clearwater drainages and two sites were located in the Bean Creek drainages (per. Comm. C. Crisafulli 1997).. The Van Dyke's salamander is generally considered to be one of the most aquatic of the woodland salamanders. They are typically found in the splash zone of creeks or water falls under rocks or woody debris, or under logs and loose bark on logs near water. When they are not found in association with water, they are usually on north facing slopes with a thick cover of mosses.

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[9] Gleans - to remove prey from a surface versus capturing in mid-air.

This species may exist throughout the Muddy River Watershed in close proximity to Class III and IV streams.

"Species of Interest"

Habitats which are potentially suitable exist in the Muddy River Watershed for several species referred to in this report as "species of interest." These are generally species that are given additional management consideration in the Forest Plan but are not imperiled, threatened, or sensitive. In some cases, the species numbers may be declining such as some cavity excavators in other cases the species has a high recreational value such as deer, elk and mountain goats.

Cavity Excavators - The density of snags in the watershed has been influenced by timber management as well as natural disturbance such as fire volcanic eruption and windthrow. The Forest's goal is to manage cavity excavators at 40 percent of their carrying capacity (GPNFLRMP).

Estimates of the existing population levels of cavity excavating birds in the sub-basins can be made by considering the age classes of the timber stands. For the purpose of this analysis timber stands that are 160+ years old are assumed to have enough snag habitats to provide for 100 percent of the potential population levels of cavity excavating birds. Stands that are 80 to 160 years old are assumed to provide for 60 percent of the potential population, stands that are 40 to 80 years old would provide for 40 percent of the potential population, and stands that are 0 to 40 years old would provide no snags. Stands that are 0 to 40 are assumed to be managed stands rather than unmanaged stands fire-regenerated stands. Table 21 shows the acres of each age class by sub-basin, and as estimated of the percentage of the habitat potential for cavity excavating birds provided.

Table 21. Percent of Population for Cavity Excavators.[10]

Sub-basin (acres)	0 - 40yrs acres	0 - 40yrs percent	41 - 80 yrs acres	41 - 80 yrs percent	81 - 160 yrs acres	81 - 160 yrs percent	160+ yrs acres	160+ yrs percent	percent of potential population
1 (2,835)	776	27%	0	0%	383	14%	668	24%	32%
2 (2,827)	1,529	54%	0	0%	365	13%	456	16%	23%
3 (3,036)	**1,379**	**45%**	**0**	**0%**	**507**	**17%**	**1,071**	**35%**	**45%**
4 (1,908)	1,199	63%	0	0%	0	0%	709	37%	37%
5 (1,330)	1,107	83%	0	0%	165	12%	58	4%	11%
6 (3,475)	3,018	87%	0	0%	403	12%	54	2%	9%

[10] The highlighted rows indicate the sub-basins containing habitat for greater than or equal to 40 percent carrying capacity for cavity excavators.

7 (2,528)	1,337 53%	122 4%	363 14%	690 28%	38%
8 (3,010)	2,307 77%	82 3%	351 12%	269 9%	17%
9 (837)	837 100%	0 0%	0 0%	0 0%	0%
10 (1,993)	1,993 100%	0 0%	0 0%	0 0%	0%
11 (749)	749 100%	0 0%	0 0%	0 0%	0%
12 (533)	533 100%	0 0%	0 0%	0 0%	0%
13 (1,322)	1,322 100%	0 0%	0 0%	0 0%	0%
14 (2,290)	2,290 100%	0 0%	0 0%	0 0%	0%
15 (2,136)	2,136 100%	0 0%	0 0%	0 0%	0%
16 (3,186)	3,144 99	30 <1%	1 <1%	0 0%	0%
17 (5,536)	**1,511 27**	**0 0%**	**2,169 39%**	**1,389 25%**	**50%**
18 (2816)	1,733 62	0 0%	0 0%	1,084 38%	38%
19 (3,809)	2,826 74	0 0%	67 2%	916 24%	37%
20 (2,086)	2,085 99	0 0%	0 0%	1 <1%	0%
21 (2,455)	2,372 97	0 0%	0 0%	63 2%	2%
22 (1,076)	**316 29**	**0 0%**	**0 0%**	**758 70%**	**70%**
23 (828)	**348 42**	**0 0%**	**0 0%**	**477 58%**	**58%**
24 (1,465)	**601 41**	**0 0%**	**0 0%**	**863 59%**	**59%**
25 (2,630)	**882 34**	**0 0%**	**9 <1%**	**1,738 66%**	**66%**
26 (3,696)	**1,688 46**	**0 0%**	**17 <1%**	**1,991 54%**	**54%**
27 (1,190)	**403 34**	**0 0%**	**33 3%**	**753 63%**	**64%**
28 (1,862)	**43 2%**	**0 0%**	**585 31%**	**1,232 66%**	**85%**
29 (3,584)	**583 16%**	**0 0%**	**514 14%**	**2,488 69%**	**77%**
30 (1,777)	**963 54%**	**0 0%**	**21 1%**	**795 45%**	**45%**
31 (3,287)	**1,114 34%**	**0 0%**	**0 0%**	**2,173 66%**	**66%**
32 (4,855)	**1,181 24%**	**1,914 39%**	**690 14%**	**1,070 22%**	**46%**
33 (4,125)	**989 24%**	**303 7%**	**1,836 45%**	**991 24%**	**53%**
34 (3,366)	**860 25%**	**0 0%**	**1,984 59%**	**425 13%**	**48%**
35 (1,105)	**492 45%**	**0 0%**	**154 14%**	**459 42%**	**50%**
36 (1,358)	1,358 100%	0 0%	0 0%	0 0%	0%

As shown in Table 21, sixteen sub-basins have adequate amounts of habitat to support cavity dependent species above 40 percent of carrying capacity. The other twenty sub-basins are below the desired condition for snag habitat. These sub-basins range from a carrying capacity of zero up to 38 percent. Figure 19 shows the distribution of sub-basins above and below 40 percent carrying capacity for cavity excavators.

Muddy River
Cavity Excavator Habitat Suitability

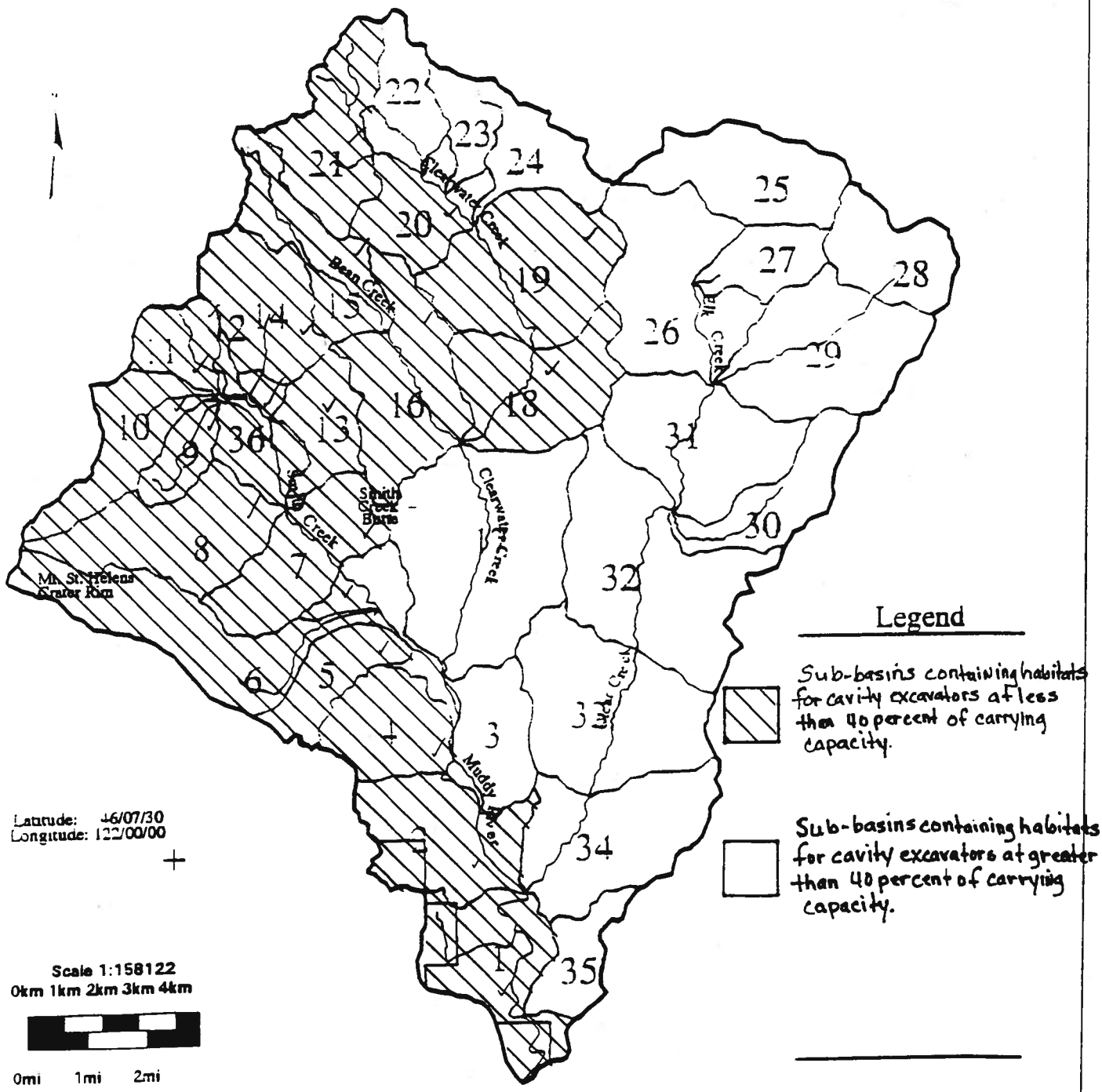

Figure 19. Areas shown are either above or below 40 percent of the maximum potential population level for cavity excavators. The sub-basins on the western portion of the watershed are below the ROD standards and guidelines for maintaining snag habitats.

Deer and Elk - See TES section - wolf prey base.

Mountain Goats -Several confirmed chance sightings of mountain goats have occurred since the 1980 eruption of Mount St. Helens. The sightings were at Ape Canyon, Kirk Rock and Badger Peak. No established herds are known to exist in the watershed or in the Central Skill Center since the 1980 eruption. The Muddy River contains no land allocations for the management of mountain goats.

Hydrologic Processes

Streamflow characteristics in the Muddy River Watershed are similar to other Western Cascade basins in the state of Washington. Average monthly discharges for the Muddy River are highest during spring runoff (see Table 22, Average Monthly Discharge), but the highest instantaneous discharges and associated floods occur between November and February. An analysis of streamflow data found that the highest instantaneous flow for each year happened between November and February 89 percent of the time. These high flows are usually associated with rain-on-snow precipitation events.

Table 22 - Average Monthly Discharge from the Muddy River Below Clear Creek.

Month	Discharge (cfs)
October	342
November	1099
December	1179
January	1137
February	1127
March	1130
April	1230
May	1315
June	913
July	391
August	205
September	185

Hydrologic Changes

A peak flow analysis was conducted using the State of Washington "Standard Methodology for Conducting Watershed Analysis" procedure. The analysis models changes in discharge resulting from vegetation removal. As recommended in the procedure, a two-year storm was modeled for the analysis. Note that this analysis does not include information on private or State land due to the lack of GIS vegetation data.

The table below displays sub-basins that currently have increased peak flows more than 10 percent when compared to a fully forested condition (see Figure 20, Peak Flow). This value is used by the State of Washington to indicate areas that have a possibility for adverse effects due to peak flow increases.

Table 23. Peak Flow Increases

Sub-basin	Peak Flow Increase
9	12%*-25 %**
10	14%*-22%**
11	13%*-27%**
12	15%*-30%**
14	16%*-32%**
16	11%*-21%**
20	10%*-19%**
36	11%*-21%**

* - peak flow increase for an average two year storm
** - peak flow increase for an unusually strong two year storm

All of the sub-basins listed in the table above are in the area that was severely affected by the 1980 eruption of Mount St. Helens. These areas are still recovering from loss of vegetation from the blast.

Another component of the peak flow analysis is the extension of the stream channel network by roads and ditch lines in roads. These factors may increase peak flows through road cut slope interception of subsurface flow and routing of surface waters through road ditch lines as "pseudo

channels" (Wemple et al, 1996). The following table displays sub-basins where roads have increased the length of stream miles by 25 percent or more (see Figure 20, Peak Flow).

Table 24 - Extension of Stream Channel Network by Roads

Sub-basin	Percent increase
1	34%
2	32%
4	33%
18	26%
19	37%
20	26%
26	40%
27	32%

A large flood event affecting a majority of the analysis area occurred in February, 1996. The magnitude of this flood and full extent of the damage are still being investigated at the time of this report. Preliminary information including some field visits and aerial photographs indicate numerous new landslides occurred in the blast area. Channel modifications resulting from this influx of sediment and woody debris are discussed in the stream channel section. As more information becomes available, it will be added to the analysis file and included in future iterations of analysis.

Aquatic Animals and Habitat

Information on aquatic organism populations is lacking. This discussion will focus on the limited aquatic information that is available, which is primarily fish habitat and distribution data, and aerial photograph interpretation. Existing habitat conditions were evaluated using the following aquatic habitat attributes: Pieces of in-channel large woody debris (LWD) per mile, potential recruitment of LWD, primary pools per mile, water temperature, channel widening, bank erosion, and aquatic habitat fragmentation. A brief discussion of the processes that are affecting the aquatic environment is included at the end of this chapter.

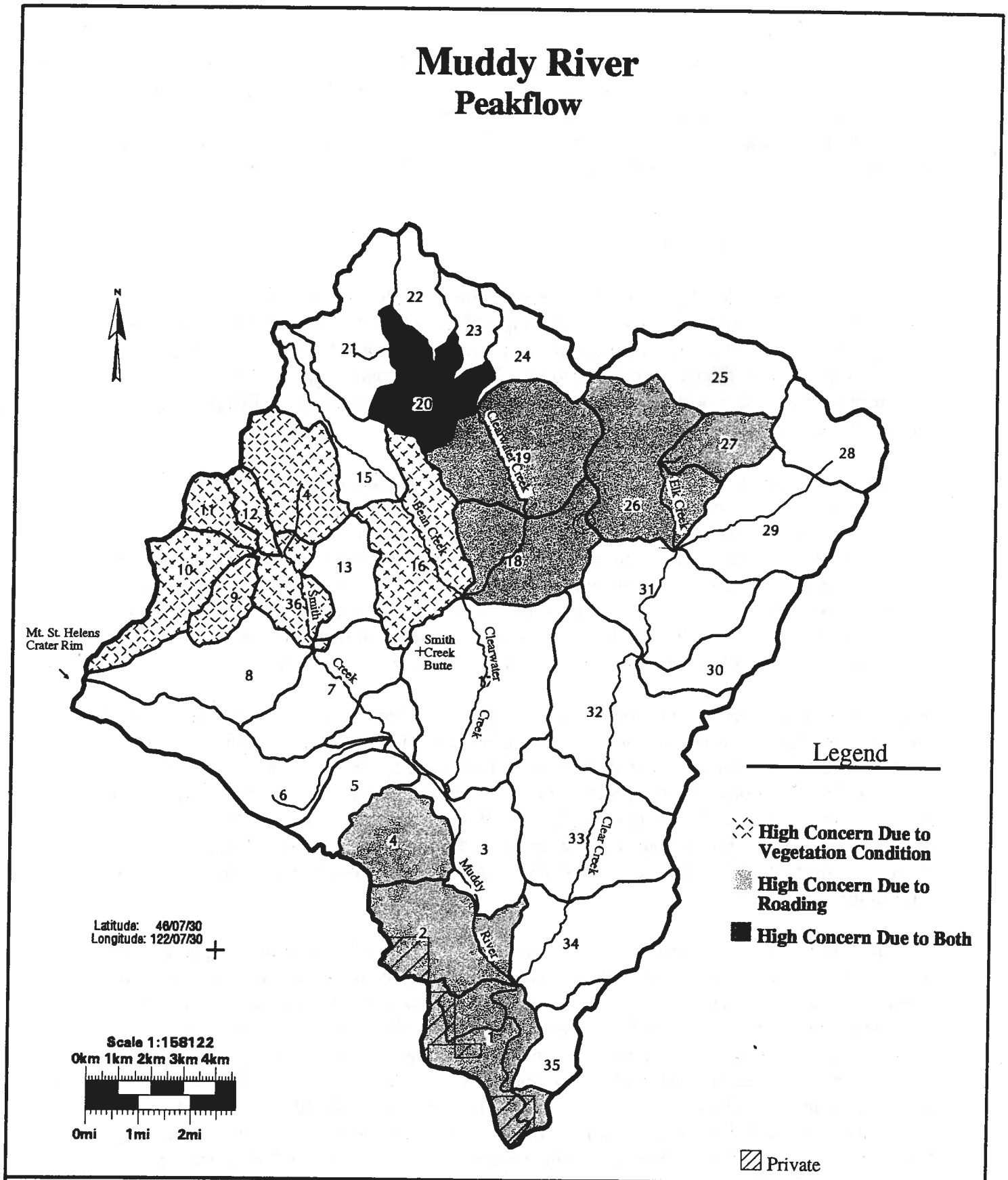

Figure 20. Areas of high peak flow concern in the Muddy River Watershed. These are defined as sub-basins with peak flow increases greater than or equal to 10 percent due to vegetation removal, sub-basins that have increased channel length by at least 25 percent from roading, or areas that meet both of these criteria.

Stream habitat surveys have been completed on approximately 46.6 miles of stream. Fish currently occupy approximately 137 miles of stream in the watershed (Figure 21). Fish and other aquatic organisms are sensitive to a variety of disturbance factors and have specific habitat requirements for their life stages. The optimum habitat factors for the species that are present in this watershed are displayed in Table 25.

Fish distribution and abundance

Resident fishes within Muddy River Watershed streams include rainbow trout, cutthroat trout, mountain whitefish, largescale suckers, and sculpin (Figure 21). Fishes within the Muddy River Watershed are managed by the Washington Department of Fish and Wildlife. No fish stocking is done in any streams above Swift Reservoir (J. Weinheimer, pers. comm.). No anadromous fish currently access this portion of the Lewis River Basin because upstream fish passage is blocked by dams at both Yale Lake and Swift Reservoir.

Bull trout are currently found in Swift Reservoir below the Muddy River Watershed analysis area. The population is estimated to be between 193 to 326 fishes. Spawning of the Swift Reservoir population occurs in Rush Creek, a Middle Lewis River tributary (see Middle Lewis River Watershed Analysis for additional information) and in Pine Creek, a Lower Lewis River tributary, (see Lower Lewis River Watershed Analysis). There have been anecdotal sightings of bull trout in the Muddy River, but radio telemetry studies and 1995 stream survey data did not find bull trout using this stream. Bull trout have been proposed to be listed under the Endangered Species Act; the decision on whether to list bull trout is expected by June, 1997.

There are six natural lakes in this area: Curtis, Badger, St. Charles, Ghost, Meta, and Crane. The lakes receive relatively low recreation use with the exception of Meta Lake (Figure 21). No stocking is allowed in Ghost, Meta, or St. Charles Lakes due to their location within the legislated National Volcanic Monument due to the scientific importance of recovery processes. According to Washington Department of Fish and Wildlife records, Ghost and Meta Lakes contain populations of brook trout which were stocked prior to the eruption (J.Weinheimer, pers. comm.). Fish stocking is allowed in Crane, Curtis and Badger Lakes, but there are no stocking records for these lakes.

The Muddy River is a major tributary to this section of the Lewis River, draining approximately 31,412 acres of land (which includes 1,247 acres of privately owned land in the lower sections). Smith Creek and Ape Canyon Creek are two large tributaries that contribute to it's watershed area. The main stem was impacted by mudflows which traveled down it's length from the May 18, 1990 eruption of Mount St. Helens. There have also been 7, 013 acres of timber harvest, some of which were salvage sales after the eruption. There were three large historical fires within the watershed: The Lewis River fire in 1902 (approximately 2,000 acres in the Muddy River watershed), and the Ape Canyon fire in 1974 (114 acres). Sub-basin road densities range from zero in the Smith Creek drainage (on the western flanks of Mount St. Helens) to 3.57 miles/square mile of area in the lower portion of the Muddy River.

Clearwater Creek is another large tributary to the Muddy River draining approximately 15,835 acres of land. Bean Creek is a tributary of the Clearwater, both of which were also affected by mudflows from the eruption. This area has been impacted by intensive salvage logging operations after the eruption including road building. Road densities in Clearwater Creek sub-basins range from 0.87 to 3.31 miles/square mile of area. Scientific studies have occurred in the Clearwater sub-basin by several researchers since the eruption.

Clear Creek, a third major tributary in this area, drains 39,666 acres of land, including two tributaries: Elk and Wright Creeks. These three drainages were affected to a lesser degree by the eruption than the previous drainages, but do have erosion of ash and pumice occurring. These sub-basins had approximately 28,000 acres of land burned by the Lewis River fire in 1902, and again by the Spencer fire in 1924, which reburned approximately 3,000 acres. There was also a significant amount of past timber harvest in these sub-basins (see Table 7).

Large woody debris

Large woody debris is a critical component of aquatic habitats for a variety of organisms. It influences channel morphology, the storage and routing of sediment, and the amount and complexity of habitat for aquatic organisms (Hicks et. al 1991). Wood is delivered to the stream channels through a variety of mechanisms (i.e., landslides, transport from upstream areas, and direct entry from adjacent sideslopes). Management activities and natural processes affect the effectiveness of these natural delivery mechanisms and the longevity of wood in the system. For example, harvest within the riparian zone reduces the amount of available wood supply for direct entry from adjacent slopes.

The USDA Columbia River Policy Implementation Guide of 1991 (CRBPIG) identifies standards for quantities of (LWD) in Western Cascade streams to provide quality salmonid habitat. The streams' existing condition, identified in surveys, is evaluated against this standard to determine a rating of good, fair, or poor. Streams in good condition meet or exceed the standard of 80 pieces of LWD per mile. Streams in fair condition contain 40-79 pieces of LWD/mile, and streams in poor condition contain less than 40 pieces of LWD per stream mile. Stream survey data indicate, approximately 60 percent of the surveyed stream segments are rated as poor, approximately 28 percent are rated as fair, and 12 percent are rated as good. Figure 22 highlights stream segments with poor LWD ratings.

Sub-basins having greater than 25 percent of their streamside riparian areas harvested are considered to have low potential for LWD recruitment because of the time needed for young conifer trees along the streams to mature and grow more dense. The harvest level was determined using GIS data for National Forest lands, and an "ocular estimate of harvest" on privately-owned lands. Figure 23 displays the sub-basins having low potential for LWD recruitment.

Table 25. Optimum Habitat Condition Factors for Fishes, by life stage.

Organism/ Life Stage	Cutthroat Trout	Rainbow Trout	Brook Trout	Bull Trout	Sculpin	Whitefish	Suckers
Distribution	Throughout basin	Throughout basin	Throughout basin	Yale Lk., Swift Res., & associated tribs	Throughout basin	Throughout basin	Muddy River and NF Lewis River
Spawn Season	Spring (Feb.-Mar)	Spring (Feb.-Mar)	Fall (Sept. - Oct.)	Fall (Sept.-Oct.) Mature 4-6 yrs old	Late Spring Sex. Mature 2 yrs old	Fall (Oct.-Dec.) Sex. Mature 3-4 yrs old	Spring (April-May)
Temp	6.1-17.2 °C	2.2-20 °C	4.5-10 °C	<9 °C	Not Available	Not Available	>5 °C
Habitat Factors	cover, coldwater, substrate 1.3-10 cm. quantity pools, volume pools	cover, coldwater, substrate 1.3-10 cm	Tied to springs/upwelling	Substrate <15% fine sediments (<1 mm), gravel and rubble cold water	Under stones in swift water	Gravel in riffle reaches or shoals of lakes	Fine gravels in shallow area of pools; occasionally along shoreline of lakes.
Rear Season	April - January	April - January	Nov. - Aug.	Emerge in April rear year round	Not Available	Nov. - Jan.	Year Round
Habitat Factors	Enter substrate in winter for hiding cover, fine sediment deposits decrease populations.	Slow velocities, cover, densities higher in pools, enter substrate in winter for hiding cover. Avg. Max. Weekly Temp 19 C. 25-50 NTU's for 2.5-4.5 days = reduced growth and emigration.	Enter substrate in winter for hiding cover, Avg. Max. Weekly Temp 19 C. 25-50 NTU's for 2.5-4.5 days = reduced growth and emigration	Densities higher in streams w/abundant cover (LWD&cover), maximum summer temp <15 C, <9 C by mid-Sept	Not Available	Not Available	Live on the bottom, typically in shallow waters. Seek deeper water at night.
Adult	Year Round	Year Round	Year Round	Year Round	Year Round	Year Round	Year Round
Habitat Factors	associated with cover, use upper reaches of streams when other spp. present, cold water.	cover, cold water substrate used as cover	LWD cover, cold water, substrate used as cover	deep pools of cold water rivers and lakes. Boulder-rubble substrate in streams. Temp=7-15 C, large adults eat other fish	Streams and Lakes with stable bottoms. Feed primarily on aquatic insects, can eat salmon fry	Streams/lakes in summer, large pools in winter. Food is primarily aquatic insects. 48-52 °C	Streams and lakes, bottom dwellers, generally in shallow water.

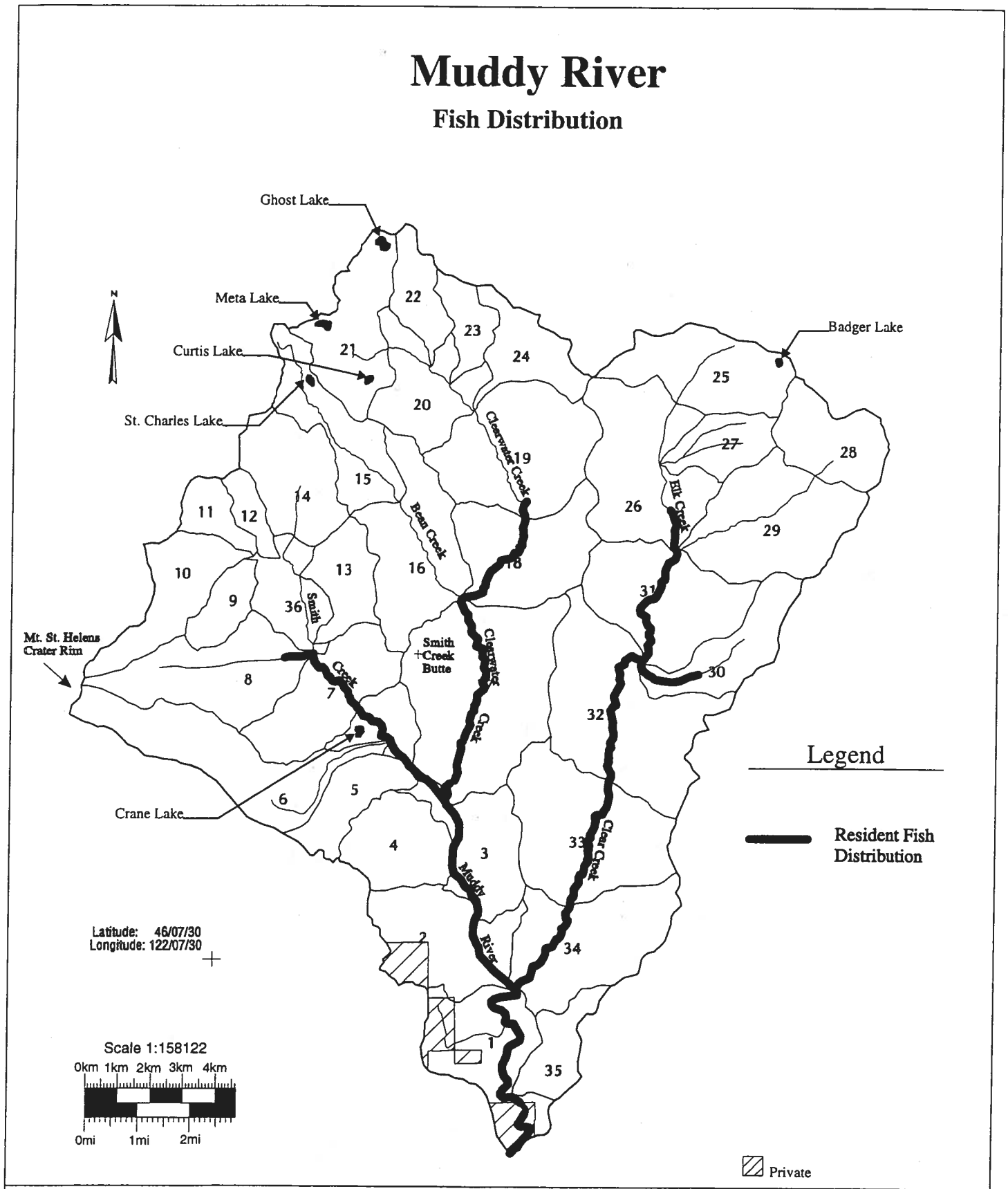

Figure 21. Muddy River Watershed distribution of resident fishes. Resident fishes include rainbow, cutthroat, and eastern brook trout, mountain whitefish, and largescale suckers.

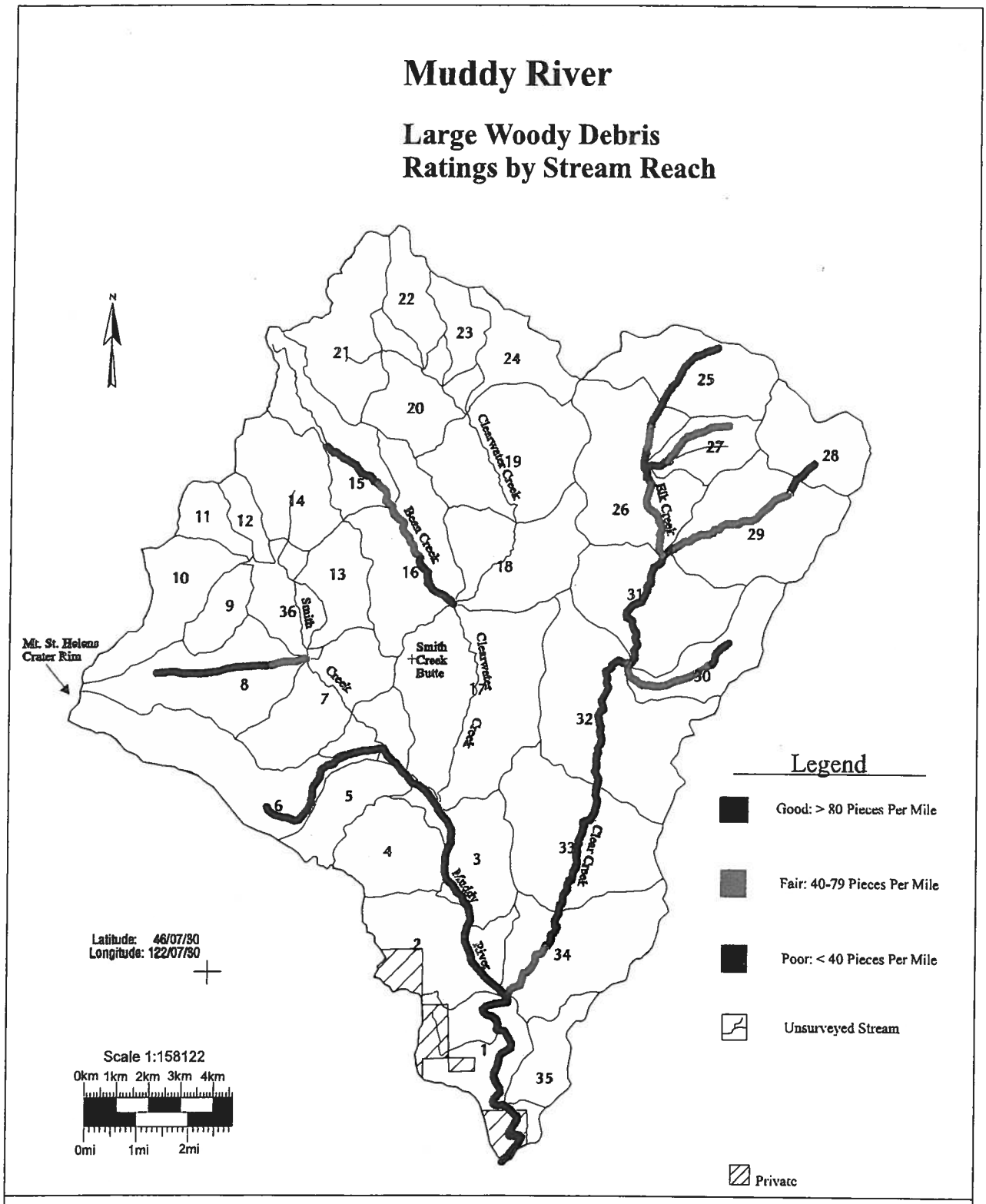

Figure 22. Large Woody Debris (LWD) ratings per mile for surveyed streams in the Muddy River Watershed.

Muddy River
Stream Riparian Reserve Fragmentation

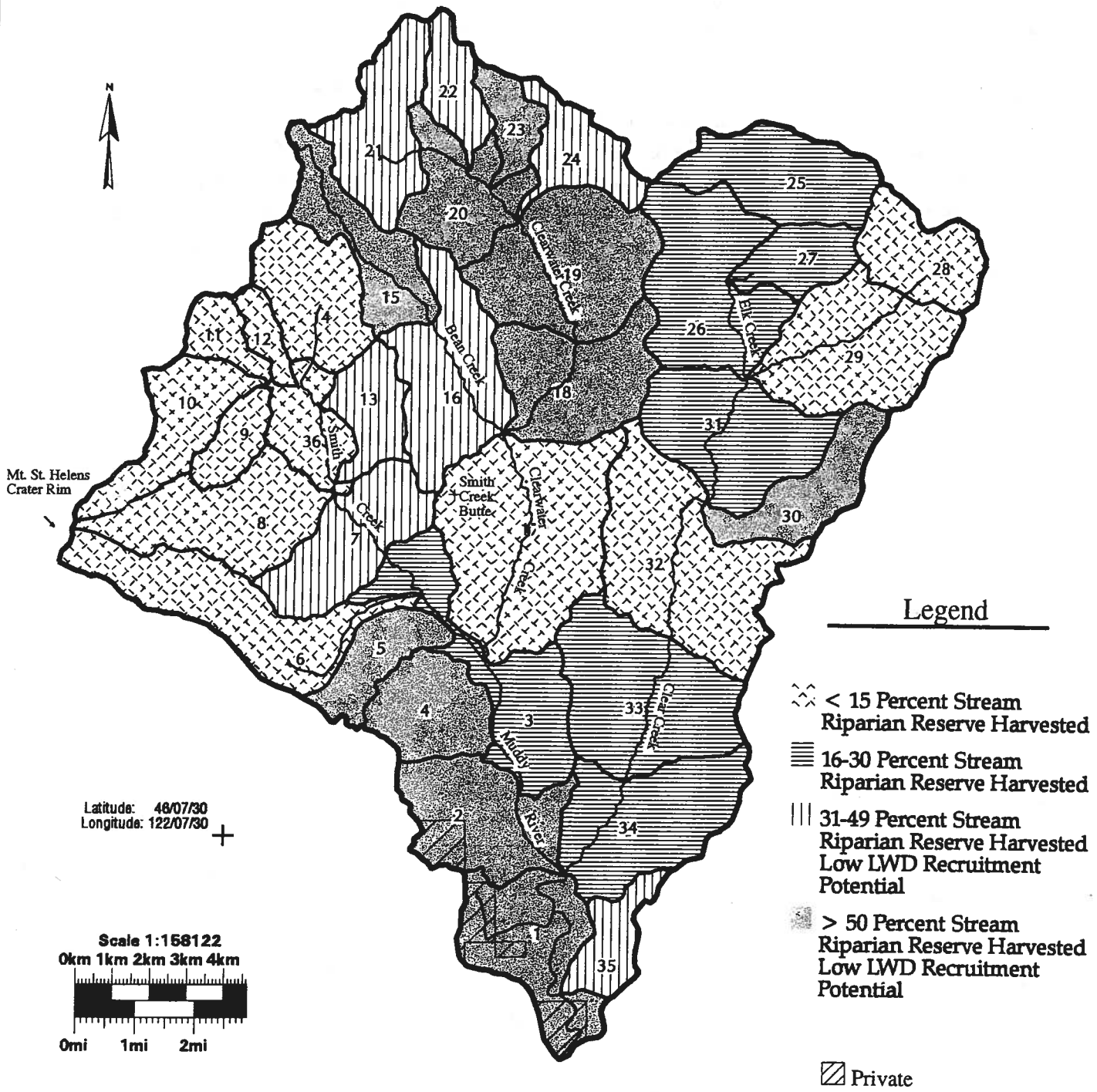

Figure 23. Amount of stream riparian reserves which have been harvested within Muddy River Watershed sub-basins. Those sub-basins which have greater than 30 percent of streamside riparian reserve harvested are also classified as having low potential for large woody debris (LWD) recruitment.

Primary Pools per Mile

Pools provide thermal refuge for aquatic organisms dependent on cool stream temperatures, protective cover for rearing, and act as holding areas for LWD flowing through the stream system. The quality of habitat formed by pools is based on several factors including: pool depth, stream width, amount of LWD in place, and the complexity of microhabitats within the pool. The number of pools increases as the stream size decreases. Channel morphology influences where pools are formed in the stream channel, and determines the hydraulic controls that create the pools.

The CRBPIG identifies standards for quantities of pools per mile in streams (based on stream width) to provide quality salmonid habitat. The existing condition (identified in stream surveys) is evaluated against this standard to determine a rating of good, fair or poor. Streams in good condition meet or exceed the quantity of pools based on width, streams in fair condition contain 50-99 percent of the desired number of pools, and streams in poor condition contain fewer than 50 percent of the desired pools per mile. Stream survey data indicate, approximately 77 percent of the surveyed streams are rated as poor, approximately 20 percent are rated as fair, and approximately 3 percent are rated good. (Figure 24).

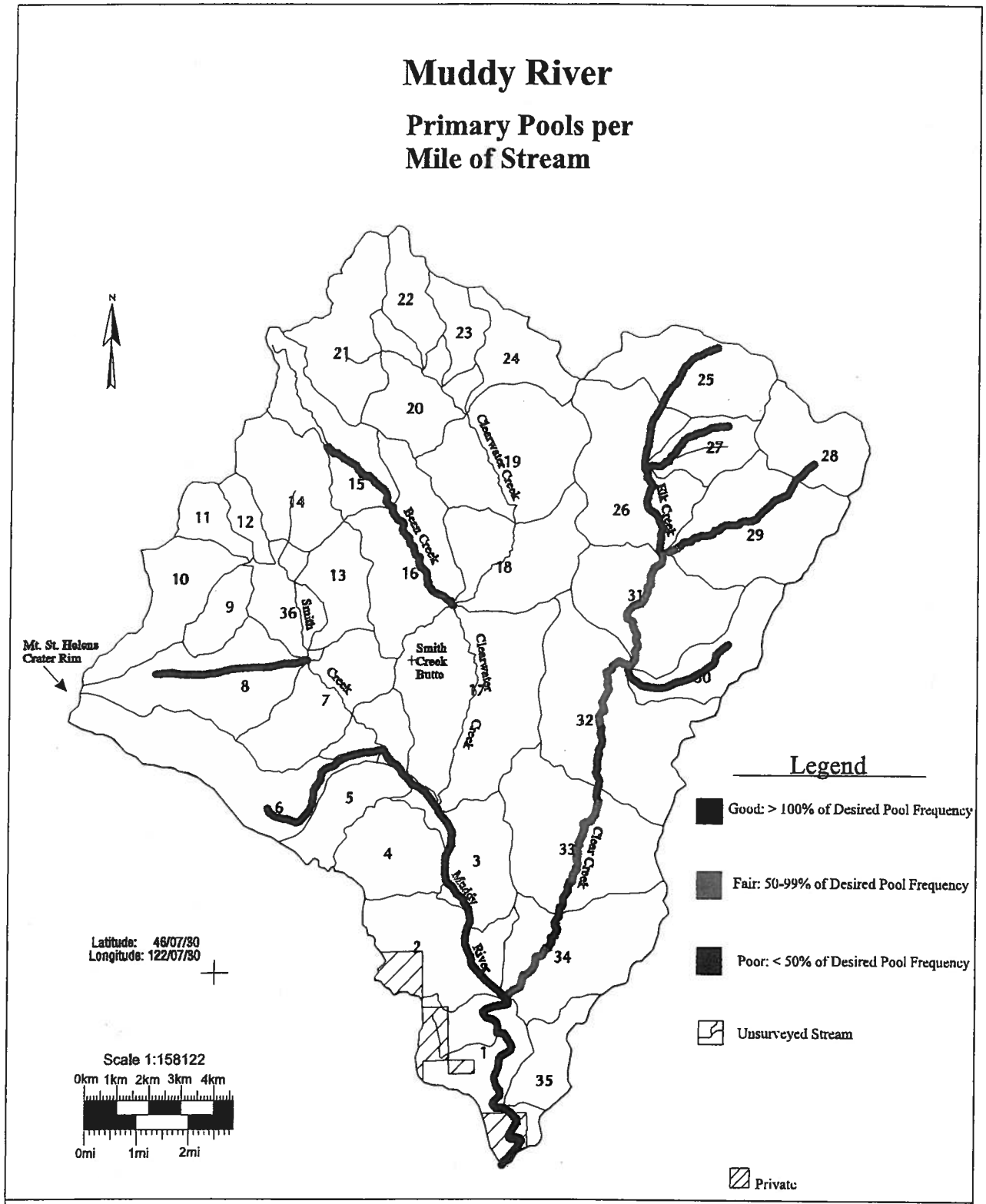

Figure 24. Primary pools per mile ratings for streams surveyed through 1995 in the Muddy River Watershed.

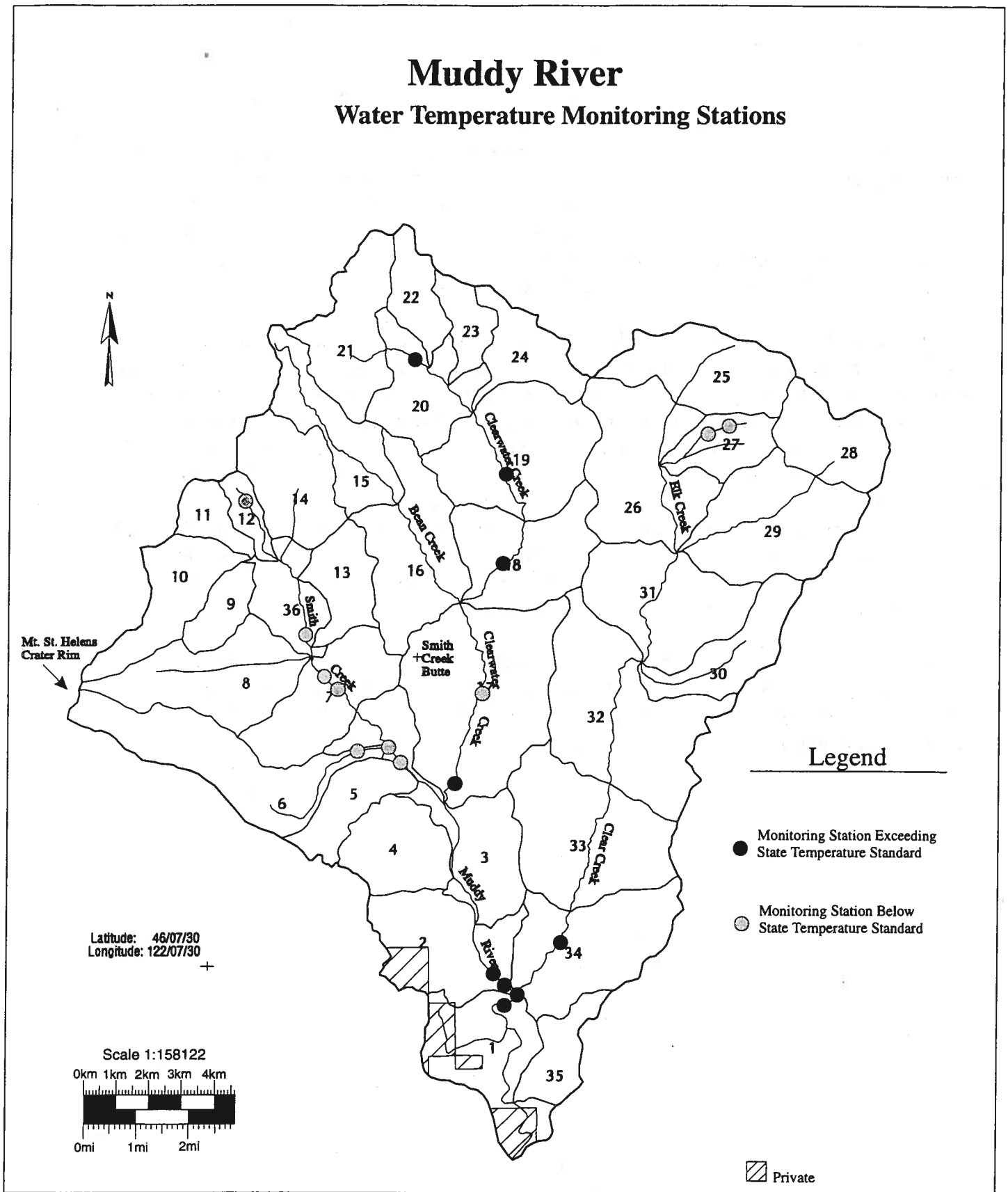

Figure 25. Monitoring stations in the Muddy River Watershed Analysis area where surface water temperature measurements were recorded. Sites have been identified as either meeting State water quality temperature standards or having measurements that have exceeded the State standard of 16 degrees C. Some sites have very limited data that may have included some grab samples only.

Stream Temperature

Stream water temperature is a major factor influencing the composition and productivity of aquatic ecosystems. Fish, aquatic macroinvertebrates, and other aquatic organisms are affected directly and indirectly by changes in water temperatures. Specifically for salmonids, stream temperature influences the timing of migration, spawning, incubation rates, growth, distribution, resistance to parasites, food supply and quality, and tolerances to diseases and pollutants (Bjornn and Reiser 1991). Aquatic organisms are often able to withstand short term increases in stream temperature and adjust by locating optimum habitat within the channel. Long term changes or peaks in water temperature may directly alter the established patterns of the salmonid populations.

Nineteen monitoring stations have collected surface water temperature data in the Muddy River Analysis Area (See Figure 25-Water Temperature Monitoring Stations). Of those 19 stations, nine have recorded temperatures that have exceeded the State water quality standards of 16° Celsius. Those nine stations are located on the Muddy River, Clear Creek, and Clearwater Creek. The number of days stream temperatures have exceeded the State water quality standard of 16° Celsius for Clearwater Creek and the Muddy River is shown in Figures 26a and 26b . These two drainages are identified on the 303(d) list by the Washington State Department of Ecology as being "troubled waters" due to high maximum water temperatures. The 303(d) list is required under the Clean Water Act and is used by the State to set environmental priorities for action and to chart water quality trends. These charts represent a compilation of all monitoring sites on these streams and include only data collected from June 1 to September 30 on any given year.

Loss of riparian vegetation from the 1980 eruption caused increased stream temperatures in Clearwater Creek. Maximum stream temperatures are decreasing and recovery is continuing as canopy begins to close back in over smaller and intermediate sized tributaries to Clearwater Creek (personal communication Charlie Crisafulli).

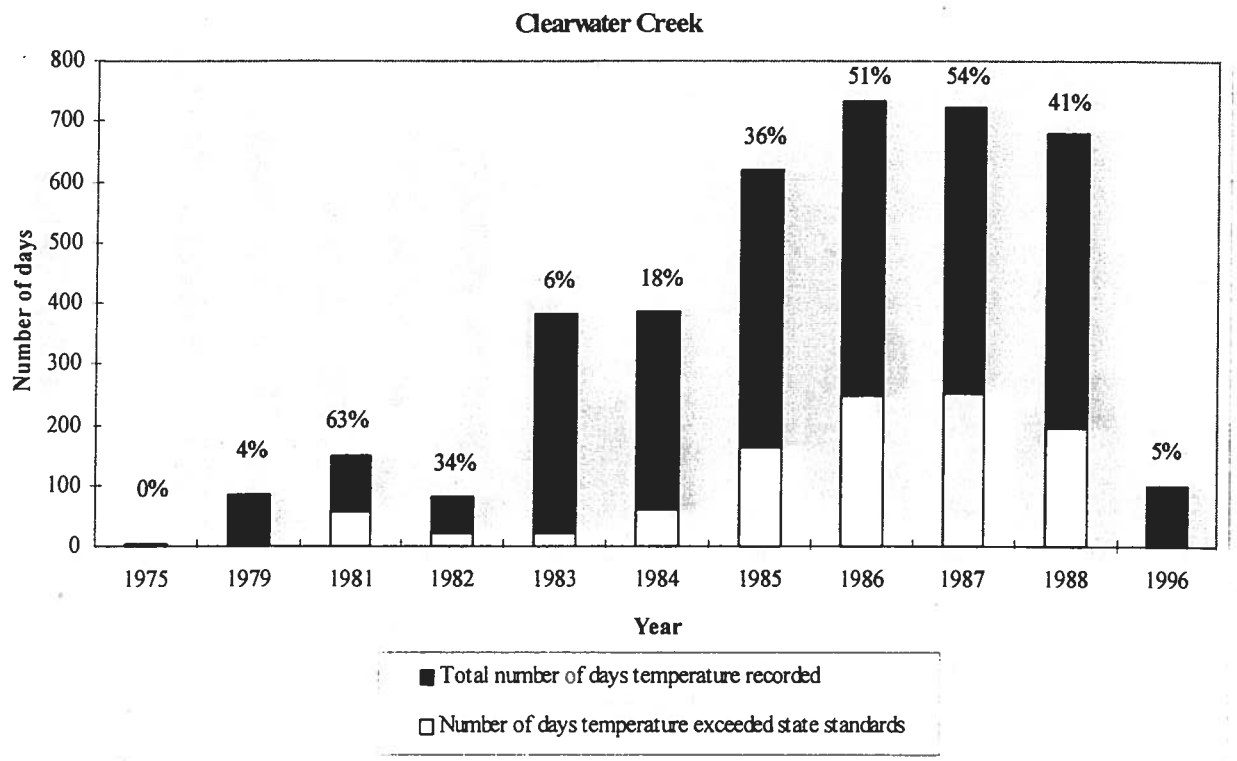

Figure 26A. Stream temperature monitoring data for all stations on Clearwater Creek. The percentage values shown above each bar are the percent of the total readings that exceed the State Water Quality Standard of 16 degrees Celsius.

Several factors associated with the 1980 eruption probably have contributed to increased stream temperatures in the Muddy River after 1980. These include loss of riparian vegetation in tributary streams, channel widening from the mudflow that traveled down the Muddy River, and channel widening from introduction of large amounts of tephra. As displayed in the figure below, this area has still not recovered to pre-eruptive conditions due to continued channel widening from upstream tephra introduction. Increased stream temperatures noted in 1977-1979 may be due to extensive mechanized channel work that occurred upstream from the baseline monitoring station during this time period. This channel work was an attempt to straighten the river channel and "repair" damage from the early 1970's floods. The work removed riparian vegetation along the river (personal communication Jim Chamberlin).

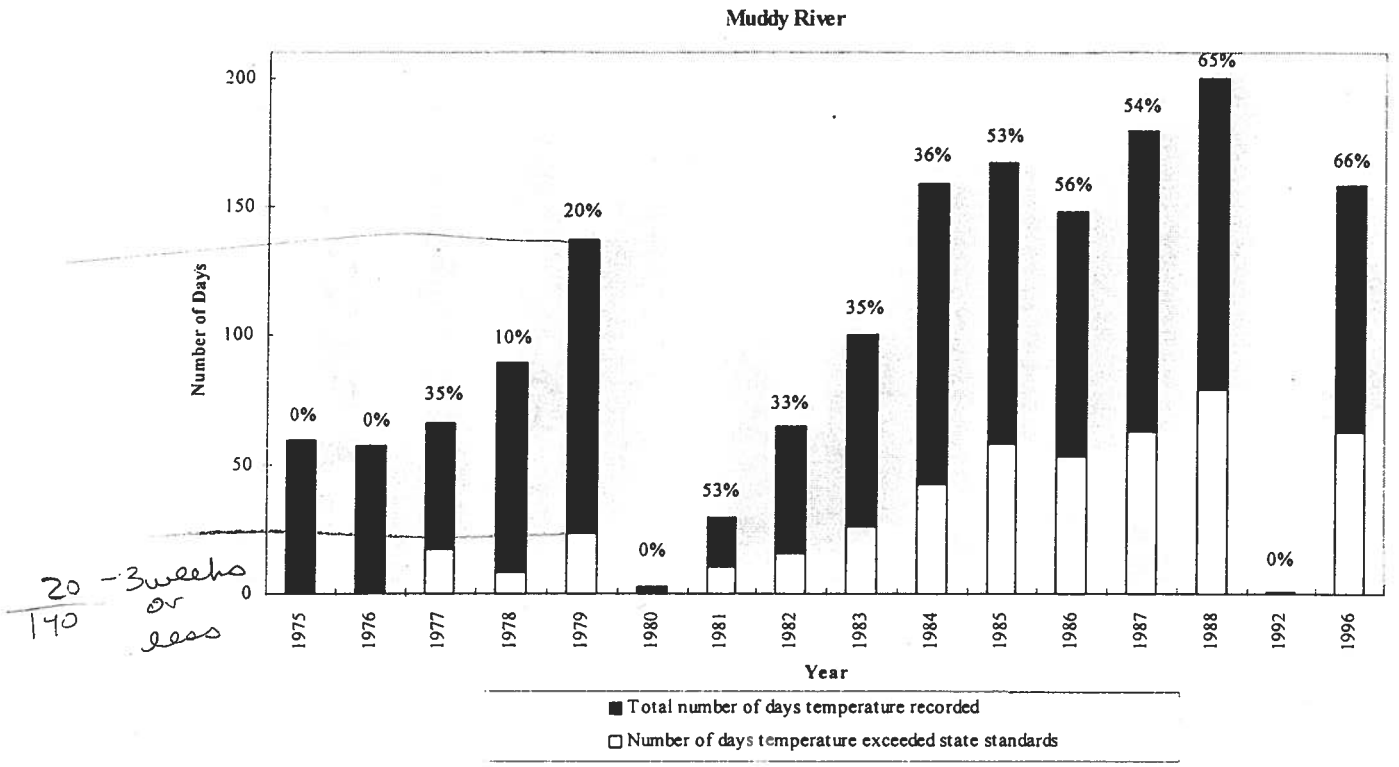

Figure 26b. Stream temperature monitoring data for all stations on the Muddy River. The percentage values shown above each bar are the percent of the total readings that exceed the State Water Quality Standard of 16 degrees Celsius.

Aquatic Habitat Fragmentation

Roads have been identified as an important factor in the decline of fish populations. Culverts that do not pass fish, and/or other road crossings that alter the flow of LWD and sediment through the system fragment the aquatic system. Roads and culverts can not only block upstream migration of resident fish, they can alter the flow pattern of LWD through the system, and increase sediment input (Furniss et. al. 1991). Figure 27 displays a map of the road network and class 1-4 streams. Sub-basin stream crossings range from one to 66 stream crossings. There are a total of 565 stream crossings within the Muddy River Watershed (Table 26).

Road densities within a sub-basin that exceed 3.0 miles per square mile of area are viewed as "red flags" and indicate where road-related problems are most likely to occur. This value is based on several years of observations by Gifford Pinchot National Forest hydrologists and fisheries biologists. Currently, mean road density in the Muddy River Watershed is 1.77 miles per square mile. Individual sub-basin road densities range from zero up to 3.77 miles per square mile (Table

26 Road Densities, etc.). Figure 28 highlights those sub-basins that exceed 3.0 miles per square mile.

The Riparian Reserve aquatic habitat fragmentation index is used as an indicator of the impact that the aquatic system has received due to increased road building. It is based upon the number of road crossings over streams, normalized by stream length in each sub-basin. The Muddy River Watershed aquatic habitat fragmentation values were divided into thirds (low, medium, and high values) to evaluate the fragementation across the entire watershed. Medium (greater than 0.46 road/stream crossings per stream mile) and high (greater than 1.05 road/stream crossings per stream mile) aquatic fragmentation values are highlighted in Figure 29. In comparison with the entire Lewis River Watershed, (see Upper, Middle, and Lower Lewis River Watershed Analyses), the Muddy River Watershed has lower aquatic fragmentation values. Seventeen percent of the Muddy River aquatic habitat fragementation values occur in the lowest one third of the total Lewis River Watershed aquatic habitat fragmentation values, while 13 percent occur in the middle one third, and only 6 percent of the Muddy River Watershed aquatic habitat fragmentation values occur in the highest aquatic habitat fragmentation values for the Lewis River Watershed.

The Elk Creek sub-basin (26) is a highly fragmented watershed, with a maximum sub-basin fragmentation index value of 2.06. The lower portion of the Muddy River watershed also had high sub-basin fragmentation in Sub-basins 1, 2 and 4 with values of 1.62, 1.71, and 1.64 stream road crossings/mile of stream, respectively. The upper portion of the Clearwater drainage had a high fragmentation value of 1.92 in Sub-basin 19.

Sub-basins within the highest one-third of the Muddy River Watershed values (i.e., greater than 0.99 stream road-crossings/mile of stream) are also highlighted in Figure 29. This indicates these sub-basins have received the most intense degree of habitat fragmentation caused by roads. Sub-basin 26 has the highest value: 2.06 crossings/mile of stream. This watershed (5649 acres) with only 23 miles of stream has 48 stream/road crossings.

Muddy River

Roads and Streams

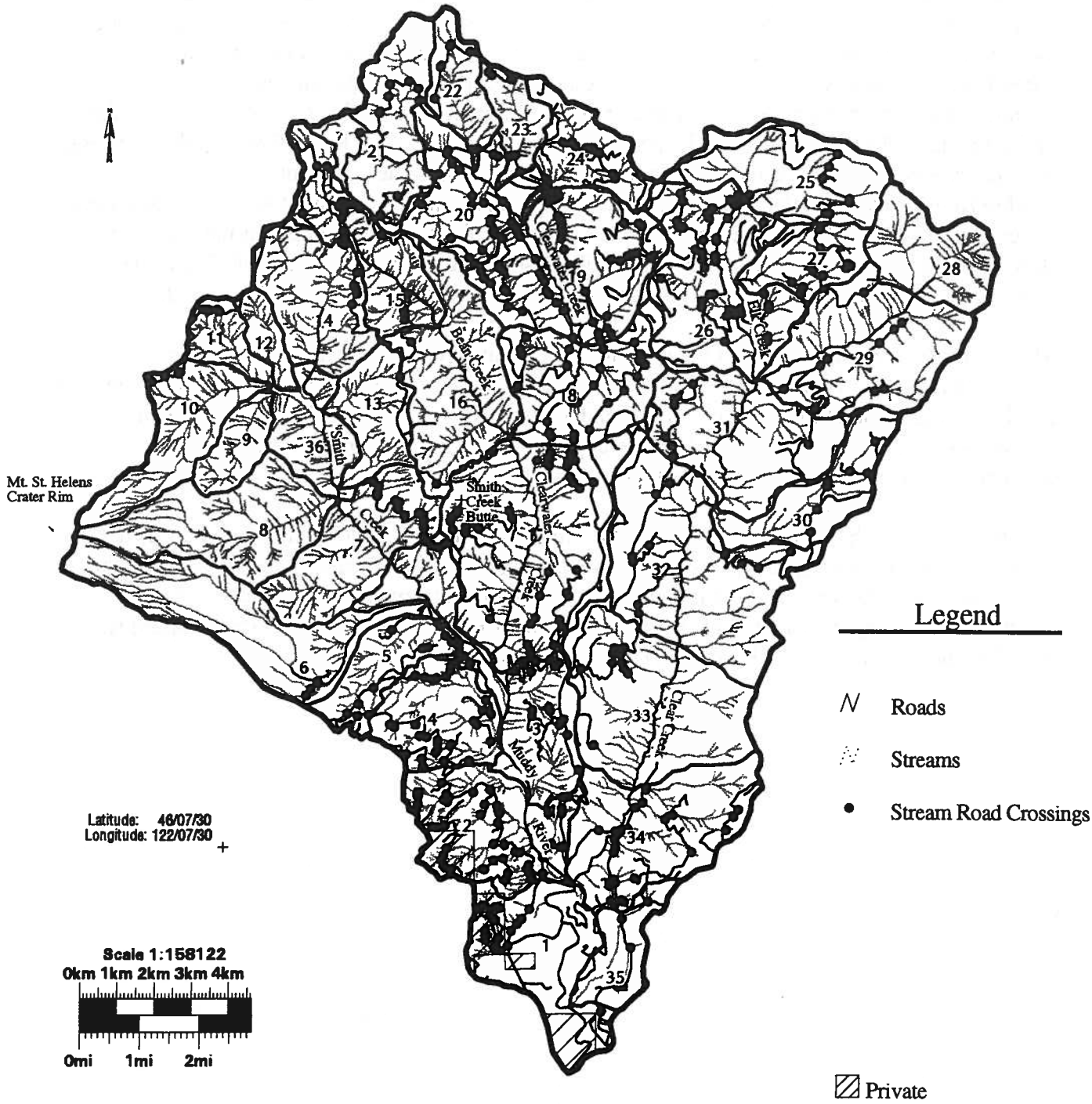

Figure 27. Display of where the road network crosses Class I - 4 streams in the Muddy River Watershed.

Table 26 - Muddy River Watershed Road Densities, Stream Crossings, and Aquatic Habitat Fragmentation Indices by Sub-basin.

Wildcat Project Area

Watershed Number	Miles of Roads	Road Density	Number of Stream Crossings	Miles of Stream	Road Crossings per Stream Mile
1 ✓	11.3	2.55	20	12.37	1.61
2 ✓	15.8	3.57	54 -47	31.50 Close	1.71
3 ✓	11.4	2.41	25	31.89	0.78
4 ✓	8.6	2.89	31 - 23	18.85 Close	1.64
5 ✓	6.5	3.11	13	12.12	1.07
6	1.1	0.20	5	32.23	0.16
7	2.6	0.65	14	30.63	0.46
8	0	0	0	33.20	0
9	0	0	0	9.23	0
10	1.0	0.33	4	22.27	0.18
11	1.6	1.39	5	9.23	0.54
12	0.30	0.40	0	5.77	0
13	2.0	0.94	1	14.01	0.07
14	4.0	1.11	7	26.18	0.27
15	7.3	2.18	21	27.57	0.76
16	4.3	0.87	2	26.65	0.05
17	22.1	2.56	47	47.49	0.99
18 ✓	12.2	2.76	30	21.21	1.41
19	19.7	3.31	66	34.35	1.92
20	9.4	2.89	22	16.55	1.33
21	7.2	1.87	12	15.27	0.79
22	2.2	1.28	9	10.46	0.86

Watershed Number	Miles of Roads	Road Density	Number of Stream Crossings	Miles of Stream	Road Crossings per Stream Mile
23	1.3	1.01	9	8.60	1.05
24	6.5	2.86	11	12.30	0.89
25	10.1	2.45	8	12.33	0.65
26	21.8	3.77	48	23.31	2.06
27	5.4	2.92	15	8.89	1.69
28	0	0	0	18.54	0
29	9.9	1.78	11	25.54	0.43
30	6.5	2.34	7	9.64	0.73
31 ?	9.0	1.75	7	21.56	0.32
32 ✓	12.3	1.62	14	27.75	0.50
33 ✓	9.8	1.52 LOW	14	26.27	0.53
34 ✓	13.0	2.48	28	22.70	1.23
35 ✓ not in	5.2	3.00	5	4.49	1.11
36	0	0	0	18.66	0
Totals	261.4	2.02	565	729.61	0.90

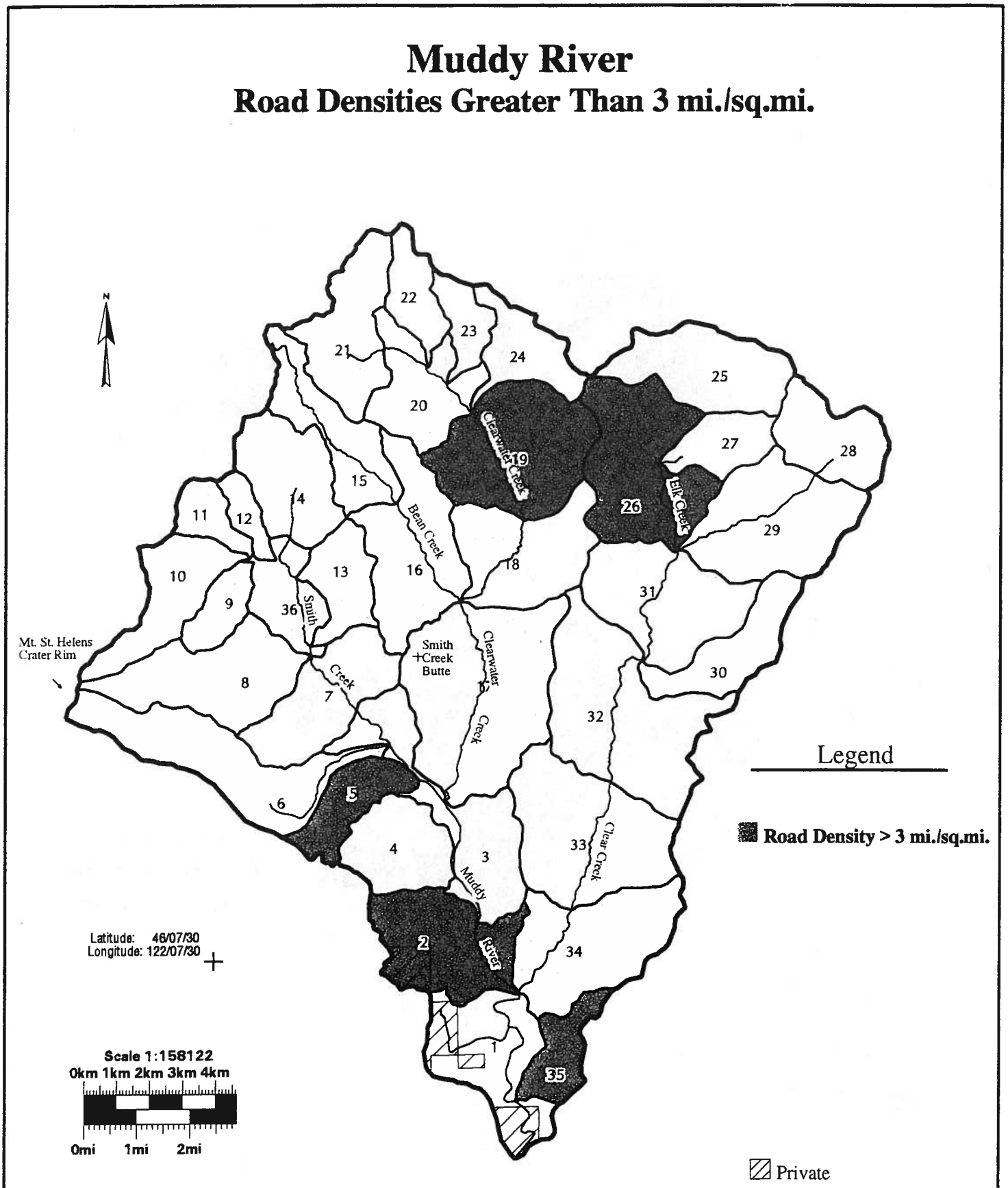

Figure 28. Muddy River Watershed sub-basins with road densities greater than 3.0 miles per square mile.

Muddy River
Sub-basins That are Highly Fragmented

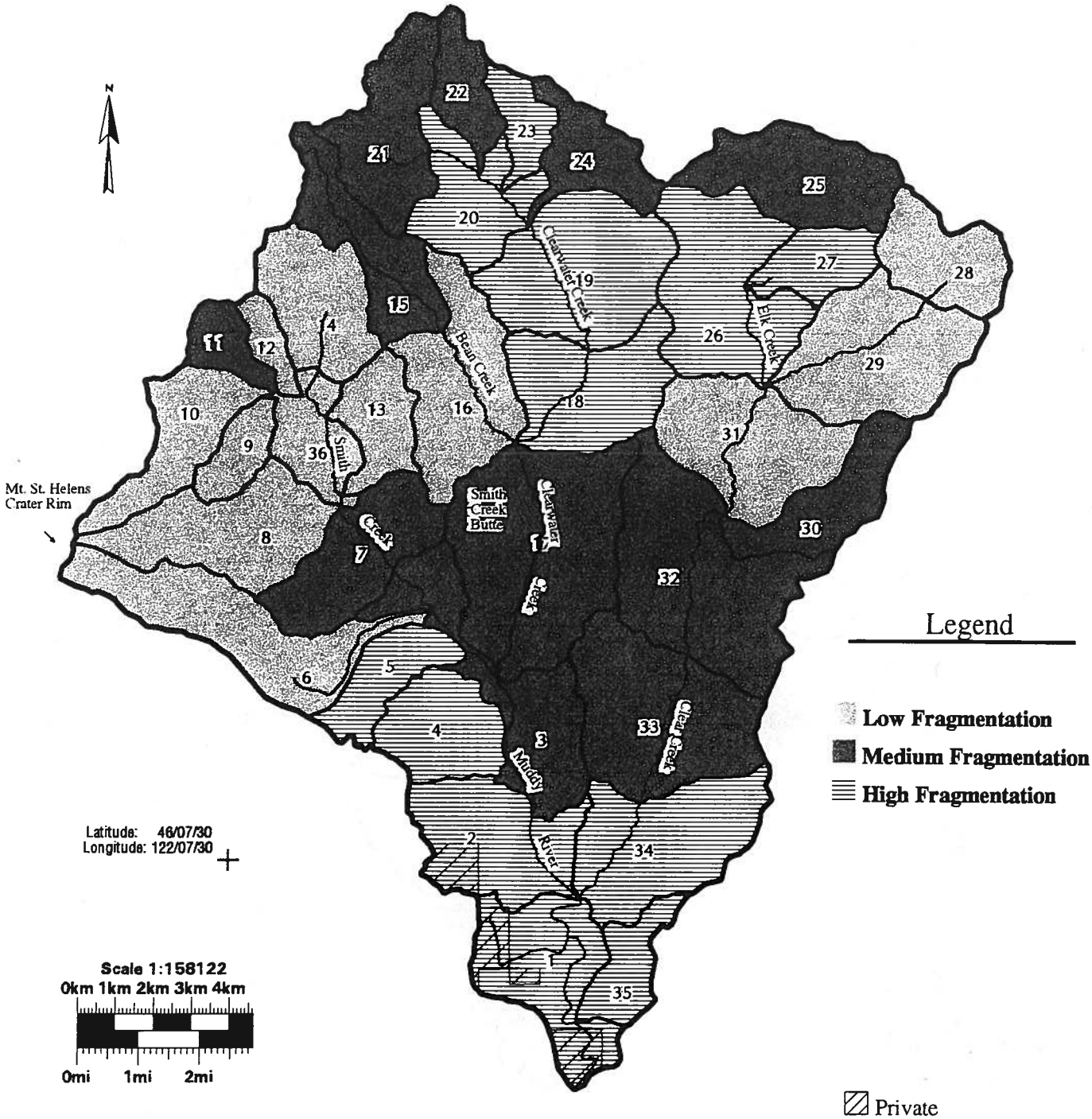

Figure 29. Muddy River Watershed sub-basin stream fragmentation values. Low ratings are values which range from 0.0 - 0.45 crossings per stream mile. Medium ratings are values which range from 0.46 - 0.99 crossings per stream mile. High ratings are values which range from 1.00 - 2.05 crossings per stream mile. Ranges were arbitrarily set by dividing the stream fragementation values of the entire Muddy River Watershed into thirds.

Stream Channels

Reaches on major streams were classified based on similar physical characteristics and placed into three major groups: erosion, transport and response. "Response" reaches have low gradients and are less confined sections that tend to be more sensitive to changes in the amount of input variables such as wood, water, and sediment. Consequently, these response reaches tend to degrade easily and take longer to recover from disturbances than erosion and transport reaches. Almost half of the length of named streams in the analysis area are characterized as "response" reaches (see Figure 30, Erosion-Transport-Response Reaches).

The rest of the length of named streams are characterized as "erosion" and "transport" reaches. Erosion-type channels usually have relatively steep gradients and are actively down cutting at various rates due to underlying geology and other physical characteristics. They are also travel paths for up slope mass wasting events (debris torrent areas). Some channels with more gentle gradients can be defined as erosional reaches if they have high rates of bank cutting. Transport reaches, on the other hand, have moderate gradients and are less confined than erosion-type channels. Both erosional and transport channels tend to move input variables such as wood, water, and sediment through relatively quickly.

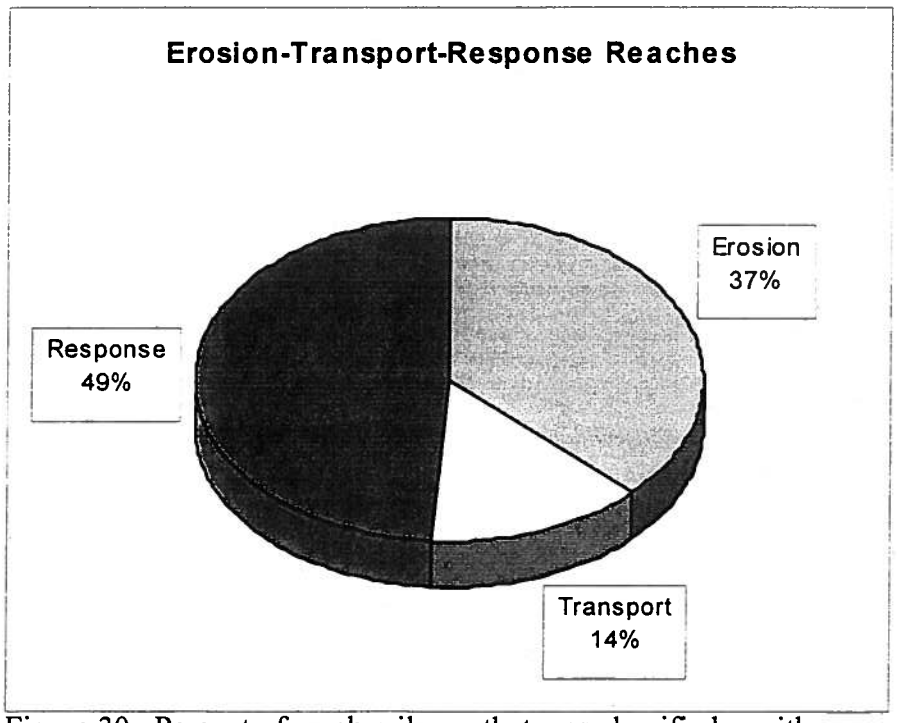

Figure 30. Percent of reach mileage that was classified as either erosion, transport or response.

The following observations and measurements of reaches were made from 1959, 1978, 1989 and 1996 aerial photos:

- Response reaches #D001 (Bean Creek) and D006 (Smith Creek) (see Figure 31 Stream Segments) are in the blast zone of the 1980 eruption of Mount St. Helens. Most vegetation was blown down and varying depths of blast deposits covered these watersheds. The eruption changed the channel types for both of these reaches from a meandering single "C" type channel to a braided "D" type channel. The eruption increased the width of these reaches 229 percent and 685 percent respectively, in the period 1978-1989. The February 1996 flood increased the width of these reaches 52 percent and 14 percent respectively.

- The Muddy River carried a mudflow from the eruption of Mount St. Helens. In the period 1959-1978, reach #D004 increased in width 49 percent and reach #D005 increased by 108 percent. The Muddy River was noticeably widened from the confluence of Smith Creek to the confluence with the Lewis River. Reach width in #D004 remained unchanged in periods' 1978-1989 and 1989-1996 (post-eruption) while reach #D005 increased in width 76 percent after the 1980 eruption.

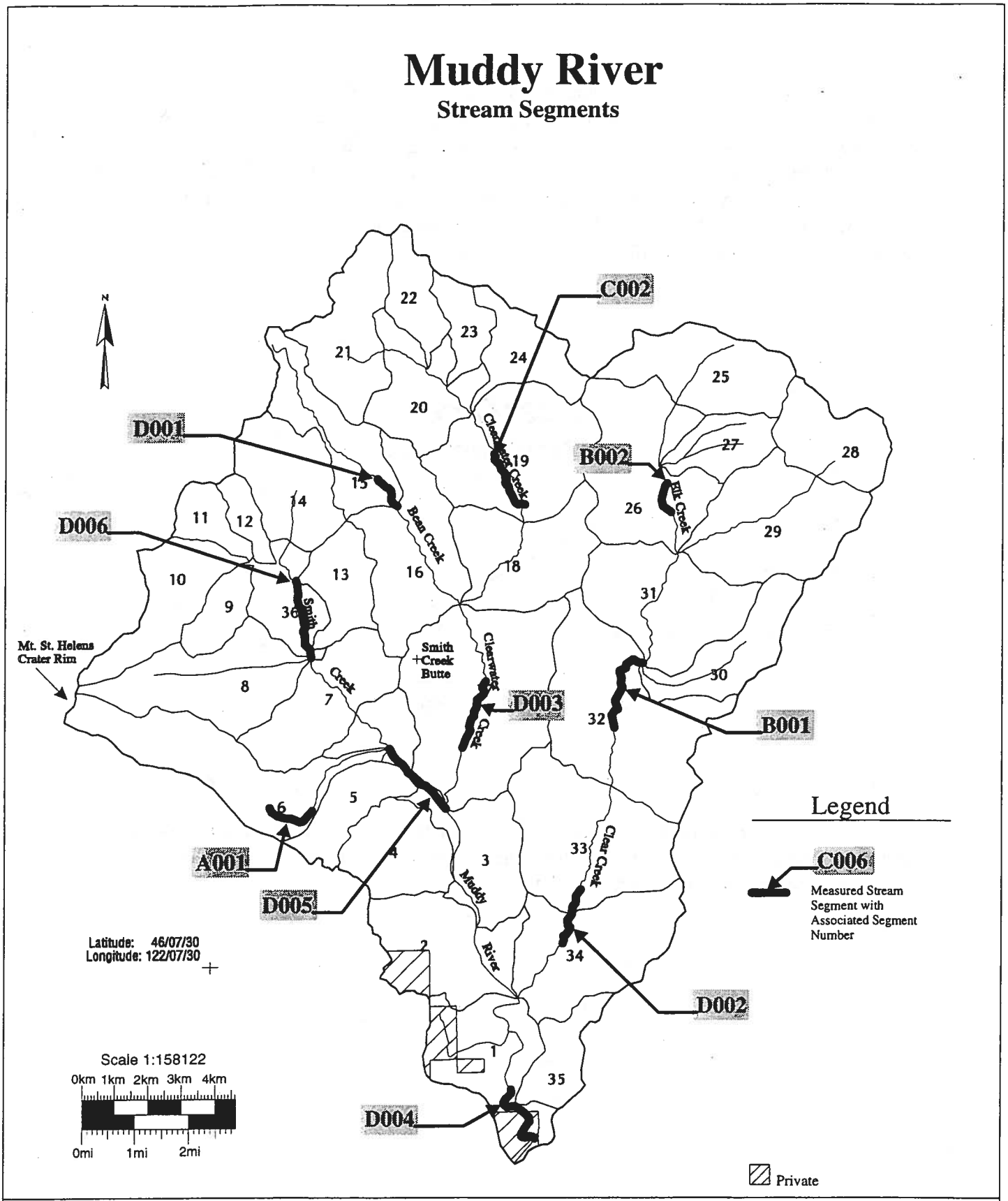

Figure 31. Stream segments that were analyzed using historic air photographs. These include known or suspected response reaches and known important fish spawning areas.

- Clear Creek was outside the blast zone and not subject to mudflows. Flood events in the 1970's changed reach # D002 from a meandering single "C" type channel to a braided "D" type channel and increased its width 81 percent during this period (see Figure 32 - Clear Creek average channel width). The reach readjusted to a meandering single "C" type channel and decreased in width 56 percent as the channel downcut and vegetation grew on the flood plain in the period 1978-1989. This reach reverted to a braided "D" type channel and increased in width 149 percent due to an influx of sediment and wood from the 1996 flood.

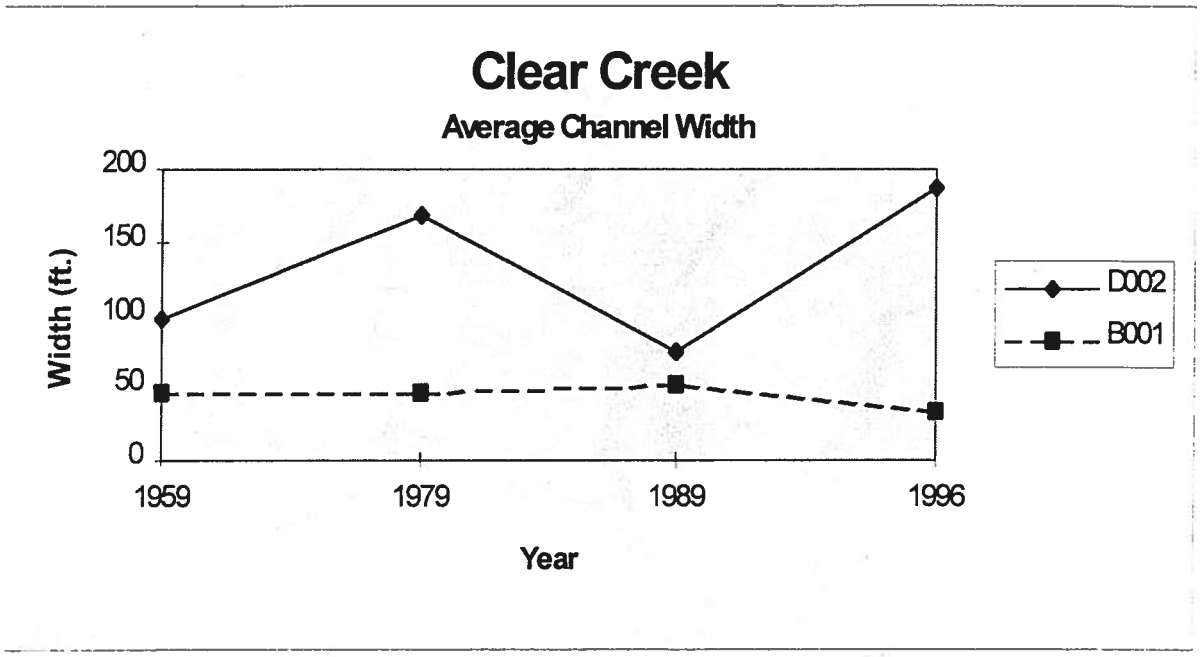

Figure 32 - Average channel width from two reaches on Clear Creek. Note the rapid rate that reach D002 widens and narrows, indicating this reach is very responsive to input of large woody debris and sediment.

Table 27 summarizes measured stream reaches and observations made relating to channel widening resulting from particular events. A "yes" means the channel width increased by at least 25 percent.

Table 27 - Channel Widening on Stream Reaches in the Muddy River Analysis Area

	Reach	Widened by 1970's floods	Widened by mud-flow from MSH eruption	Widened by blast deposits from MSH eruption	Widened by 1996 flood
Bear	D001*	no	no	yes	yes
LCC	D002	yes	no	no	yes
UCC	B001	no	no	no	no
Clear water	D003	no	no	yes	no
Clear water	C002*	no	no	no	yes
EFK	B002	yes	no	no	no
MR	D004**	yes	no	no	no
MR	D005**	yes	yes	no	no
UMR	A001**	yes	yes	no	no
Smith	D006*	yes	no	yes	yes

* In the blast zone of the May 18, 1980 eruption of Mount St. Helens.
** Subject to a mud flow from the May, 18, 1980 eruption of Mount St. Helens.

Recreation Use

The Muddy River Watershed is a popular destination for recreation visitors. Each year an average of 700,000 people visit the area to view the Mount St. Helens devastated area, hike trails, or hunt big game. Use is particularly heavy along Road 99, open from Memorial Day to early November and in the Lava Canyon and Lahar area on the upper Muddy River.

A total of 62 miles of trail is found in the watershed (Table 28). Trails are open to various types of use. The allowed uses are specified in management allocations from the Mount St. Helens Comprehensive Management Plan and the Gifford Pinchot National Forest Land and Resource Management Plan. Several trails such as Spencer Butte, Craggy Peak, and parts of the Boundary Trail are currently open to motorized use, though they pass through areas allocated as "semi-primitive, non-motorized." Motorized use within this allocation will be phased out as additional,

and matching, miles of motorized trail can be provided elsewhere on the Gifford Pinchot National Forest. Similarly, motorized use of the Truman Trail between the debris avalanche and Windy Ridge parking lot (allowed for scientific research access) is scheduled for phasing out as the road deteriorates.

Conflict between users is mostly a function of differing expectations between users. For example, hikers may anticipate hiking along a quiet trail to escape the noise and fast pace of city living. A mountain biker may anticipate the challenge of setting a new personal time record on the same trail. When a hiker encounters a fast moving mountain biker, or a number of bikers, the feeling of solitude and escape from city life, quickly erodes. The same holds true for interactions between other users as well, with the more mechanized or intrusive user, impacting less intrusive users. Table 28 shows the relative conflict between users.

Another aspect of recreation experience is risk, or perceived risk, created by encounters between different users. Recreation experience can again be affected by perceived or real danger of encounters between different users, such as horses and hikers, horses and mountain bikes, or hikers and motorcycles. Table 29 shows the risk of injury created by these encounters.

The number of encounters between different users defines the level of conflict. The use levels and user types of all trails in the watershed were compared to determine the relative level of conflict. It was found that most trails had low levels of conflict, four were rated as medium, and none high.

Hunting is the dominant activity in early winter when the State of Washington allows hunting for deer and elk. Hunters often use dispersed camp sites for a month or more, taking advantage of one or more "special hunt" periods. This activity contrasts with summer camping in the length of time camps remain established, and concurrent use of nearly all sites. Some traditional hunting camp sites have become inaccessible due to closing or decommissioning of roads. When this has occurred use has been forced into other areas in the same or adjacent watersheds. The appearance of new camp sites takes place at the prerogative of recreational users, since dispersed camping is generally not restricted on the Gifford Pinchot National Forest.

Dispersed camp sites are located mostly outside the Mount St. Helens devastated area near favored hunting locations. Some sites have road access, while others must be reached on horse back or foot. A number of camp sites located on Smith Creek Ridge can only be reached in this manner. Sites favored for summer recreation are fewer in number and are mostly located near an attraction such as a trailhead or a water feature. Principal summer sites are located near the Lower Smith Creek Trailhead, Clear Creek bridge on Road 93 and adjacent to Wright Meadow Creek at the Road 9327 crossing. These three sites account for about 85 percent of summer camping use in the watershed. In some cases camps create impacts to water quality or wildlife, such as those at Spencer Meadow and along Clear Creek. At Spencer Meadow there has been a long history of camping and vehicle use within close proximity to the wet meadow. This activity falls well within the 300 foot Riparian Reserve afforded meadows and other riparian areas. The Clear Creek camp site has vehicle access to the edge of the creek creating concern for water quality.

Table 28. Impact to Recreation Experience Created by Encounters with other Recreational Users. Read from left to right only.

	Horse	Hiker	Mtn. Bike	Motorcycle	4 x 4
Horse	Low	Low	High	High	High
Hiker	Low	Low	Medium	High	High
Mtn. Bike	Low	Low	Low	Medium	High
Motorcycle	Low	Low	Low	Low	Low
4 x 4	Low	Low	Low	Low	Low

Table 29. Risk of Injury Created by Encounters Between Recreational Users. Read from left to right only.

	Horse	Hiker	Mtn. Bike	Motorcycle	4 x 4
Horse	Low	Medium	High	High	Medium
Hiker	Medium	Low	Medium	Medium	Medium
Mtn. Bike	Medium	Medium	Medium	High	Medium
Motorcycle	Low	Low	Medium	Medium	Low
4 x 4	Low	Low	Low	Low	Low

Table 30. Trails Within the Muddy River Watershed, Showing Permitted Uses, Levels of Conflict Between Users, and Non-Conforming Uses based on the Gifford Pinchot Land and Resource Management Plan.

Trail Name	Trail Miles in Watershed	Allowed Uses from Forest Plan	Level of Conflict	Hazard of Encounter	Impact to Rec. Experience	Non Conforming Use, GP Forest Plan
Ape Canyon No. 234	5.5	A	Medium	Medium	Medium	Mountain Bikes
Loowit No. 216	4.3	C	Low	Medium	Low	
Abraham No. 216D	2.0	C	Low	Medium	Low	
Truman No. 207	1.9	A	Medium	Low	High	2X2 Vehicles, Mountain Bikes
Lava Canyon No. 184	2.6	A	Low	Low	Low	
Bridge Loop No. 184A	0.3	A	Low	Low	Low	
Ship No. 184B	0.2	A	Low	Low	Low	
Smith Creek No. 225	8.7	C	Low	Medium	Medium	
Boundary No. 1	14.5	C	Low	Medium	Medium	Motorcycles in Dark Divide
Meta No. 210	0.4	A	Low	Low	Low	
Independence Ridge No. 227A	0.5	C	Low	Medium	Medium	
Ghost Lake No. 1H	0.4	C	Low	Medium	Medium	
Smith Creek Butte No. 235	5.1	D	Low	Medium	Low	
Wildcat No. 25	4.1	B	Low	Medium	Low	
Spencer Butte No. 30	1.6	D	Medium	Medium	Low	Motorcycles
Cedar Flats No. 32	1.0	A	Low	Low	Low	
Wright Meadow No. 80	4.8	E	Low	High	High	
Snyder Pasture No. 80A	2.5	D	Low	Medium	Medium	
Craggy Peak No. 3	1.5	D	Medium	High	High	Motorcycles in Dark Divide
Total Trail Miles	62.0					

Table 31. Coding Key for allowed Trail Uses.

Code	Type of Use Permitted
A	Hiker
B	Horse, Hiker
C	Hiker, Mountain Bike
D	Horse, Hiker, Mountain Bike
E	Horse, Hiker, Motorcycle, Mountain Bike

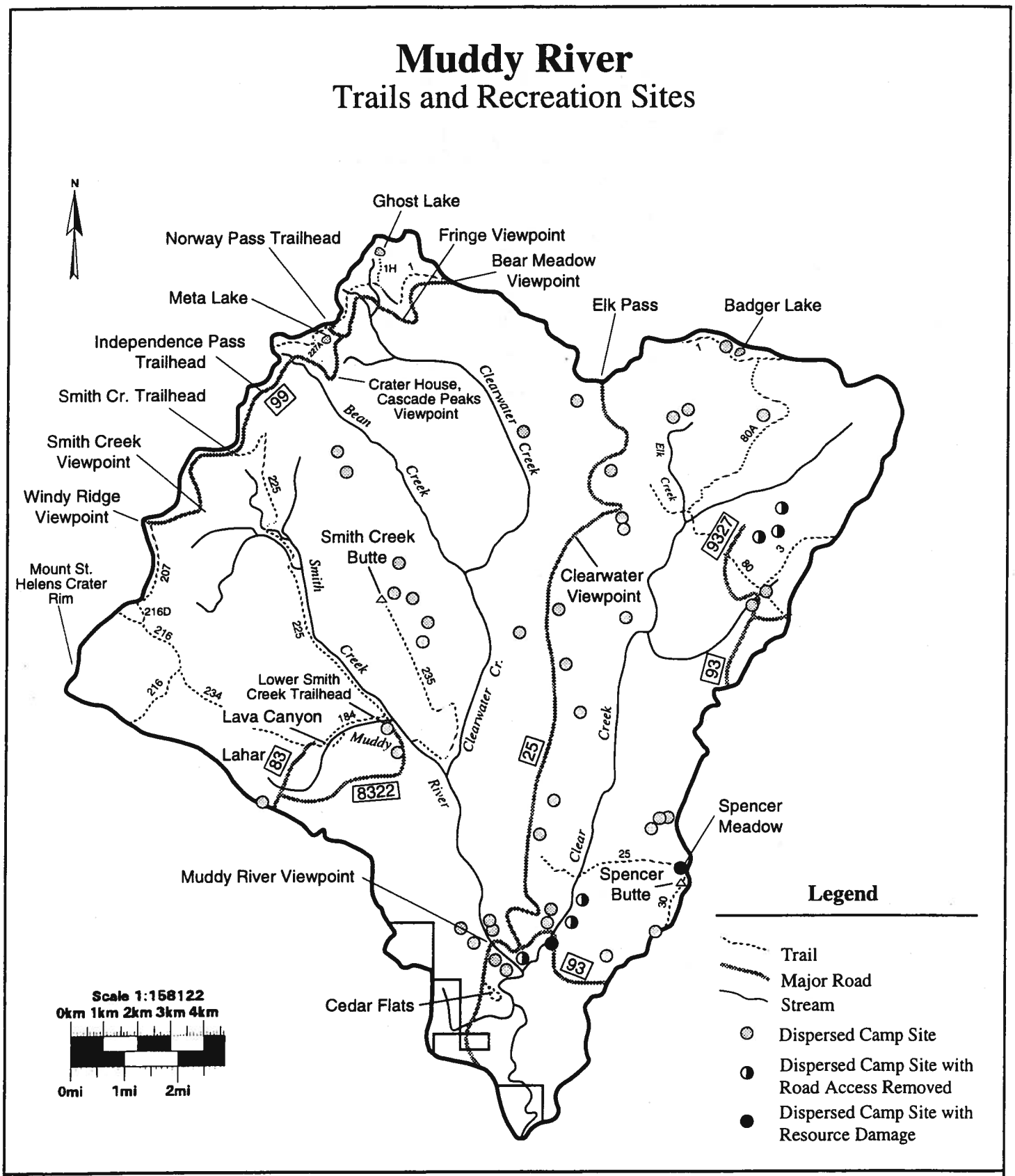

Figure 33 . Recreational use is divided between viewing scenery, hiking trails, and hunting. Dispersed camp sites are mostly used by hunters in the fall, with only a few attracting summer use. Resource damage is taking place at two camp sites, with impacts to water quality and wildlife habitat.

CHAPTER IV REFERENCE CONDITIONS

This chapter explains how the existing conditions from Chapter III have changed over time as a result of human influence and natural disturbances. The following paragraphs describe the known or inferred history of the landscape so we may know what was sustainable in the past and what changes have occurred to affect sustainability.

Geology and Physical Processes

The processes of glaciation, deposition, mass wasting and erosion have had the most effect on shaping the landscape as we see it today. Glacial activity over the past 200,000 years has shaped the watershed to the steep uplands and the flatter lowlands of many of the sub-basins. The deposition of ash and tephra on these steep slopes has created areas where mass wasting is now very active.

Past eruptions from Mount St. Helens over the last 12,000 to 18,000 years have deposited much of the soil present today. Two eruptive events have influenced the watershed by the amount of tephra and ash deposited. These events are labeled the Ye and We by Crandell and Mullineaux, 1996. The Ye eruptive phase occurred about 3400 years ago. Layer Ye is a coarse thick bed that extends mainly east-southeast from the volcano. It is about eight inches in depth at a distance of 30 miles from the summit of Mount St. Helens. Tephra layer We was formed by an eruption about 450 years ago and deposited up to eight inches of material at a distance of 20 miles from the mountain. Eruptive sequences of between 150 and 600 years over the last 4000 years have also deposited varying amounts of ash and tephra which have had an influence on vegetative growth. Table 32 shows the eruptive periods and dormant periods of Mount St. Helens over the past 40,000 years. Throughout this time period the landscape has changed dramatically. The shape of the land, as we saw it prior to 1980, developed only over the last 3000 to 4000 years. Of course, the 1980 eruption again drastically changed the landscape (more so to the area north of the watershed), altering the land that was well known since recorded human activity in the area began.

Table 32. Summary of Eruptive History of Mount St. Helens

Eruptive Period or Dormant Interval	Approximate age	Tephra Unit	Other eruptive products (not including lahars)
1980		Not yet designated	Dome & deposits of lateral blast
Dormant	~130 years		
Goat Rocks	200 to 150	T	Dome and Lava Flow
Dormant	~200 years		
Kalama	500 to 400	X & W	Pyroclastic, Dome & Lava flows
Dormant	~700 years		
Sugar Bowl	1150		Dome, pyroclastic & deposits of lateral blast
Dormant	~600 years		
Castle Creek	>2200 to 1700	B	Lava Flows, Pyroclastic & Dome
Dormant	~300 years		
Pine Creek	3000 to2500	P	Pyroclastic and Domes
Dormant	~300 years		
Smith Creek	4000 to3300	Y	Pyroclastic
Dormant	>4000 years		
Swift Creek	13000 to >8000	J & S	Pyroclastic and Domes
Dormant	~ 5000		
Cougar	20,000 to18,000	K & M	Pyroclastic, Dome and Lava Flows
Dormant	~15,000		
Ape Canyon	~40,000 to ~35,000	C	Pyroclastic flows

Other than volcanic and glacial activity, fire has had a role in shaping the landscape. Large hot fires remove vegetation which in turn makes the soils more susceptible to mass wasting and erosion.

Fire

History

Since 1900, three large fires of catastrophic intensity burned within the boundaries of the Muddy River watershed. All three fires were small portions of very large fires that burned in adjacent watersheds.

The large Lewis River Fire of 1902 burned in the vicinity of Spencer Butte. This large fire burned in the Middle Muddy, Lower and Middle Clearwater Creek, Lower Elk Creek, Wright Creek, Wright Meadow, Wildcat Trail, Spencer Butte, Lower Clear Creek and smaller portions of the Lower Muddy and Muddy River Tributaries East sub-basins. The fire totaled nearly 32,000 acres and also burned in the Lower, Middle, and Upper Lewis River watersheds. The Cispus Fire, also of 1902, burned vast acreage in the area between Mount St. Helens and Mt. Rainier to the north. A small portion of this fire burned approximately 2,500 acres in the Upper Elk Creek, Hungry Creek, and Craggy Peak sub-basins along the northern edge of the watershed. In 1920, a portion of the Lewis River Fire reburned in the Copper Creek Fire and consumed an additional 6,700 acres.

Although the Lewis River Fire of 1902 is the largest fire that is mapped and documented, a large fire of nearly 5,000 acres occurred in the mid- to late-1800's on the western slopes of Smith Creek Butte.

These large fires were all believed to be human-caused, although the specific causes are not known. Like most large fires in the Pacific Northwest, these fires were driven by strong, dry east winds in either September or October, after periods of prolonged drought.

Numerous small fires, between one-tenth and 120 acres in size, have also occurred within the watershed since the Forest Service started keeping records in the mid 1950's. The Ape Canyon Fire of 1973 was one of the largest and burned 114 acres in the Ape Canyon sub-basin on the eastern slopes of Mount St. Helens.

The eruption of Mount St. Helens in May of 1980 also burned and destroyed many thousands of acres across the northwestern one-third of the watershed. This eruption and accompanying devastation was equivalent to the large catastrophic fires that burned in the watershed in the early years of the century.

Large recorded fires that occurred within the Muddy River watershed during the period 1902 to present are displayed in the following table.

Name of Fire	Year of Occurrence	Total Acres Burned
Lewis River	1902	32,000
Cispus	1902	2,500
Copper Creek	1920	6,700

Fire Ecology

Fire frequency and intensity for the Muddy River watershed is best described as "episodal" as compared to "cyclic". Fire occurrence is constant and occurs in a cyclical pattern, whereas a large catastrophic fire or group of fires will occur randomly in what are called episodic types of events. This description is common for most western Cascade Mountain areas. Relatively small fires occur frequently, but large, catastrophic fire events occur very infrequently and only when weather conditions such as prolonged drought, strong winds and low humidity are present.

The Muddy River watershed is made up of three Fire Groups as identified in Fire Ecology of the Mid-Columbia, 1994. These groups are: Group Seven - Cool Associations Often Dominated by Lodgepole Pine; Group Eight - Warm, Moist Western Hemlock and Pacific Silver Fir; and Group Zero - Miscellaneous Special Habitats.

Fire Group Seven

Fire Group Seven occurs on the higher elevation plateaus and ridges in the watershed. Most stands occur in the mountain hemlock zone although some stands appear to fall within the Pacific silver fir zone. Low productivity characterizes Group Seven stands. These sites generally do not produce very heavy downed woody loadings or deep duff. In those instances where fuel loadings are heavy, fire can burn very rapidly through the area under dry conditions. Wildfire risk increases when climax species invade the understory and provide a fuel ladder into the overstory.

Most current unharvested stands support generally light fuel loadings. Those that have been cut have variable fuel loadings that could support low to moderate intensity fire. The present surface fuels would not readily carry a fire, lacking both duff and 0-3 inch size classes of downed woody fuels. This condition is the result of the 1980 eruption of Mount St. Helens. What effects this condition will have on probable fire behavior is unknown.

Fire exclusion does not appear to have altered potential fire behavior. Timber harvesting may have reduced the risk of large wildfires in some areas by reducing stand densities and breaking fuel continuity.

Fire Management Considerations - Wildfire risk rises during periods of prolonged drought and during extreme burning conditions. Fires at such times can crown and become very large if the stands are "ready" to burn. High recreation use and generally poor access to some areas add to the fire management concerns. During most years, generally cool conditions, a short fire season, and the lack of fuels tend to keep fires to a minimum despite the high potential for starts. Low and moderate intensity fires can start and burn, however.

Fire Group Eight

Fire Group Eight includes most of the western hemlock and Pacific silver fir plant associations. This fire group generally lacks fine fuels through most of the stand history. Classic old-growth stand conditions (closed canopy overstory of large diameter trees over a lush understory) are common in undisturbed areas, indicating infrequent disturbance. Deep duff and large logs are typical of this group. The resulting wildfire hazard is usually low to moderate depending on weather conditions in a given year. Prolonged drought (drought lasting at least 3 years) dries the forest floor enough to allow fires to start and spread. Smoldering combustion and creeping rates-of-spread are most common until dry, east winds fan the flames into a much higher intensity. Plot data information from the area indicate a fire frequency in the western hemlock associations as averaging 50 to 200+ years between large catastrophic fires and 170 to 400+ years in the Pacific silver fir associations. Average fire return intervals in the moister sites may easily exceed 300 years.

Fire history maps and recent wildfires suggest that most fires are either very small (less than one acre) or very large (greater than 1,000 acres). Mid-sized fires are not unknown but appear to depend on a combination of dry conditions and light to moderate winds.

Under current stand conditions, stand replacing fire will dominate during large fires. Most of the active burning occurs during one burning period, although it can occur over several burning periods. Low rates-of-spread and low intensities dominate; prolonged smoldering can create a high severity burn. High intensity fires depend on extreme winds, prolonged drought, or both. The highest fire danger occurs from mid-September through October.

Fire Management Considerations - Little or no hazard exists from natural fuel accumulation until late in the successional pathway. Fire exclusion may have had some effect on the typical fire behavior and fire size. The wettest western hemlock sites pose few, if any, wildfire problems.

Fire Group Zero

Areas of extensive rock, sand, or ash with varying amounts of vegetation are consistent with Fire Group Zero. In the Muddy River watershed this is predominantly the area devastated by the 1980 eruption of Mount St. Helens. These sites may support a crown fire under extreme conditions, but otherwise would not support a surface fire that spreads much beyond the point of origin.

Fire Management Considerations - Group Zero sites burn poorly under normal summer weather conditions. These sites can serve as natural boundaries between fire management zones.

Vegetation

According to REAP (Diaz & Apostol 1992), the Lewis River Basin was historically covered with broad continuous conifer stands of varying age classes. Large-scale disturbances were created by fire and episodic eruptions of Mount St. Helens. These continuous stands were characterized by diverse species composition and structure, including older remnant live trees, standing dead trees, and downed logs. Wetlands and other special habitats were scattered across the landscape.

These successional stages were probably not evenly distributed within the basin and varied between watersheds depending on the distribution and frequency of disturbance. Because stand replacing wildfires occur infrequently and do not occur within any predictable time frame or cycle, successional stages and age class distributions within the Lewis River basin could fluctuate over long periods of time. Since these disturbances do not follow any predictable spacial pattern, establishing a reference range for an individual watershed is nearly impossible.

The presence of an active volcano within this watershed has affected and will continue to affect vegetation patterns. Although the timing and magnitude of eruptions may vary, it is likely that volcanic activity will continue to create stand-replacing disturbance events at various scales, and that sometime in the future a large portion of this watershed will again return to a shrub/forb structure stage.

The REAP document estimates that between 1600 and the mid-1900's, late-successional vegetation covered between 45 and 70 percent, and early to mid-successional vegetation covered between 8 and 18 percent of the Lewis River Basin. Table 33 lists current age class estimates for the watershed. Because the watershed is adjacent to Mount St. Helens, historical amounts of late-successional vegetation were probably less than in other areas within the Lewis River basin. Approximately 20 percent of the watershed outside of the blast zone has been harvested. Assuming that these acres were late successional at time of harvest, adding the 20 percent harvested to the remaining 22 percent in age class 161-999 years puts historical levels of late-successional vegetation at about 42 percent. This is slightly lower than the REAP's 45 to 70 percent estimate. In order to bring the entire Lewis River Basin closer to REAP estimates of late-successional vegetation, other watersheds within the basin would need to have higher levels of late-successional vegetation to compensate for the lower levels within this watershed.

Table 33. Current Age Classes in Muddy River Watershed. Calculations Exclude Non-National Forest Lands.

Age Class	Acres	Percent of Watershed
000-080 years	50,833	59%
081-160 years	10,617	13%
161-999 years	23,641	28%

The structure and compositional development of forest stands following a natural disturbance varied considerably depending on a variety of factors including (but not limited to): the timing, intensity and size of the disturbance; the structure and composition of the disturbed stand; the distance from available seed sources; climate; and the physical characteristics of the land itself. After a stand replacing disturbance event, regeneration can occur within a few decades (Yamaguchi 1986) or take nearly a century (Franklin and Hemstrom 1981). These factors resulted in a wide range of variability in species composition, stand layering, age and size of trees within stands. It is possible for an even-aged, even-sized stand dominated by Douglas-fir to develop in one portion of a disturbed area whereas, in another area, a multi-aged mixed conifer stand may develop.

Habitat Condition for Animal Species

Historically, animal habitats in the watershed included a variety of timber age classes that occurred in large blocks that were the result of large scale stand replacing fires and volcanic activity. Late-successional habitat likely constituted 40 to 70 percent of the watershed at any one time, while mid to early-successional vegetation constitituted between 8 and 18 percent of the area. The different age class stands would have occurred in large blocks that provided more interior habitat than what exists today. Early- and mid-successional stands likely contained remnants of the previous stand, including large old live trees, and large snags and down logs in various decay stages.

This vegetation pattern would have favored interior species over edge species, especially those with large home ranges. Species such as elk, black-tailed deer, and great horned owl would probably have been less common, while species such as spotted owl, northern flying squirrel and northern goshawk would have been more common.

It is likely that riparian areas burned less often, or fires there were normally cooler ground fires that did not kill many of the overstory trees. Because of this, riparian areas in the watershed could have functioned as corridors through younger age class stands for species dependant on mature forest.

Most old growth on private land is now removed and is not likely to be replaced, so this type of habitat on the Forest is especially important.

Hydrologic Processes and Changes

According to streamflow records from the Lewis River above Muddy River and the Lewis River at Ariel, major flood events occurred on the Lewis River in 1933, 1972, 1973 and 1974. The pre-1972 floods were probably associated with rain-on-snow precipitation events that coincided with major fires or volcanic eruption. This was probably the primary mechanism for large scale floods in the past. REAP suggests that the historic range of basin disturbance for the entire Lewis River Basin ranged between four and five percent. Due to the addition of volcanic eruption as a major disturbance factor, the Muddy River Watershed is expected to be higher than other watersheds in this river basin.

Road construction contribution to peak flow increases was not a factor prior to the 1930's, due to the lack of roads in this area.

Aquatic Animals and Habitat

Historical aquatic habitat and population information in this basin is poorly documented. Distribution of resident fishes has been altered by road construction, the eruption and a decrease in the quality of required natural habitat elements such as temperature in the Muddy River Watershed. Historical anadromous fish distribution in the Muddy River watershed is not known. It is assumed that anadromous fishes (most likely coho and/or steelhead) utilized the lower portions of major streams in this watershed prior to the construction of Yale and Swift reservoirs.

No reference information is available for the number of pieces of large woody debris (LWD) per mile. However, given the management activities that occurred after the fires (snag removal and stream clean-out), and the natural decay of LWD pieces, we can assume that the reference condition was higher than present day conditions.

The range of natural variability for pool frequencies in the entire Lewis River basin has been estimated to be between 25-60 primary pools per mile (USDA 1993). One of the 42 surveyed reaches falls within or exceeds this range. This could indicate that the CRBPIG standards are not appropriate for this watershed.

Stream Channels

Stream channels east of Mount St. Helens have been subjected to a natural disturbance regime consisting of fires, floods, and repeated volcanic eruption. This has led to channels that probably had a high frequency of disturbance in this area. These channels are also very sensitive to disturbance and slow to recover from those disturbances due to channel type.

Other, notable observations include:

- Segment #D003 in Clearwater Creek and segment #D005 and #A001 in the Muddy River were recovering in the 1959 photos from channel widening that occurred prior to the air photos. This recovery consisted of channel down-cutting and hardwood vegetation encroachment on a recent terrace.

Stream Temperature

Historical stream temperature data in this basin is lacking. The Regional Ecosystems Assessment Project (REAP) suggests that historic maximum stream temperatures for the entire Lewis River basin ranged between 14 and 19 degrees Celsius. It can be assumed that stream temperature increases probably coincided with loss of riparian vegetation and/or channel widening associated with large fires, floods, and volcanic eruption. As mentioned in the stream channel section, the natural rate of disturbance was probably more frequent in the part of the watershed which lies east of Mount St. Helens. The cycle of stream temperature increase (and recovery for streams) in this area followed accordingly.

Human Use

Even though the Muddy River Watershed has seen a long history of human activity, the largest changes have occurred since 1960 when the first logging roads were constructed into the area. Since that time the dominant process creating change in the landscape has been related to logging and road building. This activity has created a patchwork of even-aged stands and an intensive network of roads particularly following the crests of major ridges.

The eruption of Mount St. Helens in May of 1980 erased most signs of human activity in the western half of the watershed. This area was severely altered by the eruption which destroyed an extensive road system and leveled all standing vegetation. Much of the devastated area is included within the boundary of the Mount St. Helens National Volcanic Monument. In areas outside the Monument, down timber was salvaged, and replanted with indigenous conifers. Artificial tree regeneration has clearly defined much of the monument boundary where a sharp contrast in vegetation exists.

Following the eruption of Mount St. Helens the area along Road 99 and near the head of Lava Canyon were heavily developed for recreational use through the construction of viewpoints, interpretive sites, and replacement trails. Use of these facilities is heavy and expected to gradually increase as the population of the Northwest increases. Published guidebooks for the area help visitors understand the natural forces at work and direct use to developed sites. The success of these publishing ventures is an indirect indicator of the fascination and interest Mount St. Helens holds for visitors.

Hunting and related fall camping are very popular activities in the watershed. The relatively open terrain found in the devastated area provides large quantities of browse for deer and elk allowing healthy populations to develop. Hunting activity has followed the increase in available animals, with establishment of camp sites along roads and in remote locations accessible only by foot or horse. The amount of hunting activity seems to be maintaining a constant level, neither increasing or decreasing. This may be based partly on the availability of game, camp sites, and on special hunting regulations.

Recreational use is now the dominant activity in the watershed and is expected to remain so in the foreseeable future. This is consistent with a national trend of increased demand for recreation opportunity and use of the National Forest System.

CHAPTER V INTERPRETATION

Chapter V compares the existing, historical, and reference conditions of specific ecosystem elements by explaining significant differences, similarities, or trends and their causes. The capability of the system to achieve key management plan objectives is also explored. The chapter is divided into three sections,

- **Dominant Processes**
- **Interpretation**
- **Synthesis**

In Section 1, **Dominant Processes**, the principal processes that have shaped the watershed's ecosystem at the landscape level are briefly described.

In Section 2, **Interpretation**, the issues, such as mass wasting, surface erosion from roads, etc., are each addressed in turn. The comparisons, explanations, and discussions for each issue are presented in a similar series of paragraphs and tables to enable the reader to follow the logic of the analysis.

In Section 3, **Synthesis**, different parts of the analysis are integrated. Using the material detailed in the paragraphs and tables in Section 2, the team began integrating this information spatially, i.e. displaying which sub-basins were of concern and correlating relationships between sub-basins across the watershed. This integration and synthesis is portrayed in an explanation, a table of information, and a map. Through this analysis, sub-basins having more than one ecological concern are readily apparent. Also, the various linkages between, and flows of, elements within the ecosystem can be viewed spatially. These displays of data, information, and interpretations form the basis for recommendations which are detailed in Chapter VI.

Section 1 Dominant Processes

During the analysis of current and reference conditions in the watershed, and the identification of issues and key questions for geology and physical processes, vegetation, wildlife, hydrology, fisheries, and the human component, various processes that have shaped the watershed became obvious. These processes were both natural and human induced. The processes that shaped the watershed at the landscape level are described below.

Because of the complexity of ecological systems, the interrelatedness of all ecosystem components, the scale at which the analyses were performed, and the limitations of humans to accurately identify key biotic and abiotic processes that influence an ecosystem, it is unlikely that all processes were necessarily identified. The following list serves as a starting point for future analyses. To minimize redundancy, the tables and paragraphs in Section 2 will reference these process descriptions.

Volcanic and Seismic Activity

Volcanic and seismic activity in the watershed have been occurring for millions of years with a concentration of events in the last 40,000 years around Mount St. Helens. This activity continues with the most noteworthy occurrence being the eruption of Mount St. Helens in 1980 . This event demonstrated that volcanic activity can be devastating to the landscape with effects lasting for many years afterward. Loss of vegetation, loss of wildlife and increases in sediment movement from new tephra deposits all have lasting effects on the future of the watershed. This activity can also induce further effects such as an increase in human activities.

Erosion

The erosion processes in the watershed are controlled by such factors as slope, water, soil type and what kind of management activities have occurred in the area. The main erosion concern is the loose tephra deposits on steep slopes. The other factor is the effects associated with road construction. During large storm events a noticeable increase in erosion rates is indicated by the greater amounts of sediment in streams. Erosion rates in the northern part of the watershed have had a marked increase since the eruption of Mount St. Helens in 1980. This is the result of large amounts of tephra and ash being deposited and the lack of vegetation to hold it in place especially in the blast area. Erosion will be a continual process even if all human activity were to stop. Management activity will only increase the amount of sediment transport to streams but with better management practices this amount may be kept to a minimum.

Fire

The large fires that have burned within the Muddy River Watershed have created stand structures that are in some areas single age/single species with very little diversity. Volcanic activity and harvesting practices surpass fire as the major disturbance processes within the watershed. This change in vegetative cover, due to volcanism, harvest and fire, has resulted in reduced cover for wildlife species, increased stream temperatures due to lack of stream cover/shading, and a decrease in large woody debris recruitment potential over the long term.

Timber Management

Intensive timber harvesting in this watershed began in the early 1950's and has continued through the last four decades. The objective of forest management on both federal and non-federal lands has been to increase conifer growth by clearcutting slow growing, older forest stands and replacing them with faster growing, young conifers. Harvest units on federal lands tended to be smaller than on non-federal harvest areas and were usually dispersed in small patches across the landscape.

Commonly, little or no vegetation was left along streams. Subsequent reforestation and stand-tending operations were implemented with the objective of increasing the growth rate and numbers of trees.

Roading

Roading in this area has extended the stream channel network through roads and ditch lines along roads. These features may increase peak flows through road cut slope interception of subsurface flow and routing it to surface waters using road ditch lines as "pseudo channels". Compaction from roads can reduce permeability, consequently increasing surface water flow that is routed to surrounding streams. Some culverts do not allow fish passage resulting in fragmentation of fish habitat. Roads and culverts can block not only upstream migration of resident fish, they can alter the flow pattern of large woody debris through the system and increase sediment input (Furniss et al. 1991). Poor road construction practices can result in a wide spectrum of effects: from increased surface erosion (especially during wet weather use) to massive road failures. All lead to increased sedimentation to streams.

Peak Flow Increases

Peak flow increases during fall and winter storms occur as a result of vegetation removal (fire or timber harvest), road cuts intercepting subsurface flow, and surface waters being routed through road ditch lines. The result is increased erosion and therefore an increased sediment load going into streams during high peak flows. Altering the natural flow regime of sub-surface waters may also decrease summer low flows, with negative consequences for water dwelling organisms, e.g., fish and amphibians.

Flooding

Flooding can modify both upslope and aquatic terrain through initiation of landslides and removal, transport, and deposition of wood, water and sediment. In the case of debris torrents, floods can remove much of the channel complexity (LWD, sediment) and transport it to other reaches in a stream. This will simplify some sections of stream while making other sections more complex. This may influence success of some beneficial uses such as fish by altering use patterns. Flooding can also increase bank erosion and sediment introduction in general. Floods may also damage structures such as campgrounds and roads, thus altering use patterns. Flooding can also be very beneficial by adding LWD that is stored in small tributaries to main channels as well as adding gravels for fish spawning and rearing.

Recreation Activities

The close proximity of this area to large population centers, and the ease of access, attracts large numbers of visitors each year. Principal activities include viewing scenery, hiking, mountain biking, riding motorcycles on trails, mountain climbing, hunting, and camping. The establishment of the Mount St. Helens National Volcanic Monument in 1982, following the cataclysmic volcanic eruption of 1980, brought world-wide, as well as local attention to the area. Visitor facilities have been built along Road 99, and in the vicinity of Lava Canyon and the Lahar Recreation Area. A system of new trails were developed to replace those lost during the volcanic eruption mostly within the devastated area. East of the devastated area is a network of historic trails in the vicinity of Spencer Butte and along the Boundary Trail ridge.

Visitor use of the area has increased from approximately 35,000 visitors annually before 1980 to an average of 700,000 in 1996. Most use takes place during the summer vacation season between Memorial Day and Labor Day. Most of this increased use is accounted for by day-visitors viewing scenery. Hunting and hunting related camping is concentrated in the fall, mostly during October and the first half of November. The total number of camp sites has decreased due to the eruptive activity of Mount St. Helens.

Section 2 Interpretation

The following pages provide a systematic interpretation of the issues that were analyzed in this iteration of the Muddy River watershed analysis. This interpretation is presented one issue at a time, each led off by a summary paragraph. Then, in a table format, the current conditions are compared to the reference conditions, and the dominant processes and significant trends or rates of change are identified. The existing management objectives and the desired future conditions from current management plans are compared to the current conditions. This array of information, along with the synthesis which immediately follows, sets the stage for the recommendations detailed in Chapter VI.

Issue No. 1: MASS WASTING

Summary

Most of the landslides in the watershed are naturally occurring. Some slides (the shallow rapid torrents and flows) have been activated by management activities and are typified by the damage done to the Bean Creek and Clearwater drainages during the floods of February, 1996. Future landslides in the watershed are very probable in that there are many soils susceptible to sliding as well as steep slopes. There is also the potential for existing landslides to continue to move and possibly increase due to management activities.

Components of Issue	Locations	Current Conditions Compared to Reference Conditions	Dominant Processes	Significant Trends Or Rates of Change
Harvest Techniques	Throughout watershed	Clear cutting has removed vegetation which has increased groundwater levels which in turn will increase potential for movement of the ground on steep slopes	Peak flow increases	Has been a definite increase since harvesting has taken place.
Soils	Throughout watershed	Soils probably have not changed from reference conditions	Silts and clay soils on steep slopes	No change
Water	Throughout watershed	Changes in precipitation over time may increase movement of the ground	Rain and groundwater levels	Increase in movement in years where there is a higher amount of rainfall.

Issue No. 1: MASS WASTING (Continued)

Components of Issue	Existing Management Objectives and Desired Future Conditions	Current Conditions Compared to Management Objectives & Desired Future Conditions
Fire	Current management objectives are to suppress fire in the watershed which would increase the amount of vegetation.	
Harvest Techniques	Harvest is going from clearcutting to harvest with some of the existing stands being retained. Also areas of unstable and potentially unstable ground are being placed in riparian reserve.	Leaving vegetation in potentially unstable ground should create a more natural regime in the movement of landslides.

Issue No. 2: EROSIONAL PROCESSES

Summary

Road construction has had a tendency to increase sediment into streams over the past century. Most of this increase occurs in the first 2 to 5 years following construction or until an increase in vegetation on the fills and cuts reduces soil movement. The amount of sediment attributable to roading depends on many variables which makes it difficult to quantify the amount of sediment eroding from any portion of the road. These quantified numbers are based on some data in the basin and on interpretation of data from similar roads that have survey data available. These numbers show a moderate amount of sediment being transported from the roads to streams compared to other areas on the forest.

Volcanic activity from Mount St. Helens has had a major impact on the area from about 40,000 years ago up to the present. Volcanic activity has occurred in cycles of about 150 to 600 years over the past 2000 to 4000 years. This can easily change the landscape as shown by the 1980 eruption. Mud flows not only remove any thing in their path initially, but over long periods of time have a tendency to be very erosive prolonging the time needed for vegetation re-establishment on steeper slopes. Tephra deposits leave unconsolidated material on steep slopes which will gravitate downslope by erosional processes

Component of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Roading	Sub-basins 1,2,3,4,5, 17,26,30, 35	Increased roading has increased sediment input to streams	Poor road construction practices Side cast of waste material High use of roads Wet weather use Non-cohesive soils Surfacing types	Increase in erosion

Issue No 2: EROSIONAL PROCESSES (Continued)

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Roading	For each existing or planned road, meet the Aquatic Conservation Strategy. ROD C32 & B11 Minimize sediment delivery to streams from roads. ROD C33	Existing roads need to be evaluated for their capability to introduce sediment into the stream system. New construction would follow the Aquatic Conservation Strategies for road management
Fire	Current management objectives are to suppress fire in the basin which would keep erosion at a low rate.	

Issue No. 3: VEGETATION STRUCTURE AND COMPOSITION

Summary

The current age class distribution in the Muddy watershed is outside the reference range for the Lewis River Basin described in the REAP analysis (Diaz and Apostle 1992). Because this watershed is adjacent to an active volcano, it is possible that over time periods longer than those described by the REAP report, the current age class distribution could be within historic conditions. Approximately 68 percent of this watershed is currently in early to mid-successional forest. Roughly * 60 percent of this (or 47 percent of the watershed) was initiated through wildfire or volcanic eruption. Large contiguous areas of similar age and structure are still evident within the watershed, especially in the northwestern third of the watershed adjacent to Mount St. Helens.

In other areas of the Muddy watershed, small openings created by harvest operations have fragmented the larger contiguous stands. Because harvest units are generally smaller on National Forest lands, this pattern is more prevalent where harvesting occurred on federal lands. Within the western half of the watershed (including Mount St. Helens National Volcanic Monument, or MSHNVM), many of the harvested lands were previously non-federal ownership. The harvest patterns there differ from what currently exists within the eastern portion of the watershed.

Except for the acres within MSHNVM which were harvested prior to the 1980 eruption, all harvest acres were generally managed similarly. Species composition and structure were controlled to meet management objectives and therefore lacked the diversity present in unmanaged stands.

This watershed is unique in its inclusion of large areas of young developing forest initiated by recent volcanic eruption. Vegetation successional processes within MSHNVM are progressing without significant human intervention. These large contiguous areas of rock and shrub/forb are unique and cannot be readily found in other places within the western Cascades. The abundance of research, both past and present, conducted within this watershed continues to provide valuable information on vegetation development .

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Proportion of Age Classes	The watershed as a whole	Proportion of young and old forest stands are likely outside the reference range. Over two-thirds of the vegetation is in the sapling, pole or small tree structural stage. About half the historic late successional stands have been eliminated by timber harvest.	Fire Volcanism Floods Landslides Timber Harvest	Age classes will vary in the future with natural disturbance and human activities. The effect of harvest activities in the future will be minimal for many decades. The trend will be towards the development of older forests.
Distribution of Structure Stages Across Watershed	All or portions of sub-basins 1,2,3,4,5,6, 7,17,18,19, 24,25,26, 27,28,29, 30,31,32, 33,34,35	Large contiguous stands have been fragmented by small harvest units of varying age.	Timber Harvest	The trend toward fragmentation is being reversed. Almost 80 percent of the watershed is in MACs where timber harvest is not allowed. On Matrix lands, it will be many decades before large amounts of timber are suitable for regeneration. However, the age class proportions in the REAP report may never be achieved.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Diversity of Species and Structure	Sub-basins outside of MSHNVM where harvesting has been greater than 40 percent include all or portions of the following sub-basins: 1,2,4,5,7, 15,16 19,20,23,24,26,30,35	Early seral vegetation structure has changed from young stands with pockets of green trees, snags and logs to stands of dense even-aged conifers with little to no remnant forest. Stands with a variety of species and different age/sized trees has changed to stands with more similar species composition, age and size.	Timber Harvest	It will take several decades, and in some cases, a century or more, to restore historical biodiversity.
Diversity of Species and Structure	Lands within MSHNVM	Previous harvesting and force of eruption removed or destroyed much of the coarse woody debris, but the vegetation is developing naturally without significant human intervention	Volcanism	Succession will probably continue at slower rates than on managed forest. Ongoing research monitor these vegetation trends.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Biodiversity	Sub-basins where late-succession al forest is lacking: All sub-basins except 17,22-31	Plant, lichen, fungi and bryophyte biodiversity has decreased as structural and compositional heterogeneity has decreased.	Fire Volcanism Timber harvest Reforestation	The progression towards historic conditions is proceeding more slowly than typical.

Issue No. 3: VEGETATION STRUCTURE AND COMPOSITION (Continued)

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Proportion of Age Classes	Vegetation management objectives vary by Management Area Category (MAC): Matrix lands comprise 21 percent of the watershed. MSHNVM is roughly 22 percent and the RNA and LSR accounts for 57 percent of the watershed.	The watershed should be a mix of early, mid and late-successional stands depending on the MAC of the land. The Matrix and MSHNVM will continue to be dominated by early to mid-successional stands for many decades. Over time, if major wildfire or eruption do not occur, the amount of late successional stands will increase in the RNA and LSR. Eventually lands within MSHNVM will also reach late-successional conditions.
Distribution of Structure Stages Across Watershed	The desired distribution of structure stages varies by MAC. Matrix lands should contain a mix of age classes including the majority of younger stands in the watershed. Late Successional Reserves should be comprised primarily of late-successional habitat. Vegetation strucure within individual harvest units within the Matrix will vary depending on resource objectives, issues and concerns.	The distribution of age classes varies considerably from the Desired Future Condition. Fragmentation is greatest within the LSR where it will take many decades before young harvest areas become old enough to provide contiguous stand conditions.
Diversity of Species and Structure within MSHNVM	This area is set aside to enable natural geological and ecological processes to occur.	MSHNVM continues to provide this unique opprtunity to study and learn about natural succession.

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Diversity of Species and Structure outside MSHNVM	All forest stands should contain a diversity of different aged trees, canopy layers, snags and logs. This diversity should be greatest on lands outside the Matrix.	Stand structural diversity is below desired conditions. It will take a century or more to develop structural components such as large green and dead standing trees.
Biodiversity	Survey & Manage Standards and Guidelines provide protection to vascular plants, lichens, bryophytes, and fungi on all lands.	Biodiversity is below desired future conditions.

Issue No 4: STREAM RIPARIAN RESERVE FRAGMENTATION AND RIPARIAN HABITAT

Summary

Stream Riparian Reserves in this watershed have experienced a high level of disturbance from a combination of recent volcanic activity, wildfire, and timber harvest. This combination of disturbances has resulted in vegetation composition and structure that is probably below the historic range of variability. The large coniferous tree components are lacking in many areas, structural diversity is low, and riparian functions are probably impaired. Stream Riparian Reserves are intended to provide important natural habitats and ecosystem functions, including dispersal corridors and connectivity between suitable habitat blocks. Sub-basins with greater than 30 percent of the Stream Riparian Reserves harvested, or where the large tree and hardwood components are low, are identified as areas especially vulnerable to impaired ecological functioning. Stream Riparian Reserve restoration and enhancement opportunities exist in many areas within the watershed.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Reduced Structural Diversity	Sub-basins where large tree component is lacking: all sub-basins except 1, 17, 22-31, 35.	There is more early-successional and less late-successional vegetation structure than was present historically.	Timber Harvest Vulcanism Fire Floods	It could take many decades before historic conditions are restored.
Impaired Functional Roles of Stream Riparian Ecosystems	All sub-basins except 1,17,22-31, 35.	Because of reduced structural and compositional diversity, some stream riparian ecosystem functions are impaired.	Timber Harvest Vulcanism Fire Floods	It could take a century or more before some historic functional roles are restored, especially large woody debris input.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Reduced Stream Riparian Reserve Habitat Due to Timber Harvest	1,2,4,5,7,13,15,16,18-24,30,35	These sub-basins have had over 30 percent of their Stream Riparian Reserves harvested.	Timber Harvest	It may take many decades to return to historic conditions.
Reduced Stream Riparian Reserve Habitat Due to Fire and Volcanic Activity	All sub-basins except 1, 17,22-31, 35.	These sub-basins have high proportions of Stream Riparian Reserve habitat in early successional stages.	Vulcanism Fire Floods	It may take many decades to return to historic conditions.

Issue No. 4: STREAM RIPARIAN RESERVE FRAGMENTATION AND RIPARIAN HABITAT (Continued)

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Reduced Structure Diversity	Restoration and maintenance of environmental quality are of critical importance.[1]	Structure diversity is below desired future conditions.
Impaired Functional Roles of Stream Riparian Ecosystems	The interrelationship of all components of the natural environment are recognized. [1] "Survey and manage" standard and guideline will provide benefit to vascular plants, lichens, bryophytes, and fungi. [2]	Some ecological roles are impaired, are not meeting management objectives, and are below desired future conditions.

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Reduced Stream Riparian Reserve Habitat Due to Timber Harvest	Sustainability of all the Forests' natural resources, including the species that inhabit them, will be provided for by management. [3]	Natural stream riparian reserve conditions are below desired future conditions.
Reduced Stream Riparian Reserve Habitat Due to Fire and Volcanic Activity	Sustainability of all the Forests' natural resources, including the species that inhabit them, will be provided for by management. [3]	Natural stream riparian reserve conditions are below desired future conditions.

[1] National Environmental Policy
[2] GPNF Forest Plan Amendment 11, p. 2-63
[3] NFP ROD p. 5

Issue No 5: HABITAT FOR THREATENED, ENDANGERED, AND SENSITIVE PLANTS AND C-3 SPECIES

Summary

Many TES plants and C3 plants, lichens, mosses and fungi are associated with specific habitats such as stream and wetland riparian areas and late-successional stands. Historic disturbances resulting from fire and volcanic activity, combined with high levels of timber harvesting within the Stream Riparian Reserves, have resulted in a decrease in habitat for some TES plants and C3 plants, lichens, bryophytes and fungi. This could adversely impact population viability and dispersal processes for some species.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Reduced Late-Successional Habitat	2-21,28,32-34,36	These sub-basins have less than 45 percent late-successional vegetation.	Timber Harvest Vulcanism Fire Floods	It may take many decades to return to historic conditions.
Reduced Stream Riparian Reserve Habitat Due to Timber Harvest	1,2,4,5,7,13, 15,16,18-24,30,35	These sub-basins have had over 30 percent of their Stream Riparian Reserves harvested.	Timber Harvest	It may take many decades to return to historic conditions.
Reduced Stream Riparian Reserve Habitat Due to Fire and Volcanic Activity	All sub-basins except 17,22-31	These sub-basins have high proportions of Stream Riparian Reserve habitat in early successional stages.	Vulcanism Fire Floods	It may take many decades to return to historic conditions.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Population Viability and Dispersal Capabilities	All sub-basins except 17,22-31	Late-successional and stream riparian conditions are probably below historic conditions.	Timber Harvest Vulcanism Fire Floods	It may take many decades to return to historic conditions.

IssueNo. 5: HABITAT FOR THREATENED, ENDANGERED, AND SENSITIVE PLANTS AND C-S SPECIES (Continued)

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Reduced Late Successional Habitat	Restoration and maintenance of environmental quality are of critical importance. [1] Management objectives for Stream Riparian Reserves are to allow vegetation to develop into older successional stages.[2]	Current amounts of late successional habitat are below desired future conditions.
Reduced Stream Riparian Reserve Habitat Due to Timber Harvest	Sustainability of all the Forests' natural resources, including the species that inhabit them, will be provided for by management. [3]	Natural stream riparian reserve conditions are below desired future conditions.

Reduced Stream Riparian Reserve Habitat Due to Fire and Volcanic Activity	Sustainability of all the Forests' natural resources, including the species that inhabit them, will be provided for by management. [3]	Natural stream riparian reserve conditions are below desired future conditions.
Population Viability and Dispersal Capabilities	Sustainability of all the Forests' natural resources, including the species that inhabit them, will be provided for by management. [3] Research activities may be ongoing and proposed in all land allocations. [4]	Data are lacking to document population viability and dispersal capabilities for some species. Other species, particularly wetland and riparian dependent species, will benefit as riparian structure and functions are restored.

[1] National Environmental Policy
[2] NFP ROD p. C30-C38
[3] NFP ROD p. 5
[4] GPNF Forest Plan, Amendment 11, 2-53

Issue No. 6: HABITAT FOR FEDERALLY LISTED, SENSITIVE, C-3 ANIMAL SPECIES AND "SPECIES OF INTEREST"

Summary

Disturbances resulting from fires and volcanic eruptions, combined with timber harvest and road building, has resulted in decreased habitat for some wildlife species.

The watershed contains habitat for several species listed as either Federally listed, sensitive, C-3 animal species or "species of interest". The Muddy River Watershed contains a largely unroaded block of land in the Elk Creek area. Only about 22 percent of the elk and deer winter range in the watershed is optimal thermal cover. A majority of the suitable spotted owl habitat in the watershed is contained within management allocations that restrict scheduled timber harvest. The stream riparian reserves in the watershed are heavily fragmented, affecting ability of old growth dependant species, and amphibians to disperse.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Conditions for species requiring large blocks of late-successional habitat such as the spotted owl, northern goshawk, and American pine marten	Watershed-wide.	Amount of late-successional habitat less than reference conditions. (Approximately 22% compared to 45% - 70% historically). Existing late-successional habitat is more fragmented than historical conditions. Snag density in the watershed is lower than reference.	Fire, timber harvest, volcanism, road building	Trend is toward an increase in large tree habitat, and multi-storied habitat through forest succession in the LSR, and other areas withdrawn from scheduled timber harvest.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Conditions for species requiring seclusion from human disturbance (low road density) such as the gray wolf, grizzly bear, and wolverine.	Watershed-wide.	The road density is higher than reference conditions, and human use of the watershed is significantly higher. Opportunities for seclusion are best in the sub-basins (6, 7, 8, 9, 10, 12, 13, and 28).	Road construction for timber harvest.	Under the Northwest Forest Plan the trend is toward a reduction in road density, especially in the LSR, through watershed restoration projects.
Conditions within elk and deer winter range.	In biological winter range.	Currently, about 22 percent of the biological winter range is in optimal cover. It is assumed that the watershed contained 45 to 70 percent late successional habitat (optimal cover) prior to forest management. The sub-basins that contain winter range have an average road density of 2.1 miles per square mile. Sub-basins 6, 7, 16, 17, 32, 33 and 34 have road densities of less than 1.7 miles per square mile.	Timber harvest, volcanism, fire, road building	The trend is to increase optimal cover over time. Under the Northwest Forest Plan the trend is toward a reduction in road density through watershed restoration projects.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Conditions for semi-aquatic and terrestrial amphibian species (Van Dyke's and Larch Mountain salamander)	Class III and IV Stream Riparian Reserves.	Fragmentation of the Riparian Reserves through road building and timber harvest has left the habitat more fragmented than reference conditions.	Timber harvest and road construction.	Slow trend to development of more large tree habitat in Riparian Reserves through forest succession. Riparian Reserves will be protected under the ROD.
Habitat for cavity excavating birds and forest bats	Sub-basins 1, 2, 3, 4-16, 18-21, and 36.	These sub-basins in Matrix likely do not contain habitat capable of supporting at least 40 percent of the potential population of cavity excavators. This habitat capability is lower than reference conditions when a mixture of old growth and fire regenerated stands would have supplied abundant snags.	Timber harvest and salvage of dead and dying trees, volcanism, and road building.	Forest Plan standards and guidelines mandate maintaining habitat capable of supporting at least 40 percent of the potential population. This standard, as well as protection of riparian reserves, and 15% retention in harvest units will likely provide more snags in the future.

Issue No. 6: HABITAT FOR ANIMAL SPECIES (continued)

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Conditions for species requiring late-successional habitat.	Landscape areas where little late-successional forest persists should be managed to retain late-successional patches. This standard and guideline will be applied in 5th field watersheds in which federal forest lands are currently comprised of 15% or less late-successional forest. Protect and enhance conditions of late-successional and old growth forest ecosystems in LSR's	Currently, about 22% of the watershed is late-successional habitat. About 88 % of the spotted owl nesting, foraging, and dispersal habitat on National Forest in the watershed is in the LSR. The LSR constitutes 56% of the watershed. There will be an increase in the abundance of LSR over time as stands develop structurally.
Conditions for species requiring seclusion from human disturbance.	Reduce existing system and non-system road mileage in LSR and deer and elk winter range. If funding is insufficient to implement reductions, there will be no net increase in the amount of roads in key watersheds .	There are opportunities to decommission roads as part of watershed resoration.

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Conditions within elk and deer winter range.	Maintain 44% of biological winter range in optimal thermal cover. Optimal and thermal cover blocks should be should be at least 60 acres in size, and dispersed through the winter range. Open road density within winter range should average 1.7 miles per square mile or less. Roads not needed for through traffic or access to an active project or a specific recreation destination should be closed, either permanently or seasonally from December 1 to April 1, to prevent wildlife harassment.	Currently about 22 percent of the biological winter range is optimal cover. No harvest is to occur in optimal thermal cover stands if less than 44 percent of the fifth field watershed is in optimal cover. Reduce the road density to 1.7 miles per square mile. Road density in the sub-basins that contain winter range averages about 2.1 miles per square mile.
Conditions for semi-aquatic amphibian species.	Standards and guidelines in the Forest Plan prohibit and regulate activities in Riparian Reserves that retard or prevent attainment of Aquatic Conservation Strategy.	Currently, about 68 percent of the stream riparian reserves is early to mid-seral habitat. Riparian Reserves will be identified in the watershed and managed to protect and enhance habitat.
Conditions for cavity excavating birds.	Within Matrix, maintain habitat capable of supporting at least 40 percent of the potential population of cavity excavating birds.	There are several sub-basins in Matrix where the habitat capability does not meet Forest Plan standards.

Issue No. 7: HYDROLOGIC CHANGE

Summary

In general, sub-basins within the analysis area are recovering from volcanic eruption, fire and timber harvest. Analysis found that 22 percent of the sub-basins in the area have increased peak flows of 10 percent or greater due to loss of the mature conifer vegetation component by the eruption of Mount St. Helens. Roading has also contributed to the situation by increasing stream lengths in the watershed by 6 to 15 percent, thus contributing more surface water to streams.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Peak Flow Increase - Vegetation Related	Sub-basins 9,10,11,12, 14,16,20,36	68% of the watershed in early successional stands currently compared to 8 to 18% (USDA, 1993) of the watershed historically.	Primarily volcanic eruption and timber harvest, some fire.	Recovering as large conifers return to the sub-basins.
Peak Flow Increase - Road Related	Sub-basins 1,2,4,18,19, 20,26,27	Approximately 779 to 843 miles of stream channel currently compared to 736 miles historically.	Road systems have increased the length of stream channels.	Number of miles of streams is increasing due to increasing road miles.

Issue No. 7: HYDROLOGIC CHANGE (Continued)

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Peak Flow Increase - Vegetation Related	The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.[1] The distribution of land use activities, such as timber harvest or roads, must minimize increases in peak flows.[2]	Current condition is probably consistent with management objectives for sub-basins mentioned in previous table. This is due to the increased peak flows from vegetation loss that has resulted from natural events (volcanic eruption), not human caused.
Peak Flow Increase - Road Related	See Above	Current condition compared to management objectives is unknown due to lack of knowledge about the amount of increased peak flow, if any, resulting from roading.

[1] ROD B11

[2] ROD B9

Issue No. 8: KEY HABITAT ATTRIBUTES FOR SALMONIDS

Summary

Components of salmonid habitat in the Muddy River Watershed are affected by the following natural and human induced processes: fire, the eruption of Mount St. Helens, harvest/management activities, and road construction. Each of these processes has influenced the condition of habitat in the watershed.

Riparian harvest and LWD removal from stream channels has resulted in a limited supply of large woody debris that is available to the stream channel. Lack of LWD in the channels could be contributing to a lack of pools in the channels as well, which results in a lack of quality habitat for the salmonid species that use this watershed.

Road construction resulted in loss of available habitat when fish were not provided adequate passage facilities through culverts. Roads constructed on native surfaces also deliver additional sediment to the stream channels that can alter in-channel conditions decreasing quality habitat (i.e., filling in pools, silting in spawning beds, etc.).

The following information is provided for each component of salmonid key habitat attributes addressed in this watershed analysis: locations (each stream and sub-basin is listed where the habitat attribute is below desired management objectives), current conditions compared to reference conditions, what the dominant processes are affecting the attribute, and how the attribute is changing (or expected to change with current management policies).

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
In-Channel Large Woody Debris (LWD)	Sub-basins 1, 2, 3, 4, 5, 6, 8, 15, 16, 25, 26, 27, 28, 29, 30, 31, 32, 33.	Below natural levels due to management activities and fire regime	Past harvest activity in riparian areas and removal of LWD from stream channels	LWD increasing as ROD is implemented and riparian areas continue to mature into a late successional forest

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Large Woody Debris Recruitment Potential	Sub-basins: 1, 2, 4, 5, 7, 13, 15, 16, 18, 19, 20, 21, 22, 23, 24, 30, 35.	Outside the range of natural condition identified by the CRBPIG	Past harvest activity in riparian areas	Maintaining/ Increasing LWD potential as ROD is implemented and riparian areas continue to mature into a late successional forest
Primary Pools Per Mile	1, 2, 3, 4, 5, 6, 8, 15, 16, 25, 26, 27, 28,29, 30, 31, 32, 33, 34	Outside range of natural variability as identified by REAP 1993	Fire, Erosion, Lack of LWD	Maintaining/ Increasing pools as ROD is implemented and riparian areas continue to mature into a late successional forest
Stream Temperature	Muddy River, Clearwater Creek, and Sub-basin 34 in Clear Creek	Probably within range of reference conditions during period of large scale disturbance (volcanic eruption).	Exposed channels due to volcanic eruption, timber harvest, and road building.	Temperature decreasing as canopies develop and mature, with recovery from eruption and implementation of Riparian Reserves.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** Or Rates of Change
Aquatic Habitat Fragmenta-tion	Sub-basins: 1, 2, 4, 5, 18, 19, 20, 23, 26, 27, 34, 35,	Fragmentation has increased due to road building	Road building without fish passage	Fragmentation is decreasing as ROD is implemented, and roads are decommissioned, and culverts replaced
		Flow of LWD thru system has decreased	Road Maintenance removes LWD at crossings	Maintain/Slight increase of LWD
Stream Channel/ Sediment	Smith Creek, Muddy River, Clearwater Creek, Clear Creek	Chronic input of fine sediment now compared to episodic input of fine sediment in the past.	Surface erosion from roads.	Unchanged to slight recovery.
		Input of large amounts of tephra into stream systems consistent with past large volcanic eruptions.	Volcanic eruption.	Slow recovery as vegetation returns.

Issue No. 8: KEY HABITAT ATTRIBUTES FOR SALMONIDS (Continued)

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
In-Channel Large Woody Debris	> 80 pieces per mile that are > 50' long and 24" DBH (Columbia River Policy Implementation Guide)	Of the total length of surveyed streams, 40 percent are outside the management objectives (i.e., have a poor rating).
Large Woody Debris Recruitment Potential	Aquatic Conservation Strategy Objectives (ROD B-11)	Riparian areas not currently supplying amounts and distributions of LWD sufficient to sustain physical complexity and stability.
Stream Tempera-ture	Stream Temperatures shall not exceed 16°C due to human activities (Water Quality Standards for Waters of the State of Washington)	Stream water temperature is within management objectives for the Muddy River and Clearwater Creek due to temperature increase from "natural causes" (volcanic eruption). Unknown for Clear Creek since the cause of channel widening in sub-basin 34 is not known.
Primary Pools Per Mile	The number of pools per mile are established by the CRBPIG and relate to the average wetted width of the channel (CRBPIG)	Of the total length of surveyed streams, 61 percent is outside the management objectives (i.e., have a poor rating).
Aquatic Habitat Fragmenta-tion	Provide and maintain fish passage at all road crossings of existing and potential fish-bearing (ROD S&G's C-33) New stream crossings on fish-bearing streams should be designed to allow fish passage (GPNF Forest Plan)	Some existing culverts do not provide fish passage, these are not meeting management objectives.

Components of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives & Desired Future** Conditions
Sediment	Existing beneficial uses shall be maintained and protected, and no further degradation which would interfere with or become injurious to existing beneficial uses will be allowed.	Current sediment levels are high due primarily to volcanic eruption. Other sources of sediment include roads and some harvest units.

Issue No. 9: RECREATION USE

Summary

Recreation use of the watershed has increased from approximately 35,000 visitors in 1979 to an average of 700,000 in 1996. Most of this increase if from summer visitors viewing scenery along road 99, and 83. A network of 62 miles of trail is found in the watershed, segments of which are open to a variety of allowed uses. On some of these segments conflict takes place between users, and will need to be further assessed, or corrected in the future. On several trail segments the allowed use is out of compliance with the Gifford Pinchot National Forest Land and Resource Management Plan.

Components of Issue	Locations	**Current** Conditions Compared to **Reference** Conditions	Dominant **Processes**	Significant **Trends** or Rates of Change
Dispersed Camping	2, 5, 6, 14, 16, 17, 19, 26, 27, 30, 32, 33, 34	Slight decrease in the number of sites due to the eruption of Mount St. Helens in 1980.	Demand remains constant based on hunting.	Road access to camp sites to decrease with road decommissioning
Conflict Between Trail Users	6, 8, 10, 25, 28, 30, 34	Increasing conflict between trail users.	Increased recreational use.	Increased demand for mountain bike, and hiking opportunities

IssueNo. 9: RECREATION USE (Continued)

Component of Issue	Existing **Management Objectives** and **Desired Future** Conditions	**Current** Conditions Compared to **Management Objectives** & Desired Future Conditions
Dispersed Camping	Dispersed camp sites should meet standards for water quality, and impact to wildlife habitat.	Water quality of Clear Creek should not be impacted by motorized vehicle use along the stream. At Spencer Meadow camping and vehicle access should not impact wildlife habitat.
Conflict Between Trail Users	Allowed trail uses should meet those listed in Appendix D of the Gifford Pinchot National Forest Land and Resource Management Plan.	Some trails are out of compliance with the Forest Plan, creating conflict between users. These include the Truman Trail, Ape Canyon Trail, Boundary Trail, Spencer Butte Trail, and Craggy Peak Trail.

Section 3 Synthesis

In the following section, information from earlier stages of the analysis is synthesized in order to further understand and discover interreationships between elements of the ecosystem. The synthesis was conducted in three dimensions of the ecosystem: aquatic, terrestrial, and social/economic. The synthesis for each of these three dimensions is presented in its own separate package consisting of an explanation, a table showing the location (sub-basins) of conditions of concern, and a map which shows the locations of important features. The terrestrial synthesis includes two maps. The three synthesis packages are followed by Table 37, Synthesis Table, which shows in which sub-basins the ecosystem elements of concern from all three syntheses occur. This provides readers with an over-all view of the watershed and highlights those sub-basins with the greatest number of elements.

Aquatic synthesis explanation

For the aquatic synthesis process, ecosystem elements having linkages are combined to identify critical zones within the watershed. For example, the locations of stream channels that are sensitive to sediment input are compared with areas that have high surface erosion rates from roads. The places where these two mapped polygons overlap identify important zones because here we currently have high surface erosion rates and stream channels are likely being degraded from sediment input.

Other relevant information is shown on the synthesis map and in the aquatic synthesis table. This includes: (1) sub-basins that have high aquatic fragmentation from roads and low LWD recruitment potential are combined to identify places of high concern for replenishment and flow of large wood to stream systems; (2) stream reaches that lack both LWD and pools are considered to be in extremely poor condition for fish; (3) areas that have increased peak flows from vegetation loss and roading; (4) stream response reaches that are sensitive to changes in amounts of wood, water, and sediment; (5) monitoring sites that exceed the State Water Temperature Standards; and (6) areas with high surface erosion from roads or areas that have high rates of erosion due to debris torrents, shallow/rapid landslides, or upslope surface erosion of tephra.

Summary

A large area, encompassing Sub-basins 9-13, 15, 16, 19, 20, 29 23, 36 (Figure 40), is identified as having concerns due to large areas of unstable or potentially unstable soils, presence of sensitive stream response reaches, peak flow concerns associated with loss of vegetation or roading, and high stream temperatures. Most of this degraded situation is a result of the Mount. St. Helens eruption, although peak flow concerns due to roading are present in the upper Clearwater Creek area. Sub-basin 20 is also of concern with increased peak flow resulting from loss of vegetation from the 1980 eruption of Mount St. Helens and numerous road/stream crossings.

Another large area containing degraded aquatic conditions is located in the southern portion of the analysis area. This area forms the core of the lower Muddy River and has poor fish habitat, high amounts of surface erosion due to roads, presence of sensitive stream response reaches, peak flow concerns due to roading and high stream temperatures. Most of the poor fish habitat and high stream temperatures are a result of deposition of tephra and resulting channel widening from the 1980 eruption, although channel widening and sediment deposition were noted in aerial photographs prior to the eruption. Sub-basins 1, 2, 4 and 19 also have high aquatic fragmentation and low LWD recruitment potential making these areas poor sources of wood for the Muddy River.

The Clear Creek basin is in fairly good shape, but it does have high stream temperatures, some poor fish habitat conditions, peak flow concerns associated with roading in the upper part of the basin and some high surface erosion due to roads. The source of high stream temperatures is not known, but is suspected to be due to the extreme sensitivity of the stream reach in which the monitoring

station is located. Historic air photos show this reach has widened several times in the last 40 years, exposing the reach to solar radiation fairly frequently. Sub-basins 28, 29, and 32 are identified as good source areas for LWD to Clear Creek, having low aquatic fragmentation and high LWD recruitment potential.

Table 34 - Aquatic Synthesis of Muddy River Watershed. Sub-basins are listed in general order of concern.

Sub-basin	High Frag. and Low LWD Recruitment Potential	High Risk of Increased Peakflow	High Sediment Concern	Extremely Poor Fish Habitat Conditions	High Water Temp.
1*	X	R	R	X	X
2*	X	R	R	X	X
19	X	R	U		X
4	X	R	R	X	
20		B	U		X
16		V	U	X	
26		R	R	X	
17			R		X
18		R			X
3			R	X	
30			R	X	
15			U	X	
27		R		X	
9		V	U		
10		V	U		
11		V	U		
12		V	U		
14		V	U		
36		V	U		
34					X
6				X	
8				X	
25				X	
28				X	
33				X	
35			R		
5			R		

Sub-basin	High Frag. and Low LWD Recruitment Potential	High Risk of Increased Peakflow	High Sediment Concern	Extremely Poor Fish Habitat Conditions	High Water Temp.
23			U		
13			U		
7					
21					
22					
24					
29					
31					
32					

* - Sub-basin has incomplete data due to private land

For "High Sediment Concern"; R=concern due to surface erosion from roads; U=concern due to upslope erosion

For "High Risk of Increased Peak Flow"; V=concern due to vegetative conditions; R=concern due to roading; B=concern due to both roading and vegetative conditions

Muddy River
Aquatic Synthesis

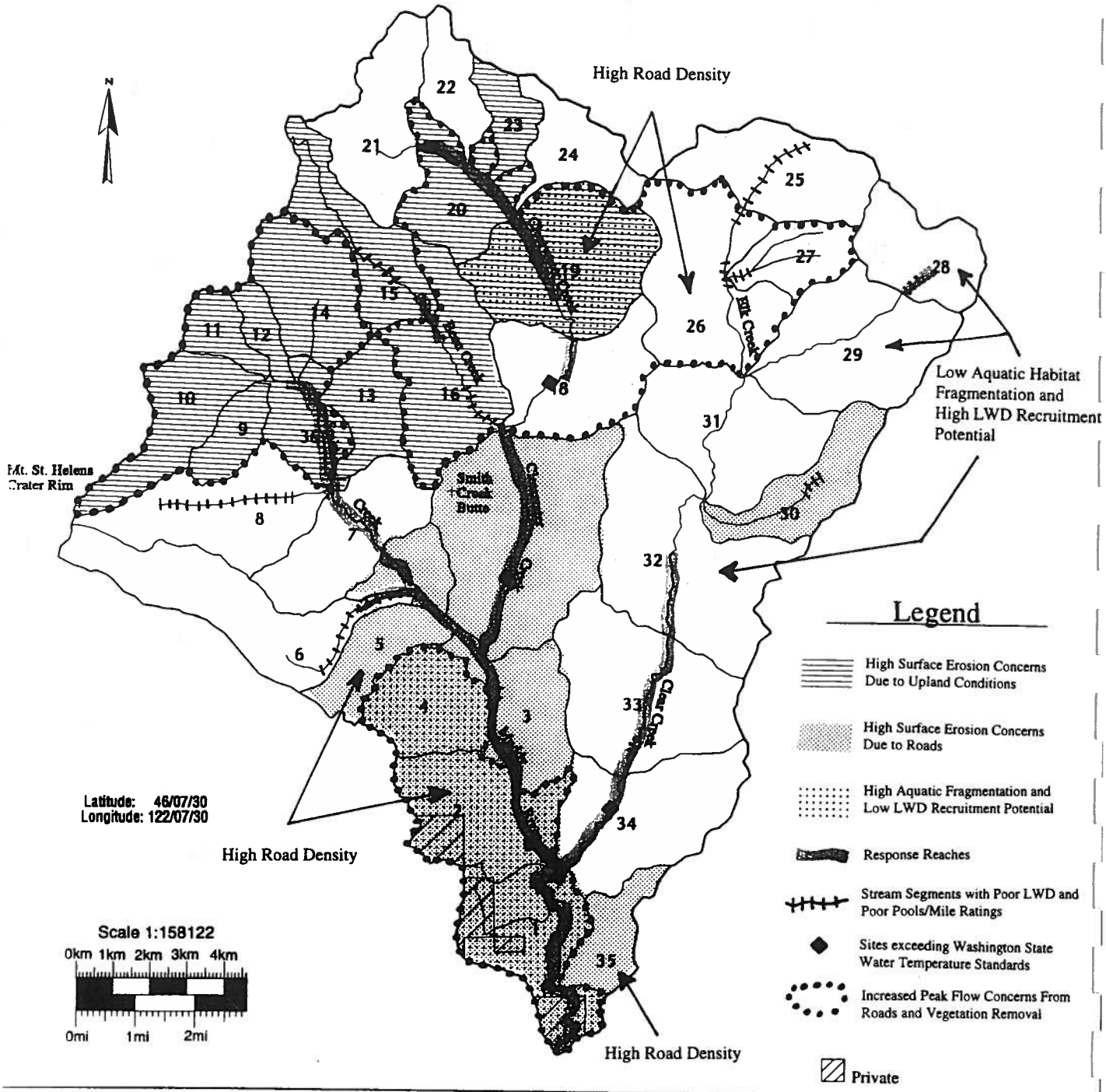

Figure 34. Synthesis of data showing sub-basins and stream reaches that have known problems, based on in-channel and up-slope conditions.

Terrestrial Synthesis Explanation

Volcanic eruptions, wildfire, timber harvest and road construction are natural and human caused processes which have altered the Muddy River landscape. The combination of these activities have left the area's forests highly fragmented. Currently interior forest habitats are sparsely scattered throughout the watershed but are located primarily in the LSR.

The watershed contains or is suspected to contain suitable habitat for several Federally listed, Region 6 sensitive and C-3 species. Animal species include the northern spotted owl, bald eagle, gray wolf, grizzly bear, wolverine, and Van Dyke's and Larch Mountain salamander. Plant species include *Pleuriscpora fimbriolata* and *Carex interrupta.*

The interior forest blocks may provide key habitat for species closely associated with late successional forest such as the northern spotted owl. Interior forest habitats and late successional forest blocks probably contain the largest snags at the highest densities. These areas are important for sustaining viable populations of snag dependent species.

A cluster of sub-basins located in the western section of the watershed, which provides winter range for deer and elk, have road densities of less than 1.7 miles per square mile. Several sub-basins have road densities of even less than one mile per square mile and offer seclusion to those species highly sensitive to human disturbance. These areas in the future may play a key role in maintaining healthy ungulate populations.

The vast majority of the large tree structure habitat is within the eastern side of the watershed. Where late-successional habitat is not available upslope, the importance of Riparian Reserves as habitat for many of the TES plants and C3 plants, lichens, mosses, and fungi becomes more critical. Sub-basins where the large tree component is less than 15 percent of the area and the Riparian Reserves are dominated by younger aged stands provide the least habitat for these important species. Not all of these younger stands were created through harvest operations and the habitat these stands provide varies.

Two areas within this watershed provide unique vegetation conditions. The Cedar Flats Research Natural Area was established as an example of old-growth, valley bottom, western red-cedar and Douglas-fir growing in the southwestern Washington Cascade Range. Mount St. Helens National Volcanic Monument was designated by Congress as a unique area where natural succession could continue substantially unimpeded after volcanic eruption. Both areas are extremely valuable for ongoing research and education.

Table 35. Terrestrial Synthesis

Sub-basin	NWFP Allocations	Lacking Large Areas of Int. Habitat	<15% Large Trees Structure Stage	>50% Riparian Reserve in Young/Mid Structure Stage	Likely Supports <40% Potential Pop. Of Cavity Excavators	Rd Densities >1.7 m/sq/m In Winter Range
1*	LSR,RNA,MAT				X	X
2*	LSR,MAT	X		X	X	X
3*	LSR		X	X		X
4*	LSR,MAT		X	X	X	X
5*	LSR,MAT		X	X	X	X
6*	NVM	X	X		X	
7*	NVM,MAT			X	X	
8	NVM	X	X		X	
9	NVM	X	X	X	X	
10	NVM	X	X	X	X	
11	NVM	X	X	X	X	
12	NVM	X	X	X	X	
13	MAT	X	X	X	X	
14	NVM	X	X	X	X	
15	MAT,NVM	X	X	X	X	
16*	MAT		X	X	X	
17*	LSR,MAT			X		
18*	LSR,MAT			X	X	X
19*	LSR,MAT			X	X	X
20	MAT,,LSR	X	X	X	X	
21	NVM,MAT	X	X	X	X	
22	LSR	X				
23	LSR,MAT			X		
24	LSR,MAT					
25	LSR					
26	LSR	X				
27	LSR					
28	LSR					
29	LSR					
30	LSR					
31	LSR					
32*	LSR		X	X		
33*	LSR		X	X		
34*	LSR		X	X		
35*	LSR					X
36	NVM, MAT	X	X	X	X	

* - Sub-basins which contain biological winter range.

Muddy River
Terrestrial Conditions

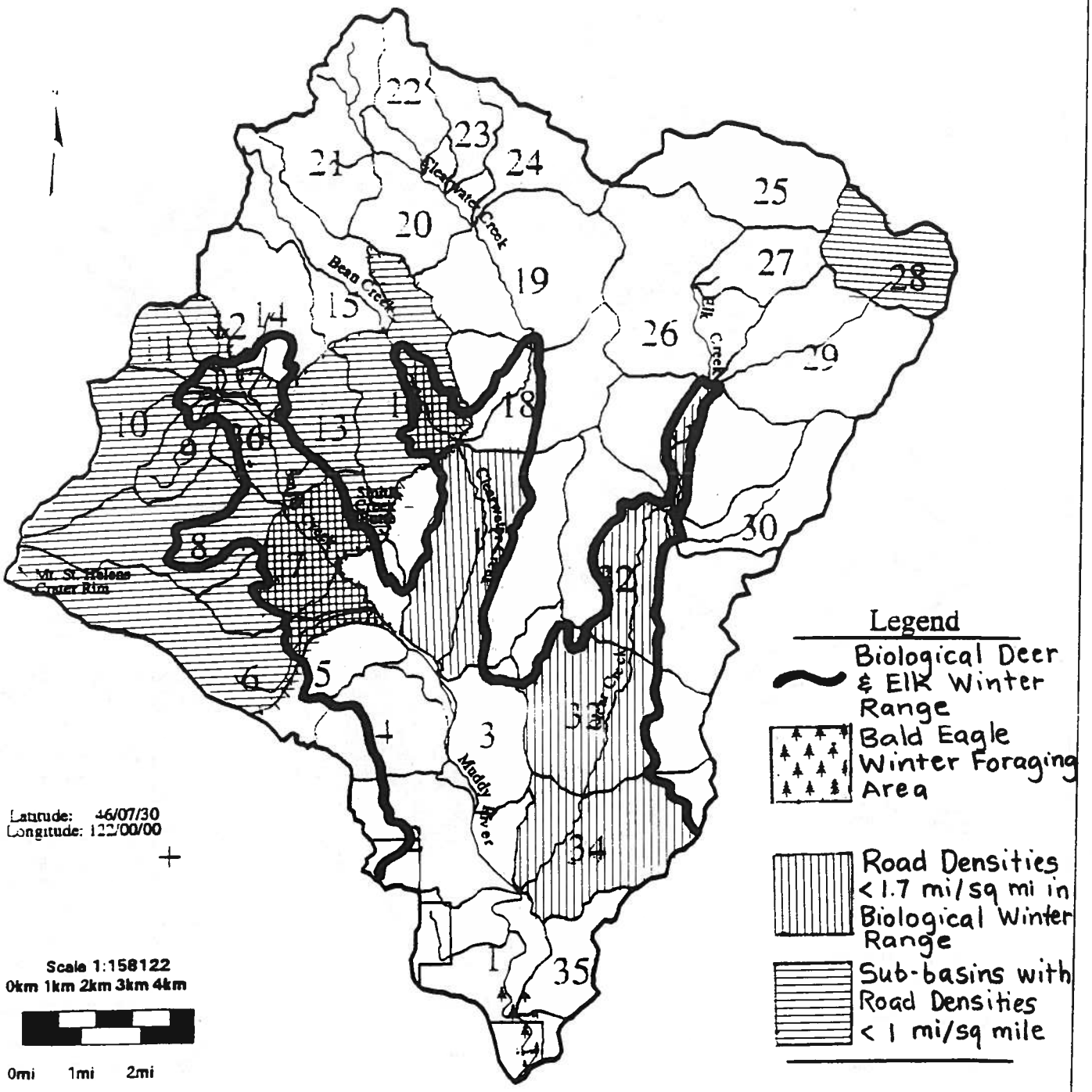

Figure 35. A cluster of sub-basins provide winter range for deer and elk and have road densities of less than 1.7 miles per square mile. Several sub-basins have road densities of less than one mile per square mile and offer seclusion to those species highly sensitive to human disturbance.

Muddy River
Terrestrial Conditions

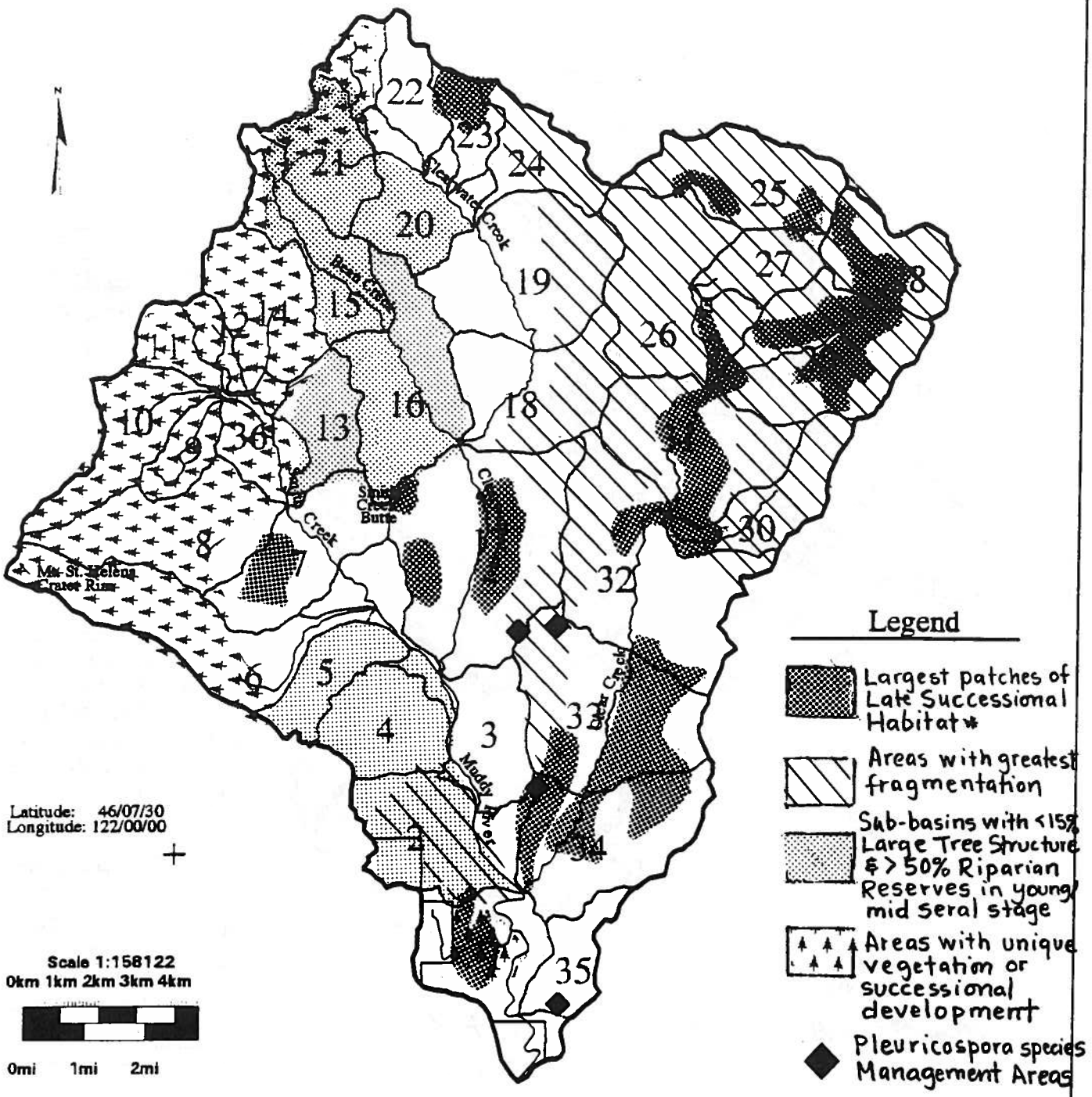

Figure 36. The majority of late-successional habitat is located in the eastern portion of the watershed where fragmentation is the greatest, but some scattered, large patches of late-successional habitat remain. Several sub-basins were identified as lacking late-succesional habitat (both upslope and within the Riparian Reserves).

* Stands with >15" tree diameter with a Structure Stage of

Recreation Synthesis Explanation

The synthesis table shows the three primary recreation issues related to the watershed: environmental impact caused by dispersed camp sites, conflict between trail users, and trail use not in compliance with the Gifford Pinchot National Forest Land and Resource Management Plan. The table is ordered by sub basin, with the highest priority at the top.

Serious environmental impact is taking place at two dispersed camp camping areas, Clear Creek and Spencer Meadow. In both cases vehicles are being driven into riparian areas, causing loss of habitat and impact to water quality.

Conflict between trail users is found on the Truman Trail, Spencer Butte Trail, and Craggy Peak Trail in the Dark Divide Roadless Area. Vehicles have been allowed to drive on the first two miles of the Truman Trail to provide easier access for researchers and field trips to the north slope of Mount St. Helens. As use of the Monument increases, the level of conflict between users increases. All three trails have moved from a low level of conflict to medium and are building to a high level.

The Forest Land and Resource Management Plan establishes allowed uses of trails. Four trails are out of compliance with the plan, the Truman Trail, Ape Canyon Trail, Spencer Butte Trail, and Craggy Peak Trail. The Truman Trail is listed as hiker only, but currently motorized researcher access and mountain bike use are taking place on the first two miles. The Ape Canyon Trail is listed as hiker only; however, mountain bike use is taking place. Spencer Butte Trail is receiving motorized use but is listed as a horse-hiker trail in the plan. The Craggy Peak Trail is listed as horse-hiker, but current motorized use is being allowed to continue until a mile-for-mile replacement of lost motorized opportunity can be substituted elsewhere on the forest.

Table 36. Social and Economic (Recreation) Synthesis

Sub Basin	Environmental Impact from Dispersed Camping	Unsatisfactory Conflict Between Trail Users	Trail Use Not in Compliance with Forest Plan
6		X	X
8		X	X
10		X	X
25		X	X
28		X	X
30		X	X
34	X		X

Note: Only those sub-basins of concern are shown

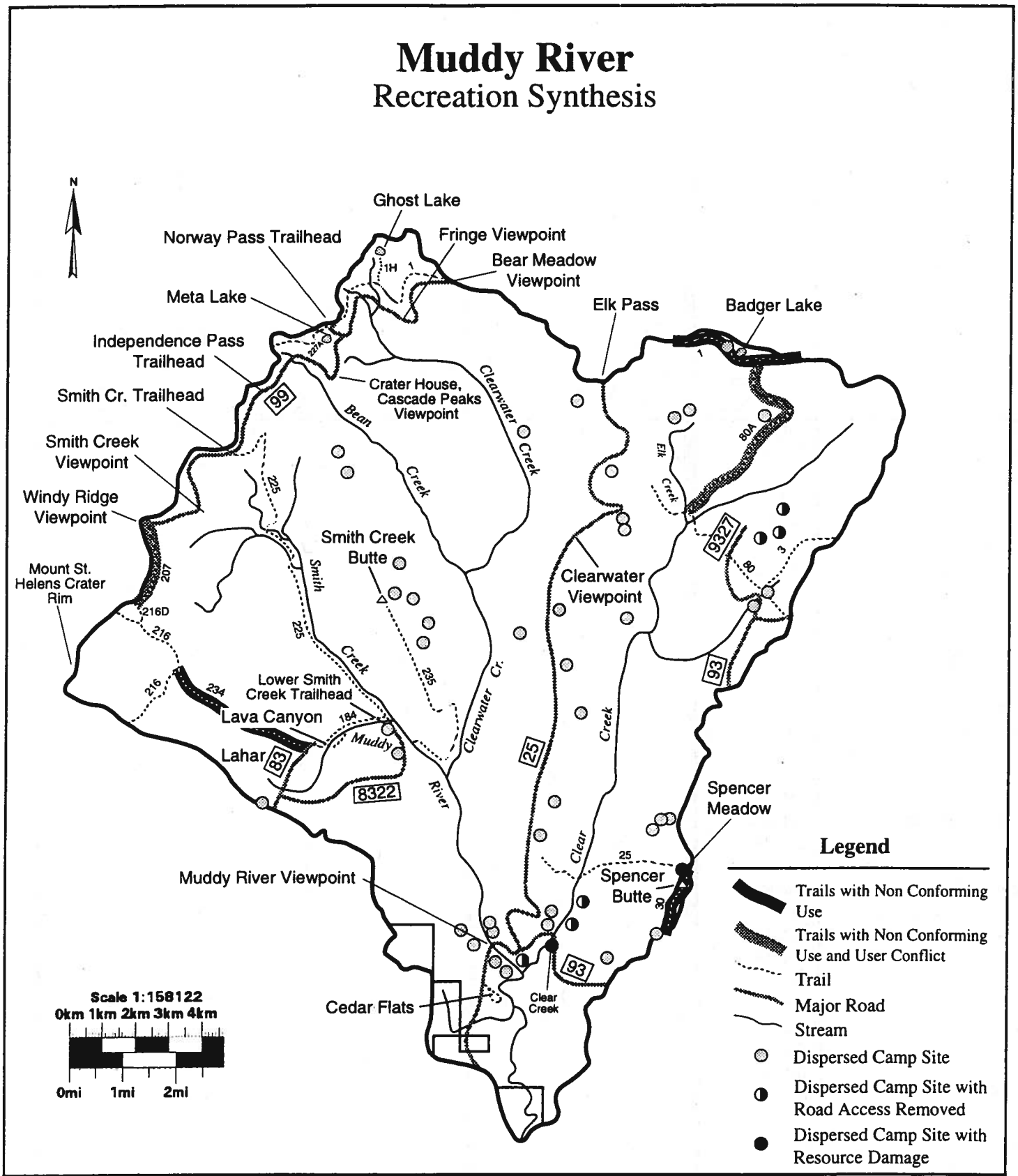

Figure 37. Synthesis of data showing areas with recreation problems, including user conflict, non conforming use, and resource damage at dispersed camp sites.

Table 37. Aquatic, Terrestrial, and Social and Economic Synthesis by Sub-basin

		AQUATC					TERRESTRIAL					SOCIAL & ECONOMIC		
	NWFP Allocations	High Aquatic Habitat fragmentation and Low LWD Recruitment Potential	High Risk of Increased Peak Flows	High Sediment Concerns	Extremely Poor Fish Habitat Conditions	High Water Temperatures	Lacking Large Areas of Interior Habitat	<15% Large Tree Structure Stage	>50% Riparian reserve in Young/Mid Structure Stage	Likely Supports <40% Potential Population of Cavity Excavators	Road Densities <1.7 sq mi/mi in Winter Range	Environmental Impact From Dispersed Camp	Unsatisfactory Conflict Between Trail Users	Trail Use Not in Compliance with Forest Plan
1 Cedar Flats	LSR,RNA,MAT	X	R	R	X	X				X	X			
2 Lower Muddy	LSR,MAT	X	R	R	X	X	X		X	X	X			
3 Middle Muddy	LSR			R	X			X	X		X			
4 Lower Muddy Tribs W	LSR,MAT	X	R	R	X			X	X	X	X			
5 Lahar	LSR,MAT			R				X	X	X	X			
6 Upper Muddy	NVM,MAT				X		X	X		X			X	X
7 Lower Smith Crk	NVM,MAT								X	X				
8 Ape Canyon	NVM				X		X	X		X			X	X
9 Upper Smith Tribs SW	NVM		V	U			X	X	X	X				
10 Upper Smith Tribs W	NVM		V	U			X	X	X	X			X	X
11 Upper Smith Tribs NW	NVM		V	U			X	X	X	X				
12 Upper Smith Tribs N	NVM		V	U			X	X	X	X				
13 Upper Smith Tribs E	MAT						X	X	X	X	X			
14 Upper Smith Crk	NVM		V	U			X	X	X	X	X			
15 Upper Bean Crk	MAT,NVM			U	X		X	X	X	X				
16 Lower Bean Crk	MAT		V	U	X			X	X	X				
17 Lower Clearwater Crk	LSR,MAT			R		X			X					
18 Middle Clearwater Crk	LSR,MAT		R			X			X	X				
19 Clearwater Crk	LSR,MAT	X	R	U		X			X	X				
20 Upper Clearwtr Crk Tribs	MAT,LSR		B	U		X	X	X	X	X				
21 Upper Clearwtr Crk	NVM,MAT						X	X	X	X				
22 Upper Clearwtr Crk Tribs N	LSR						X							
23 Upper Clearwtr Crk Tribs NE	LSR,MAT			U					X					
24 Upper Clearwtr Crk Tribs E	LSR,MAT													
25 Upper Elk Crk	LSR				X								X	X
26 Lower Elk Crk	LSR		R	R	X		X							
27 Hungry Crk	LSR		R		X									
28 Craggy Crk	LSR				X								X	X
29 Snider Pasture	LSR													
30 Wright Crk	LSR			R	X						X		X	X
31 Wright Meadow	LSR													
32 Wildcat Trail	LSR							X	X					
33 Spencer Butte	LSR				X			X	X					
34 Lower Clear Crk	LSR					X		X	X			X		X
35 Muddy River Tribs E	LSR			R										
36 Middle Smith Crk	NVM,MAT		V	U			X	X	X	X				
	R=From Roads, V=From Vegetation Conditions, B= From Roads & Vegetation													
	U=From Upslope Erosion													

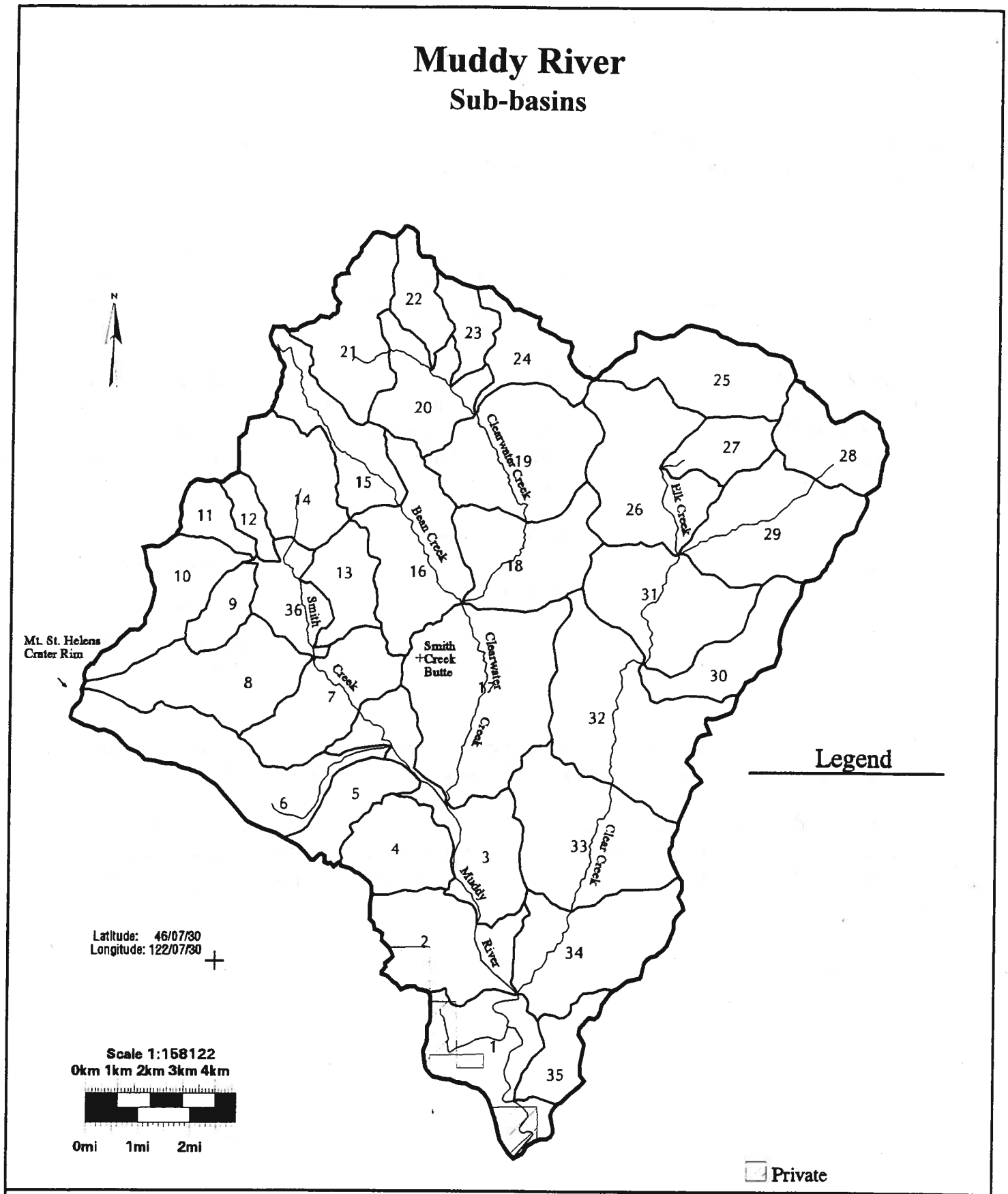

Figure 4. Sub-basins. For this analysis, the 86,913-acre Muddy River Watershed is divided into 36 sub-basins.

Anticipated Social or Demographic Changes or Trends

The trends in social use and values associated with this watershed reflect the diversity of those segments of the public who see themselves as stakeholders in the management of these lands. People will continue to seek both commodities and spiritual and emotional enrichment from the forest.

The demand for year-round recreational opportunities is primarily on weekends and holidays. Approximately two-thirds of the Vancouver and rural southwest Washington residents visit the Forest several times each year. Developed sites are full during peak seasons of use and the overflow moves out to dispersed recreation sites (Porter, December 1993).

Sightseeing, picnicking, camping, hiking, nature study, hunting, fishing, and winter sports are the most popular recreation activities for the Forest in order of participation. The demand for recreation activities from 1997 to 2000 is expected to exceed the Washington State population increase of 18 percent. Forecasted increases in activity demand are highest for Nature study, hiking, mountain biking, photography, and four-wheel-drive riding (Porter, December 1993).

It is expected that during the next decade the Forest can expect increased use primarily by middle-aged and older users with advanced education and higher disposable incomes, who will be looking for a greater variety of activities (Porter, December 1993).

The Forest Service anticipates an increase in illegal dumping, drug manufacturing, crime, and conflict between users. These adverse impacts could degrade the environment and decrease the quality of recreational experiences.

The demand for Special Forest Products will continue to increase and will create a need to develop additional regulations, and more closely control harvests on national forest land.

Attracted by the quality of life compared to other parts of the nation, people will be drawn to southwest Washington in greater numbers. With this population increases, the demand for housing is expected to increase. The need for a sustainable flow of wood products from the region will become more accute.

CHAPTER VI RECOMMENDATIONS

From the information gathered, synthesized, interpreted and displayed in previous chapters, the ID team identified those management activities that could move the system toward reference conditions or management objectives, as appropriate.

The recommended actions are grouped into three categories:

- Restoration Activities
- Monitoring Activities, and
- Activities associated with Commodities and Development

For each of the 21 recommended actions, an explanation of the rationale for the recommendation is presented. This is displayed under four sub-headings for each recommendation in turn, as follows:

A. What is it? Specific description of the recommended activity.

B. Ecosystem conditions and/or functions that would be altered, maintained, or restored.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

D. The anticipated rates and time-lines for achieving the management objectives.

Priorities: In the paragraphs describing each recommendation, the priority sub-basins to which a particular recommendation applies is shown.

For the restoration grouping, the types of recommendations are prioritized as High or Moderate as follows:

High	Road Decommissioning
Moderate	Road Weatherization
Moderate	Silvicultural Treatment of Upland Stands
Moderate	Silvicultural Treatment of Riparian Stands
Moderate	Stream Enhancement
High	Erosion Control/Slope Stabilization
Moderate	Snag Creation
High	Manage Dispersed Campsites

The team could see no purpose in applying priorities to the other two groupings: Monitoring and Commodities/Development.

It is expected that priorities will be used later to help decide which proposed projects will be

implemented when competing for limited funds. Decision makers are reminded the above priorities are based upon limited knowledge, and projects of higher priority may become known as more is learned about site-specific conditions on the ground.

The locations of recommended activities (by sub-basin) are shown in Table 38 Recommendations by Sub-basins. This table shows the full array of recommended activities where readers may see which sub-basins contain more than one recommendation.

Restoration Activity

ROAD DECOMMISSIONING

A. What is it?

Road decommissioning is the action of removing a road from the transportation system and returning to a stable configuration to revegetate and recover. This action includes but is not limited to culvert removal, construction of water bars and cross-drains to control surface water runoff (such as where ephemeral draws cross the roadway), fill slope removal in areas of unstable road fill, and subsoiling or ripping of the road running surface in areas of soil compaction.

Following equipment operations, all exposed soil is seeded and fertilized. Annual grasses such as cereal rye are utilized to provide quick cover while not adversely affecting the re-establishment of native vegetation (native species are preferred and if available will be used). Conifers may also be planted on these sites. Native species are preferred for re-establishment of vegetation. Finally, a closure berm is constructed to prevent vehicular access to the treated area.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

The purpose of decommissioning roads is to reduce habitat fragmentation in uplands and Riparian Reserves, erosion rates from roads, mass wasting hazards, and peak flows. It will also improve habitat quality for wildlife species that are sensitive to human activity and provide quality hunting, fishing, and recreation areas.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins on National Forest lands that are a high priority for this treatment include 1, 2, 4, 5 (Muddy River sub-basins); 17, 18, 19, 20 (Clearwater Creek sub-basins); 25 (Elk Creek sub-basin), 27 (Hungry Creek sub-basin); and 35 (Muddy River Tribs East sub-basin). Priority areas were identified as those places where multiple road related concerns exist. These include sub-basins that had high aquatic fragmentation, high road densities, high surface erosion, adjacent beneficial uses, sub-basins in winter range with road densities greater than 1.7 miles per square mile, and road related peakflow concerns.

Of particular concern, is FS Road 2560, in the Clearwater Creek sub-basin. Several places have had large failures which is causing resource damage to stream habitat within Clearwater Creek. This road should be decommissioned in order to prevent further sedimentation of streams and allowing the Aquatic Conservation Strategy objectives to be met.

Among restoration recommendations for the watershed, road decommissioning is given a high priority.

D. The anticipated rates and time frames for achieving the management objectives.

Benefits derived from reducing aquatic fragmentation begin immediately after project implementation. It takes 20 or more years to realize the benefits related to reducing upland habitat fragmentation. One immediate benefit is reduced sedimentation. The benefits relating to reduced surface erosion and reduced peak flows are realized within five years as vegetation is established on exposed soil. The time line for achieving these benefits is dependent on funding available later.

Restoration Activity:

ROAD WEATHERIZATION

A. What is it?

Road weatherization involves stabilizing a road that is not currently needed for transportation, but will be needed in the future (10-20 years from the present). This involves putting the road in a stable configuration that will not create resource damage while requiring a minimum of road maintenance. This action includes but is not limited to construction of water bars and cross-drains to control surface water runoff (such as where ephemeral draws cross the roadway), fill slope removal in areas of an unstable road fill, and to a lesser extent, culvert removal and to subsoiling or ripping of the road running surface in areas of soil compaction.

Following equipment operations, exposed soil is seeded and fertilized. Annual grasses such as cereal rye are utilized to provide quick cover while not adversely affecting the re-establishment of native vegetation. Finally, a closure berm is constructed to prevent vehicular access to the treated area.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Weatherizing roads reduces surface erosion rates from roads, including the cut banks and fill slopes. It also reduces the amount of surface water flow, helping to reduce peak flows in the watershed.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins where this treatment is a priority are those primarily in Matrix, which have a high road density, and where surface erosion is a concern, but where roads are needed for future timber sales or for fire control purposes.

Isolated roads or individual that are a high priority for this treatment are located in sub-basins: 1, 2, 4 (Muddy River sub-basins), and 17 (Clearwater Creek sub-basin).

Among restoration recommendations for the watershed this is given a moderate priority. Isolated opportunities exist for this type of activity in this watershed.

D. The anticipated rates and time frames for achieving the management objectives.

Benefits relating to decreased surface erosion and mass wasting will take up to five years as vegetation establishes on exposed soil. Some immediate benefits will be derived relating to peak flow decreases by allowing moisture to infiltrate the soil profile in ripped areas, routing flow away from road ditch lines. Another immediate benefit is reduced sediment that results from vehicle use on these roads. The time line for achieving these benefits is dependent on availability of restoration funding.

Restoration Activity:

SILVICULTURAL TREATMENTS TO ACCELERATE DEVELOPMENT OF RIPARIAN SAPLING/POLE & SMALL TREE STANDS.

A. What is it?

Release of under story conifer trees by cutting overtopping hardwood trees will accelerate development of large conifer trees in riparian areas where large conifers are scarce. Crews walk to scattered hardwoods between 100 and 300 feet from stream channels and use chain saws to fall hardwood trees directly overhead and adjacent to young conifer trees. Trees are left in place where they fall. This treatment is recommended for riparian hardwood stands with a small component of conifers in the under story. The objective is to encourage development of a mixed stand of hardwoods and large conifers.

Interplanting of conifer tree seedlings to increase the conifer component of riparian stands enhances species and structure diversity and allows for future recruitment of quality large woody material. Conifer seedlings (western red cedar, western hemlock, and Douglas-fir) are hand planted in areas where vegetation or species diversity is lacking. Trees are planted between 100 feet and 300 feet from channels, in existing openings or small openings which are created with chain saws to facilitate open growing of seedlings. Seedlings may be protected with vexar tubing or netting to prevent browse damage.

Thinning of conifers in riparian areas will accelerate development of large conifer trees: Chain saws are used to fell young conifers. Trees are left in place where they fall. Minor species in the stand are favored as leave trees to promote species and structure diversity. In riparian reserves, emphasis is on thinning wide enough to avoid the need for future thinning or other stand manipulation (falling of larger trees may be more likely to result in soil disturbance).

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Over story release provides conifers with additional light and, to a lesser degree, moisture and nutrients. Conifers respond with accelerated diameter growth. Interplanting of conifers enhances species diversity. Thinning of conifers results in fewer trees using limited resources and residual trees respond with accelerated diameter growth. Accelerating conifer development in riparian areas provides quality future habitat for fish and wildlife and reduces erosion and peak flows.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Treatments are conducted spring through fall when areas can be accessed.

These treatments are a priority in sub-basins with riparian areas lacking in large conifers. The highest priority sub-basins to evaluate for treatment are 1, 2, 4 (Muddy River sub-basins), and 19 (Clearwater Creek sub-basin). These four sub-basins have had high riparian harvest, are highly fragmented, and have streams with both poor LWD and poor pool ratings. Other priority sub-basins to evaluate include 5 (Muddy River sub-basin), 7, 13 (Smith Creek sub-basins), 15, 16 (Bean Creek sub-basins), 18, 20 - 24 (Clearwater Creek sub-basins), 30 (Wright Creek sub-basins) and 35 (Muddy River Tribs East sub-basin).

Potential treatment areas should be walked by an integrated resource staff group with expertise from silviculture, watershed/fisheries, and wildlife/ecology to evaluate site specific treatment needs and methods.

Among restoration recommendations for the watershed, these treatments were assigned a moderate priority. Treatments that create large wood will provide long-term results.

D. The anticipated rates and time frames for achieving the management objectives.

Treatments will generally take place within 1 to 3 years after the need is identified. Silvicultural treatments enhance movement towards desired conditions but many years of stand growth, natural disturbance, and other dynamics contribute to gradual development of desired conditions.

Restoration Activity

SILVICULTURAL TREATMENTS TO ACCELERATE DEVELOPMENT OF UPLAND SAPLING/POLE & SMALL TREE STANDS.

A. What is it?

Noncommercial thinning (including precommercial thinning): Chain saws are used to fell trees in young stands (sapling/pole or small tree stands). Felled trees are left in place where they fall. Minor species in the stand are commonly favored as leave trees to promote species and structure diversity. Leave trees are irregularly spaced to promote structure diversity. Noncommercial thinning on Matrix lands is called precommercial thinning and occurs in closed sapling/pole stands with trees less than 8 inches D.B.H.

Commercial thinning occurs in stands of closed small tree stands, generally about 8 inches to 15 inches D.B.H.. Felled trees are bucked and yarded to a landing and are hauled to markets by truck.

Fertilization: Helicopters are used to spread nitrogen fertilizer in urea form over young managed stands which have been previously thinned. Application is done in the spring or fall when temperatures are relatively cool but not during heavy rains.

Pruning: Branches are removed from selected young conifer trees up to 18 feet from the base of the tree to increase the wood quality of trees.

Interplanting and planting: Tree and shrub seedlings are hand planted in areas where vegetation or species diversity is lacking.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Silvicultural treatments are applied to forest stands to accelerate the development of desired vegetation conditions. Treatment prescriptions vary depending on the land allocation (MAC) and specific stand objectives. The majority of Matrix lands within this watershed are comprised of sapling/pole stands. Thinning, fertilization and/or pruning treatments are needed in these plantations to increase conifer growth, maintain stand vigor, and meet management objectives. Outside of Matrix lands, silvicultural treatments can be applied to increase understory development, accelerate the growth of large trees, and create diversity where it is lacking.

Thinning treatments are prescribed to accelerate the development of larger diameter trees. Cut trees can be left on site or removed as commercial timber. Cutting and/or removing these trees allows increased light into the stand resulting in the development of larger, fuller crowns in the overstory and the growth of shrubs, forbs and smaller trees in the understory. Selection and spacing of trees can be specified to increase species and structure diversity for wildlife habitat, increase the growth and value of stands for timber production, and provide root strength and snow interception for watershed protection.

Fertilization results in a temporary increase in available nitrogen (approximately 10 years duration). Trees respond with accelerated height and diameter growth. Because fertilization is generally applied in conjunction with or after thinning treatments, the resulting vegetation conditions vary depending on the number of trees, species, spacing, age and vigor of the forest stand. Fertilization can be used to accelerate conditions favorable for wildlife, watershed protection, or timber production.

Pruning: Removal of conifer branches result in higher quality wood, increased shrub and forb development, and increased structure diversity within young stands.

Interplanting and planting results in establishment of diverse vegetation on exposed sites. This initiates or enhances development of quality wildlife habitat and reduces erosion and peak flows.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Noncommercial stand thinning treatments are recommended:

(a) in sub-basins where peak flows are a problem

Sub-basins 16, 20, and 36.

(b) in areas within the LSR where accelerated successional development will reduce fragmentation of existing or soon-to-be late-successional habitat.

Sub-basins 1,17,29,31,32,33, and 34

(c) on lands managed for timber growth and yield

Precommercial thinning is recommended for sub-basins 1,2,4,6,7,13,15,16,17,18,19,20,21

Commercial thinning opportunities on lands suitable for timber management are identified in the recommendations for timber harvest. Opportunities also exist to thin some of the stands within the LSR to accelerate the development of characteristics associated with late-successional habitat. Most of these stands are unmanaged and thinning opportunities would depend on access and economics. Where roads are not present, thinning would need to be accomplished by helicopter. Sub-basins where thinning would benefit the LSR the most include 1,17,29,31,32,33, and 34. The greatest number of acres less than 80 years old with merchantable timber are in sub-basins 30,31,32 and 33.

Fertilization opportunities exist in sapling/pole or small tree stands between 15 and 80 years of age which have been thinned. Previously thinned units were not identified as part of this analysis. Opportunities to fertilize previously thinned or proposed thinning units exist on Matrix lands (sub-basins 1,2,4,6,7,13,15,16,17,18,19,20,21) and will be identified as part of proposed silvicultural projects within the watershed.

Pruning opportunities will occur on Matrix lands (sub-basins 1,2,4,6,7,13,15,16,17,18,19,20,21) and will also be identified as part of proposed silvicultural projects within the watershed.

Specific interplanting and planting projects in all sub-basins outside of the MSHNVM should be identified as additional fieldwork or project planning occurs.

These types of treatments are a moderate priority in the group of restoration activities.

D. The anticipated rates and time frames for achieving the management objectives.

Treatments will generally take place within 1 to 3 years after the need is identified. Silvicultural treatments enhance movement towards desired conditions but many years of stand growth, natural disturbance, and other dynamics contribute to gradual development of desired conditions.

Restoration Activity:

STREAM ENHANCEMENT

A. What is it?

Stream channels would be modified through the addition of LWD or boulders to create additional or higher quality salmonid habitat. Structures could be added in several ways 1) large machinery used to place boulders/LWD, 2) helicopters used to place boulders/LWD 3) hand winching of existing on-site material into different locations or 4) a combination of one or all of these methods. Large woody debris would not be removed from existing riparian areas, but instead would be located through reconnaissance of blow-down sites, and from other off-site locations.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Channel morphology indicates that specific reaches are better able to "use" large woody debris. These reaches are likely suitable for stream enhancement of existing condition to bring the channel into the range of natural variability for pools per mile and pieces of LWD per mile. Channels would become more complex, and pools would be created enhancing salmonid habitat for both spawning and rearing.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Stream enhancement projects should be done only after upslope stabilization problems have been corrected. Enhancement activities could proceed after an intensive stream survey of the reach is completed, and designs for the structures are developed. Design of the project would receive peer review prior to implementation. Work would likely occur during the late summer (low water times). Sub-basins where this activity may be appropriate include: 25, 26 (Elk Creek sub-basins), 27 (Hungry Creek sub-basin), 28 (Clear Creek sub-basin), and 30 (Wright Creek sub-basin).

Among restoration activities, this is rated as a Moderate priority.

D. The anticipated rates and time frames for achieving the management objectives.

Time frames for this activity are dependant on receiving restoration funding. A project of this scope and scale could cost as much as $100,000, and would need to be prioritized with other restoration activities both in this sub-basin and across the Forest.

Restoration Activity

EROSION CONTROL/SLOPE STABILIZATION

A. What is it?

Erosion control/slope stabilization is the action of stabilizing actively eroding areas such as mass wasting sites, dispersed recreation sites, rock quarries, road cut and/or fill slopes, and stream banks, in an effort to reduce sediment input. This involves primarily soil bioengineering techniques such as planting trees and shrubs, live fascine bundles and live staking, erosion control blankets, hydromulching, and installing live cribwalls.

B. Ecosystem conditions and/or functions that would be altered, maintained or restored?

The major condition restored are sediment regimes that more reflect historic conditions.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins where this treatment is a priority are those areas that are known or suspected sediment sources that have the potential to deliver sediment to beneficial use areas. These sub-basins are outside of the Legislative Monument only.

Sub-basins that are a priority for this treatment are: 34 (Clear Creek sub-basin), 13 (Smith Creek sub-basin), 15, 16 (Bean Creek sub-basins),and 19, 20, and 23 (Clearwater Creek sub-basins).

Among restoration recommendations for the watershed this is given a high priority.

D. The anticipated rates and time frames for achieving the management objectives.

Benefits relating to reducing surface erosion and mass wasting will take three to five years after project implementation to begin to see results of reduced sedimentation. This is due to the time necessary for the vegetation to establish on exposed soil. Time frames for achieving these benefits are dependent on availability of restoration funding.

Restoration Activity

SNAG CREATION

A. What is it?

Create snags in future harvest units that are in addition to what is normally done to meet Forest Plan standards (habitat sufficient to provide for 40 percent of the potential population of cavity excavators). This is recommended to partially compensate for a lack of standing dead trees in clearcuts and burned-over areas, and would be implemented in future harvest units that are adjacent to clearcuts or other stands devoid of snags.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Snag densities in identified sub-basins in the watershed are below levels specified in the Forest Plan. This restoration project would move snag habitat closer to the desired condition for Matrix lands.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins completely or partially occupied by the Matrix allocation where snag densities are likely below what is needed to provide for 40 percent of the potential population are: 1, 2, 5, 7, and 19. The work is most likely to be done with KV funds that are collected on any future timber sales in these sub-basins.

Snag creation has a moderate priority in the grouping of restoration activities.

D. The anticipated rates and time frames for achieving the management objectives.

In addition to created snags, snag levels in the watershed will increase through natural mortality. Even so, it will take many years or decades to achieve the desired condition.

Restoration Activity:

MANAGE DISPERSED CAMPSITES

A. What is it?

Dispersed camping is camping outside of developed campgrounds, and is generally allowed on national forest lands. If conflicts develop with managing other resources, camping may be prohibited or limited to designated areas.

Within this watershed are found 48 dispersed camp sites. Many of these are located along the edges of roads, while others can be reached only by horseback or hiking. Camp sites are unevenly distributed, with some close to each other, and even blending togeather, while others are isolated. At some locations campers have developed primitive roads by driving their vehicles through the woods to the camp sites. At Clear Creek, vehicles are being driven into the stream, and at Spencer Meadow a 1/4 mile long user-road has developed. Accumulations of horse manure, straw, trash, abandoned camping equipment, and human waste present environmental and health problems at some heavily used sites.

B. Ecosystem conditions and/or functions that would be altered, maintained or restored?

The objective of this recommendation is to manage dispersed camping consistent with sound recreation management practices. Dispersed recreation is a recognized use of national forest lands, and is permitted when impact is within an acceptable range.

Two camp sites have been identified as posing damage to wildlife habitat, and impact to water quality. Use of these sites, listed below, will be modified or eliminated.

1. Clear Creek. Vehicle access will be limited by physical barriers to prevent driving into the stream.
2. Spencer Meadow. Vehicle access will be removed from camp sites situated in the riparian protection zone surrounding the meadow. In the future vehicles will be restricted to parking along Road 93. Spencer Butte Trail No. 30 will be extended to a trailhead parking area on Road 93.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Areas of concern are located in sub-basin 34.

D. The anticipated rates and time frames for achieving the management objectives.

Modifications to vehicle access will be made during road decommissioning projects by the fall of 1999.

Monitoring Activity:

STREAM TEMPERATURE.

A. What is it?

Monitoring to ensure that stream temperature is within State water quality standards, and if not, identify where problems exist.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Maintain or restore the functions of aquatic ecosystems that depend upon cold water temperatures.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins within National Forest lands include: 17, 18, 19, 20 (Clearwater Creek sub-basins), 1, 2 (Muddy River sub-basins), 34, 33, 32, and 31 (Clear Creek sub-basins) are priorities for this monitoring.

There is a high need for this type of monitoring.

D. The anticipated rates and time frames for achieving the management objectives.

Identifying areas that are not within State water quality standards could happen within a short time if funding is received. However identifying the causes of water temperature problems within a reach, would probably not be done until the next iteration of watershed analysis in the watershed.

Monitoring Activity:

STREAM SURVEYS.

A. What is it?

Stream surveys would collect data on the condition of aquatic and riparian habitat, and may include characterization of riparian vegetation, channel type and stability, bank stability, substrate type, and fish species present and their distribution.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Collecting stream survey data would help to identify which stream reaches do not meet the desired condition. These streams would then be a priority for restoration.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins that are a priority for this monitoring are those for which there is no existing stream survey data, and/or where there is a high likelihood of future management actions. These National Forest land sub-basins in prioritized order are: 17, 18, 19, 20, and 21 (Clearwater Creek sub-basins), 34, 33, 32, 31, 29, and 28 (Clear Creek sub-basins), and 3, 7-14 and, 36 (Smith Creek and Ape Canyon Creek sub-basins). Streams within the remaining sub-basins should also be surveyed.

Since this type of monitoring is ongoing, there is only a medium priority to emphasize in comparison to other monitoring needs.

D. The anticipated rates and time frames for achieving the management objectives.

Stream surveys are completed at a rate of about12-20 miles per year (over the entire Lewis River Watershed), depending on availability of funding and management activity levels. There are approximately 82 miles of Class I and II streams in the Muddy River Watershed sub-basins that have not been surveyed. At current funding and management activity levels these surveys would be completed within a minimum of four to seven years.

Monitoring Activity:

LAKE SURVEYS.

A. What is it?

Lake surveys would collect data on the condition of aquatic and riparian habitat, and may include characterization of riparian vegetation, littoral zone type, bank stability, inlet and outlet habitat condition, substrate type, zooplankton and phytoplankton populations, water chemistry, and fish species present and their condition.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Collecting lake survey data would help to identify which lakes do not meet the desired condition. These lakes would then be a priority for restoration.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins that are a priority for this monitoring are those for which there is no existing lake survey data, and/or where there is a high likelihood of future management actions. These National Forest land sub-basins in prioritized order are: 21 (Meta, Ghost and Curtis Lakes--Clearwater Creek sub-basins), 15 (St. Charles Lake--Bean Creek sub-basin), 25 (Badger Lake--Elk Creek sub-basin), and 3 (Crane Lake--Muddy River/Smith Creek sub-basin).

Since this type of monitoring is ongoing, there is only a medium priority to emphasize in comparison to other monitoring needs.

D. The anticipated rates and time frames for achieving the management objectives.

Lake surveys are completed at a rate of about 10 acres per year, depending on availability of funding and management activity levels. None of the lakes (28 acres) in the Muddy River Watershed sub-basins have been surveyed. At current funding and management activity levels these surveys would be completed within a minimum two to three years.

Monitoring Activity:

PHASE II ROAD CONDITION SURVEYS

A. What is it?

Inventory of road conditions for all system roads. A protocol is already in place to identify a variety of road related conditions that help in determining whether particular roads are causing, among other things, resource damage. This information is used for many programs including restoration, road maintenance, and project planning. This inventory has not been done on any roads in the analysis area.

B. Ecosystem conditions and/or functions that would be altered, maintained or restored?

The inventory would identify locations where unacceptable resource damage (mainly sedimentation) is occurring and areas where resource damage has a potential to occur. Mitigation to reduce the impacts could then be proposed and implemented.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins where the inventory would be a priority are those with high road densities and high sediment concerns: 1, 2, 3, 4, 5 (Muddy River sub-basins), 15 (Bean Creek sub-basin), 17, 18, 19, 20 21, 24 (Clearwater Creek sub-basins), 25, 26 (Elk Creek sub-basins), 27 (Hungry Creek sub-basin) 29, 31, 34 (Clear Creek sub-basins) 30 (Wright Creek sub-basin) and 35 (Muddy River Tribs East sub-basin); although this inventory is a priority to conduct throughout the analysis area.

This is high priority monitoring.

D. The anticipated rates and time frames for achieving the management objectives.

Completion of phase II road surveys would be the first step in a restoration program aimed at achieving management objectives dealing with sedimentation and aquatic habitat fragmentation.

Monitoring Activity:

VERIFICATION OF ECOLOGICAL INVENTORY DATA.

A. What is it?

Much of the vegetation, soil, and water data used in this analysis is from air photo and map analysis and has not been field verified. The highest priority need is verification of locations of and ecological conditions within large tree stands, and locations and ecological data for TES species, C-3 species, class IV streams, and wetlands. Very little of the watershed has been surveyed for TES or C-3 species. This watershed is unique, however, in the amount of research conducted. Some of this information has been published or is otherwise available. Lichen and C-3 inventories have also been completed within the Cedar Flats RNA.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

On-site collection of data or field verification of ecological conditions would help provide a better information source for the management of the watershed. An accurate inventory will enable better decisions to be made regarding potential projects.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

The Forest's Ecological Unit Inventory (EUI) is scheduled to be completed within 5 years. This project will map forest stands according to vegetation type, soil, and geology. Surveys for TES and C-3 species, and the location of Class IV streams and wetlands will occur in conjunction with planned projects within the area. Since most projects are anticipated to occur in the Matrix, a higher amount of field verification is expected to occur in Matrix lands than in Administratively Withdrawn areas. Ongoing research within the watershed will continue to provide additional information.

D. The anticipated rates and time frames for achieving the management objectives.

The amount of funding available along with the scope of issues will determine actual survey priorities and accomplishment levels.

Monitoring Activity:

NORTHERN SPOTTED OWL

A. What is it?

Monitoring for the northern spotted owl site centers in the LSR.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

The objective of this monitoring is to increase knowledge about the fecundity (birth rate), death rate and survival-ship of northern spotted owls in the LSR. This action will vaild the assumptions made in the Northwest Forest Plan.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins that are a priority for this monitoring are those that are within the LSR and contain known site centers. Sub-basins with the highest priority are: 1, 2, 3, 4, 17, 18, 25, 26, 28, 29, 31, 32, and 34.

Surveys would be done according to established Pacific Northwest Region protocol, which requires surveys to be conducted generally in March through August.

D. The anticipated rates and time frames for achieving the management objectives.

Monitoring should begin as soon as funding is available, or in coordination with habitat inprovement projects the are planned in the reserve. Increased knowledge gained from monitoring would be an immediate benefit.

Monitoring Activity:

PEREGRINE FALCON

A. What is it?

Monitoring of potential peregrine falcon nest site.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

The objective of this monitoring is to assess Spencer Butte and determine if contains highly suitable nesting habitat for peregrine falcons. This would allow better decisions to be made in the future regarding what is needed to manage this species.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Sub-basins that are a priority for this monitoring include Sub-basin 32 and 33. Surveys would be done in early spring.

D. The anticipated rates and time frames for achieving the management objectives.

Monitoring should begin as soon as funding is available. Increased knowledge gained from monitoring would be an immediate benefit.

Monitoring Activity:

BALD EAGLE

A. What is it?

Monitoring of potential bald eagle nest site.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

The objective of this monitoring is to assess an unfirmed bald eagle nest that was reported some time between 1989 and 1990. It will allow better decisions to be made in the future regarding what is needed to manage this species.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

The priority sub-basin for this monitoring is Sub-basin 3. Surveys would be done in early spring.

D. The anticipated rates and time frames for achieving the management objectives.

Monitoring should begin as soon as funding is available. Increased knowledge gained from monitoring would be an immediate benefit.

Monitoring Activity:

RECREATION USE

A. What is it?

Monitor changes in recreation use through use of traffic counters located on roads 83 and 25, 99, and 93. By measuring traffic volumes, total visitor use of the area can be calculated. By comparing this data with previous years, trends in recreation demand can be tracked.

Monitor changes in recreation use at the six lakes (Meta, Ghost, Crane, Curtis, St. Charles and Badger) through use of recreational information forms which could be posted at access areas.

B. Ecosystem conditions and/or functions that would be altered, maintained or restored?

Monitoring will identify areas where use levels are changing, and where use conflicts are developing. By monitoring for peaks in recreation use, strategies can be developed to better accommodated use, and identify areas where changes in facilities are needed.

Monitoring will identify lakes where use levels are high and identify the type of recreational activity being performed at the lake (i.e. angling, camping, hiking, etc.). By monitoring the type of recreation and level of use at the lakes, strategies can be developed to accomodate this use.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Monitoring would be conducted year-round on roads providing access to all sub-basins in the watershed.

Monitoring would be conducted year-round once recreational information forms are developed with the assistance of WDFW.

D. The anticipated rates and time frames for achieving the management objectives.

Traffic monitoring is currently active and will continue indefinitely.

Benefits would be determined by the number of forms filled out and the quality of information provided by the recreational user.

Monitoring Activity:

DISPERSED CAMPING

A. What is it?

Dispersed camp sites exist throughout the watershed, primarily used by hunters, but also by hikers, and families during the summer. Dispersed camp sites have developed through the initiative of recreation users, mostly through repeated use of a location over many years. Since these sites fall outside Forest Service development standards, resource damage can sometimes take place because they are too close to streams, or other sensitive areas.

B. Ecosystem conditions and/or functions that would be altered, maintained or restored?

Monitoring will identify camp sites where use levels or impacts are changing, and where unacceptable environmental impacts are taking place. By monitoring for changes in use, it will be possible to identify sites where changes in use may be needed.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Monitoring activity will take place throughout the watershed

D. The anticipated rates and time frames for achieving the management objectives.

Monitoring of dispersed camping is currently active, and takes place yearly, during hunting season. This monitoring will continue.

Commodities and Development:

OPPORTUNITIES FOR TIMBER HARVEST

A. What is it?

Timber harvest is a scheduled activity on lands designated suitable for timber management. Approximately 20% of this watershed is comprised of Matrix lands. Approximately 12% of this acreage is Riparian Reserve where no timber harvest is scheduled. The remaining 8% is designated as land where timber management is emphasized.

B. Ecosystem Conditions and/or functions that would be altered, maintained or restored?

Timber offered will provide commodities for human use, as well as other social and economic benefits.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

Out of the 7,379 acres within the watershed that are suitable for timber management, approximately 750 acres (less than 1% percent of the watershed) have merchantable timber. Only about one third of this acreage is suitable for commercial thinning or regeneration harvesting. Over half of this timber is located in sub-basin 17. Other patches greater than 50 acres are in Sub-basins 2,6,and 7. Over half of these stands are 101 to 150 years of age. About a third are younger. Total timber volume available within this watershed likely ranges from 7 to 17 MMBF. Opportunities for commercial thinnings or small regenration openings may be the most feasible harvest option in these sub-bains at this time.

Access into sub-basin 17 is a problem and will need to be assessed as part of any timber sale planning process. Possible timber haul routes include Road 2562 which accesses Smith Creek Butte to Road 99 (Windy Ridge Road) or the 2560 Road. Both 2560 and 2562 are currently causing resource damage and are being recommended for decommissioning. Helicopter logging may be a feasible alternative.

D. The anticipated rates and time frames for achieving the management objectives.

The opportunity exists for a timber sale this decade within the Muddy watershed. It is likely that this sale will occur within the next 5 years.

Commodities and Development

CONFLICT BETWEEN TRAIL USERS

A. What is it?

Conflict between trail users takes place when anticipated recreation experiances are not met. These normally take place between more obtrusive and less obtrusive trail users. An example is mixing motorized and foot traffic on the same trail. The motorized user feels or sees no conflict, while the non-motorized user becomes offended by the noise, smell, and failure to achieve an expected recreation experience. Similar conflicts take place between other users, some of which pose a risk of physical harm to the subordinate user, such as when horses are frightened by quickly appearing mountain bikes. (See Chapter III for an explanation of conflict between users.)

B. Ecosystem conditions and/or functions that would be altered, maintained or restored?

Under this proposal, the following actions will be taken.

1. Motorized use will be removed from trails in the Dark Divide roadless area (Boundary No. 1, and Craggy Peak No. 3. This action will be taken when "mile-for-mile" replacement motorized trail can be provided elsewhere on the Gifford Pinchot National Forest. During road decommissioning, opportunities will be assessed for creation of replacement trail mileage.
2. Truman Trail No. 207, between Windy Ridge and the debris avalanche, will be designated as a non-motorized trail as directed by the Forest Plan. Researcher access is currently permitted using vehicles. This road will no longer be maintained for vehicles, and will be permitted to revert to a trail.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

These conflicts occur in sub-basins 10, 25, 28, and 29. The highest priority is the Truman Trail in sub-basin 10.

D. The anticipated rates and time frames for achieving the management objectives.

These actions will be completed by the year 2000, when most road decommissioning will be completed.

Commodities and Development:

NON-CONFORMING TRAIL USE

A. What is it?

The Gifford Pinchot National Forest Land and Resource Management Plan established allowed uses of trails in the Forest. Several trails in the watershed are out of conformance with the Forest Plan. Those in the Dark Divide Roadless Area are designated as non-motorized, but the implementation of the designation is delayed until a "mile-for-mile" replacement of motorized trail can be provided (see Conflict Between Users, Chap. VI). Other trails such as the Truman Trail No. 207, and Ape Canyon No. 234 have motorized and mountain bike use, respectively, which also do not conform to the Forest Plan.

Mountain biking was a minor trail use at the time of forest plan development, and was not considered in detail. In the past five years mountain biking has become increasingly popular, and is beginning to impact other users on certain trails. The Ape Canyon and Truman Trails form a popular mountain bike route on the east side of Mount St. Helens, causing an increased conflict between users

B. Ecosystem conditions and/or functions that would be altered, maintained or restored?

Under this proposal, the following actions will be taken.

1. Forest Plan direction will be followed in removing motorized used from the Dark Divide Roadless Area.

2. Mountain bike use on the Ape Canyon and Truman Trails will be allowed to continue until a forest-wide assessment of mountain bike use is completed.

C. Appropriate timing, sequencing, and general location. Show priorities for sub-basins.

These conflicts occur in sub-basins 10, 25, 28, and 29.

D. The anticipated rates and time frames for achieving the management objectives.

These actions will be completed by the year 2000, for item 1, in B., above, and at the time of a forest wide mountain bike trail assessment for item 2.

Riparian Reserve Widths/ Interim Riparian Reserve Widths

Current condition of the riparian reserves is not conducive to reducing the interim widths that have been established by the ROD. Currently 53 percent of sub-basins in the analysis have more than 25 percent of their stream Riparian Reserves harvested, which is an indication of some widespread impaired condition. This decision to vary Riparian Reserve widths should be visited in future iterations of watershed analysis, to assess recovery of the area and to determine if the Riparian Reserve is in sufficient condition to consider reducing the width.

Table 38. Recommendations by Sub-basin

Sub-basins	NWFP Allocations	RESTORATION								MONITORING										COMMODITIES & DEVELOPMENT			
		Road Decommisioning	Road Weatherization	Silv Trmts to Accel Riparian Areas	Silv Trmts to Accel Upland Stands	Stream Enhancement	Erosion Control/Slope Stabilize	Snag Creation	Manage Dispersed Campsites	Stream Temperature	Stream Surveys	Lake Surveys	Phase II Road Condition Surveys	Verification of Ecological Inventory	No. of Spotted Owls in LSRs	Peregrine Falcon Habitat	Bald Eagle's Nest Site	Recreation Use	Dispersed Camping	Opportunities for Timber Harvest	Conflict Between Trail Users	Non-conforming Trail Use	
1 Cedar Flats	LSR,RNA,MAT	X	X	X	X			X		X		X	X	X	X			X	X				
2 Lower Muddy	LSR,MAT	X	X	X	X			X		X		X	X	X	X		X	X	X	X			
3 Middle Muddy	LSR										X	X	X	X	X			X	X				
4 Lower Muddy Tribs W	LSR,MAT	X	X	X	X								X	X	X			X	X				
5 Lahar	LSR,MAT	X		X				X					X	X				X	X				
6 Upper Muddy	NVM,MAT				X									X				X	X	X			
7 Lower Smith Crk	NVM,MAT			X	X			X			X			X				X	X	X			
8 Ape Canyon	NVM										X			X				X	X				
9 Upper Smith Tribs SW	NVM										X			X				X	X				
10 Upper Smith Tribs W	NVM										X			X				X	X		X	X	
11 Upper Smith Tribs NW	NVM										X			X				X	X				
12 Upper Smith Tribs N	NVM										X			X				X	X				
13 Upper Smith Tribs E	MAT			X	X		X				X			X				X	X				
14 Upper Smith Crk	NVM										X			X				X	X				
15 Upper Bean Crk	MAT,NVM			X	X		X					X	X	X				X	X				
16 Lower Bean Crk	MAT			X	X		X							X				X	X				
17 Lower Clearwater Crk	LSR,MAT	X	X		X					X	X		X	X	X			X	X	X			
18 Middle Clearwater Crk	LSR,MAT	X		X	X					X	X		X	X	X			X	X				
19 Clearwater Crk	LSR,MAT	X		X	X		X	X		X	X		X	X				X	X				
20 Upper Clearwtr Crk Tribs	MAT,LSR	X		X	X		X			X	X		X	X				X	X				
21 Upper Clearwtr Crk	NVM,MAT			X	X						X	X	X	X				X	X				
22 Upper Clearwtr Crk Tribs N	LSR			X										X				X	X				
23 Upper Clearwtr Crk Tribs NE	LSR,MAT			X			X							X				X	X				
24 Upper Clearwtr Crk Tribs E	LSR,MAT			X									X	X				X	X				
25 Upper Elk Crk	LSR					X						X	X	X	X			X	X		X	X	
26 Lower Elk Crk	LSR	X				X							X	X	X			X	X				
27 Hungry Crk	LSR	X				X							X	X				X	X				
28 Craggy Crk	LSR					X					X			X	X			X	X		X	X	
29 Snider Pasture	LSR				X						X		X	X	X			X	X		X	X	
30 Wright Crk	LSR			X	X	X							X	X				X	X				
31 Wright Meadow	LSR				X					X	X		X	X	X			X	X				
32 Wildcat Trail	LSR				X					X	X			X	X	X		X	X				
33 Spencer Butte	LSR				X					X	X			X		X		X	X				
34 Lower Clear Crk	LSR				X		X		X	X	X		X	X	X			X	X				
35 Muddy River Tribs E	LSR	X		X									X	X				X	X				
36 Middle Smith Crk	NVM,MAT										X			X				X	X				

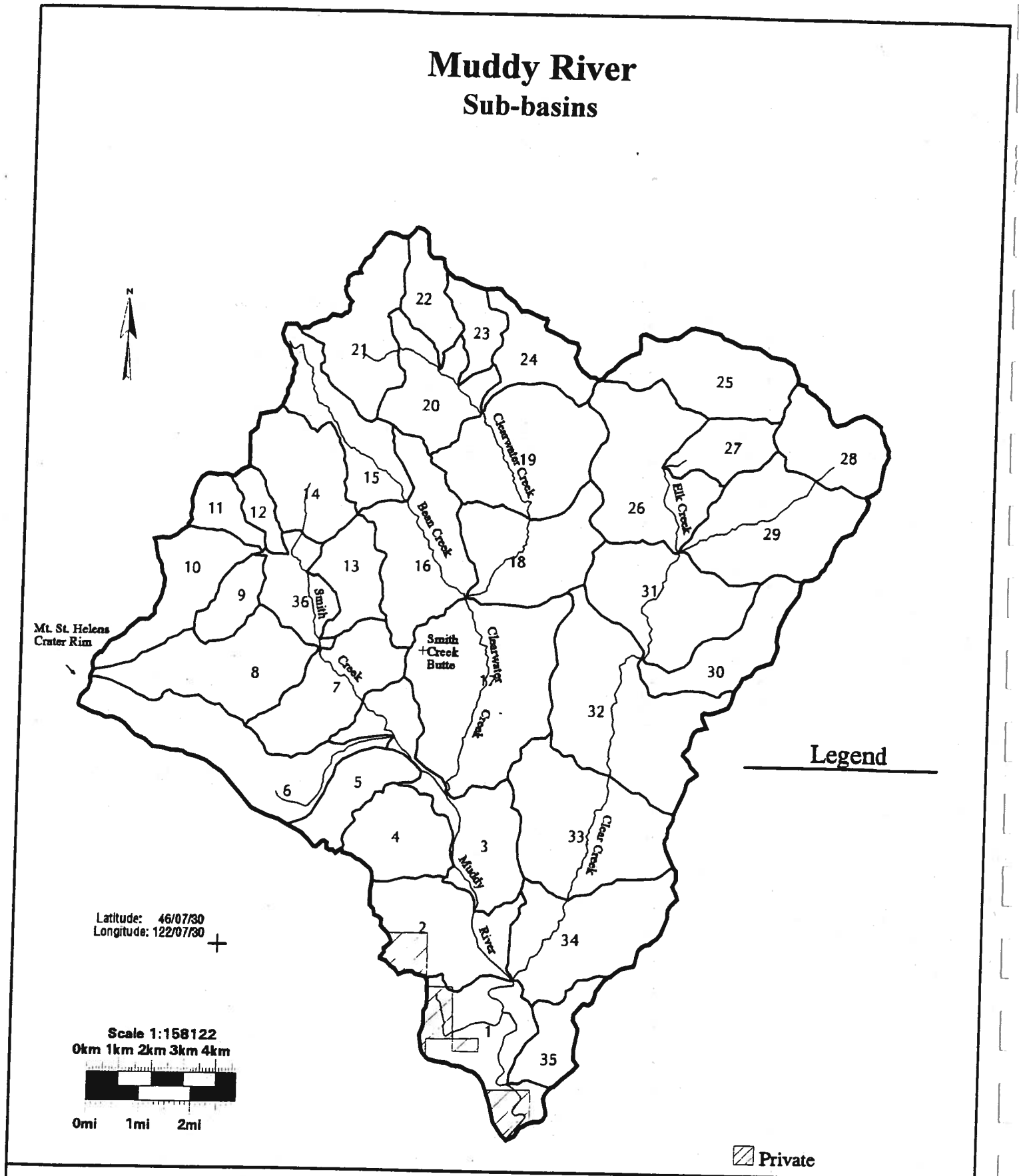

Figure 4. Sub-basins. For this analysis, the 86,913-acre Muddy River Watershed is divided into 36 sub-basins.

APPENDIX A

GLOSSARY

APPENDIX A - GLOSSARY

303(d): Sections of rivers, coastal waters, estuaries, and lakes that don't meet the state of Washington water quality standards. These standards include temperature, bacteria, siltation, oxygen levels, nutrients, and toxic compounds or heavy metals. These sections are identified by the Washington State Department of Ecology as a result of the Clean Water Act.

Aquatic Conservation Strategy (ACS): Nine objectives which were...."developed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands. The strategy would protect salmon and steelhead habitat on federal lands managed by the Forest Service and Bureau of Land Management within the range of Pacific Ocean anadromy" (ROD 1994).

Biological Winter Range - an area usually at lower elevations, used by deer and elk during the winter months. Usually this range is much more clearly defined and smaller than summer range

Boreal Forest - primarily northern spruce forest.

Carrying Capacity - the maximum number of organisms that can be supported in a given area of habitat at a given time

Cavity Excavator - wildlife species, most frequently birds, that require cavities (holes) in the trees for nesting

C-3 species: Old-growth associated species identified in the ROD to be protected through survey and management standards and guidelines. Four Survey Strategies have been identified in the ROD:

1: manage known sites
2: survey prior to activities and manage sites
3: conduct extensive surveys and manage sites
4: conduct general regional surveys

Class I - IV Streams: A classification system which defines streams as:

Class I: Perennial or intermittent streams that: provide a source of water for domestic use; are used by large numbers of fish for spawning, rearing, or migration; and/or are major tributaries to other Class I streams.

Class II: Perennial or intermittent streams that: are used by moderate though significant numbers of fish for spawning, rearing or migration; and/or may be tributaries to Class I streams or other Class II streams.

Class III: All other perennial streams not meeting higher class criteria.

Class IV: All other intermittent streams not meeting higher class criteria.

Columbia River Policy Implementation Guide (CRBPIG): This refers to the Columbia River Basin Policy Implementation Guide which was developed in 1991 to document the implementation schedule for salmon restoration in the Columbia River Basin.

DBH: Diameter of a tree at breast height.

Endangered - any species in danger of extinction throughout all or a significant portion of its range excluding insects which the secretary determines to be pests

Eyrie - ledge where a falcon nests on a cliff

Facine Bundles: Small bundles of plant material such as willows that are laid along slope contours to stabilize erosional areas.

Fecundity - number of young produced in a given population.

GPNF - Gifford Pinchot National Forest.

GPNFLRMP, LRMP - Gifford Pinchot National Forest Land and Resource Manangement Plan.

Guild - Groups of wildlife species that would be expected to react to different distributions and amounts of habitats in similar ways.

Large Woody Debris (LWD): Pieces of wood within the active channel that are greater than or equal to 24 inches diameter at breast height and that are greater than or equal to 50 feet in length

Limits of Acceptable Change (LAC): A pre-determined threshold or limit to the amount a site or area can change without exceeding acceptable standards for that site or area..

Live Staking: Stakes made out of plant material such as willows that are pounded into erosional areas. These stakes then grow and stabilize the areas.

Large Woody Debris (LWD): Pieces of wood larger than 50 feet long and 24 inches in diameter at the large end.

Management Area Category (MAC) - Land management allocation from the Gifford Pinchot National Forest Land and Resource Management Plan. Each MAC has a goal or management emphasis.

Mass Wasting or Mass Movement: Dislodgement and downslope transport of earth material as a unit under direct gravitational stress. The process includes slow displacements such as creep and rapid movements such as landslides, rock slides, and falls, earthflows, debris flows and avalanches. Agents of fluid transport (water, ice, air) may play a subordinate role in the process.

MMBF - Million board feet. A board foot is a unit of wood volume measuring one inch by 12 inches by 12 inches.

Monitoring: A process of collecting information to evaluate if objective and anticipated or assumed results of a management plan are being realized or if implementation is proceeding as planned.

MSHNVM, NVM - Mount St. Helens National Volcanic Monument.

Opportunistic - chance event or sighting

Optimal Thermal Cover - habitat for deer and elk which has tree overstory and understory, shrub and herbaceous layers; the overstory canopy generally exceeding 70 percent crown closure and dominant trees generally exceed 21 d.b.h; provides snow intercept, thermal cover, and maintenance

Northwest Forest Plan - See ROD.

Northwest Forest Plan Allocations:

LSR - Late Successional Reserves - Lands with objectives to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth forest related species including the northern spotted owl.

Riparian Reserves - As a key element of the Aquatic Conservation Strategy (ROD, page B-9), the Riparian Reserves provide an area along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian dependent resources receive primary emphasis.

Matrix (MAT) - Those federal lands not designated in other categories. Most timber harvest and other silvicultural activities would be conducted in that portion of the Matrix with suitable forest lands, according to standards and guidelines.

People At One Time (PAOT): The capacity of a recreation site in terms of People-At-One-Time (PAOT). The number of people that can use the area all at the same time.

REAP (Regional Ecosystem Assessment Project): USDA. 1993. A First Approximation of Ecosystem Health, National Forest Lands, Pacific Northwest Region.

Reference Conditions: Those conditions which describe the known or inferred history of the landscape so we may know what was sustainable in the past and what changes have occurred to affect sustainability.

Refugia: a region of relatively unaltered conditions that remains as a center of relict forms of plants and animals that may re-colonize adjacent impacted habitats as they become suitable. Singular: refugium.

Rendezvous site - areas used by wolf pups while adults are away hunting, once pups have left the den.

ROD - Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. April 1994. The ROD and the accompanying Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl are collectively known as the **Northwest Forest Plan**, formerly known as the President's Forest Plan.

Seclusion - areas where humans have minimum influence; lacking human presence.

Seclusion Habitat - Refers to habitat for grizzly bears and gray wolves that is more than one mile from a road open to motorized vehicles.

Sediment: Solid material of any size, both mineral and organic, that is in suspension and is being transported from its site of origin by air, water, gravity, or ice, or has come to rest on the earth's surface either above or below sea level.

Sensitive Species - those species identified by the Regional Forester for which population viability is a concern, as evidenced by: a significant current or predicted downward trend in population numbers or density; or a significant current or predicted downward trend in habitat capability that would reduce a species' viability.

Snag - standing dead tree.

Stochastic - random, uncertain; involving a random variable.

Subsoilers: are large shanks attached to a tool bar mounted to the rear of a crawler tractor.

Survey strategy: One of four survey strategies for C-3 species identified in the ROD. See C-3 for explanations of strategies.

Threatened - any species likely to become endangered in the foreseeable future throughout all or a significant portion of its range

Wilderness: Undeveloped federal land retaining its primeval character, without permanent human habitation or improvements. It is protected and managed to preserve its natural condition. Wilderness areas are designated by an act of Congress.

APPENDIX B

REFERENCES

APPENDIX B REFERENCES

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APPENDIX C

ISSUES AND KEY QUESTIONS

APPENDIX C ISSUES AND KEY QUESTIONS

Geology, Soils, Erosion Processes

Issue: Mass Wasting

The Muddy River Watershed has many landslides and debris torrents within its boundaries. The impact of 1980 tephra deposits and loss of timber from the blast has increased the potential for mass wasting in much of the watershed. Management activities such as salvage logging after the 1980 eruption may have contributed to the increased amount of land movement seen in the watershed.

Key Questions:

1. Is there evidence of, or potential for, mass wasting in the watershed?
2. What mass wasting processes are active?
3. How are mass wasting features distributed throughout the landscape?
4. What physical characteristics are mass wasting features associated with?
5. Do landslides deliver sediment to stream channels or other waters?
6. Do forest management activities create or contribute to instability?
7. What areas of the landscape are susceptible to slope instability?

Issue: Surface Erosion from Roads

Surface erosion from roads has been a major contributor to sedimentation to streams in the past. Most sediment is transported during new road construction and within the first two to three years thereafter. After this time, vegetative growth on the cut and fill slopes help alleviate the problem, but in areas near stream crossings erosion can continue to influence stream habitat for many years. Poor construction practices in the past have recently created numerous problem areas where fill slope failures have directly and indirectly moved sediment into many streams. This type of sediment movement is especially evident since the large storm events of 1995 and 1996.

Key Questions:

1. What are the roads' erosion potential?

2. Are contributing activities present?

3. Is sediment delivered to streams?

4. What roads are sensitive to forest practices?

5. What is the potential effect of sediment on public resources?

6. What is the baseline sediment level?

7. What are the amounts and types of sediment contributions from forest practices?

Issue: Surface Erosion from Upland Slopes

The tephra deposits and blast area created by the eruption in 1980 has left varying amounts of loose unconsolidated material on the entire watershed. This material is highly erosive especially on the steeper slopes and where the vegetation was destroyed. Recent storm events have given a good picture of the erosive properties of these deposits.

Key Questions:

1. What areas of the landscape are susceptible to surface erosion?

2. What areas are susceptible to development activities?

3. What surface erosion processes are active and how are they distributed across the landscape?

4. How have the rates, frequencies and processes of surface erosion changed with management activities?

5. What are the relative amounts and types of sediment contributions from natural events and from development activities?

Issue: Fire History

In the past, large catastrophic fire has been a change agent at the landscape (watershed) scale.

Key Questions:

1. Where and when have catastrophic fires occurred within the watershed?

Issue: Vegetation Structure and Composition

Historically, the Muddy River Watershed was probably comprised of large contiguous stands which originated from wildfire or the eruption of Mount St Helens. The species composition and structure of these stands varied considerably depending on the nature and size of the disturbance. Because disturbance events were infrequent, it is likely that through time a large proportion of the vegetation was late-successional. Within the last 60 years, timber harvest and artifiucial regeneration activities have changed this historic successional pattern to include a greater number of young, small, uniform openings with single storied structure and reduced species diversity. These younger stands are distributed across the watershed fragmenting the larger contiguous stands historically present. The structure, composition, and distribution of these patches has diminished the diversity and distribution of some plants, lichens, fungi, bryophyte and animal species and their habitat.

Key Questions:

1. What are the present stand structures and compositions?

2. How do these compare with past conditions?

3. How are the vegetation structure stages distributed across the watershed?

4. Is a minimum of 15 percent of the watershed in a late-successional seral stage?

5. Which plant, lichen, fungi, and bryophyte species in the watershed are vulnerable to conversion of multi-layered canopies to single-layer canopies?

6. What are the implications for future conditions?

7. When will the Management Plan for Cedar Flats RNA be completed?

8. Which Survey and Manage C-3 lichen species are present in the RNA?

<u>Issue</u>: Stream Riparian Reserve Fragmentation and Riparian Habitat

Stream riparian areas provide habitat for wildlife, plants, lichens, fungi, and bryophytes, and provide corridors for wildlife migration and plant dispersal. Some critical components of terrestrial habitat within Stream Riparian Reserves have been altered by fragmentation due to wildfire, the 1980 eruption of Mount St. Helens, and timber management activities. This has influenced the capacity of these ecosystems to provide effective habitat for riparian dependent species and other species that may use Stream Riparian Reserves as corridors between larger habitat blocks. Disruption of connectivity between these areas can potentially result in species isolation. This can lead to undesirable changes in species composition, use, and ecosystem functions within Riparian Reserves and the watershed.

Key Questions:

1. What is the current distribution of age classes and stand structure types within Stream Riparian Reserves?

2. Where are Stream Riparian Reserves inadequate in providing dispersal habitat for species of concern?

<u>Issue</u>: TES and C-3 Plant Species

Numerous populations of *Pleuricospora fimbriolata,* a State Sensitive plant, are present in the watershed. Four Forest Plan Botanical Special Interest Sites have been designated as Selected Species Management Areas for *Pleuricospora fimbriolata. Carex interrupta*, a state Sensitive and Survey and Manage (C-3) Category 3 plant species is also present. An additional 33 threatened, endangered or sensitive (TES) plant species are suspected to occur within the watershed, based on suitable habitat. Less than 10 percent of the watershed has been surveyed for TES species.

Lobaria oregana, L. scrobiculata, Nephroma bellum, N. resupinatum, Pannaria saubinetti, Pseudocyphellaria anomala, P. anthraspis and *P. crocata,* C-3 Category 4 lichens are present in Cedar Flats Research Natural Area. It is highly likely that these and other C-3 lichens are present in the watershed. *Tetraphis geniculata*, a C-3 Category 1and 3 bryophyte, and *Ulota meglospora*, a protection buffer bryophyte species are also present in Cedar Flats. None of the rest of the watershed has been surveyed for C-3 bryophytes, lichens or fungi.

Key Questions:

1. Which TES and C-3 plants, lichens, bryophytes and fungi are present, and where?

2. Which TES and C-3 are species are likely to occur, and in which habitats?

3. Has habitat fragmentation impacted TES and C-3 population viability?

4. Has disruption of dispersal corridors impacted population viability?

Issue: Habitat Condition for Threatened, Endangered, and Sensitive Animal Species

The watershed contains suitable, or potentially suitable habitats for threatened, endangered, and sensitive species including the northern spotted owl, peregrine falcon, gray wolf, grizzly bear, bald eagle, Townsend's big-eared bat, and Larch Mountain salamander.

Key Questions:

Northern Spotted Owl:

1. Where are spotted owl activity centers located in the watershed? In which Northwest Forest Plan allocations are they located? Which of these activity centers are currently above "take" thresholds?

2. How many acres of northern spotted owl suitable habitat are there in the watershed and in each sub-basin? What percent of the watershed and in each sub-basins is this?

3. What is the amount of NRF habitat in each Northwest Forest Plan allocation?

4. What is the amount of dispersal habitat (11/40 and above) in each allocation in the watershed?

Bald Eagle:

1. Is there any known historical or current bald eagle nest or winter roost in the watershed?

Peregrine Falcon:

1. Are there suitable cliff sites in the watershed?

2. Are any of these sites historical or current peregrine falcon eyries?

Gray Wolf and Grizzly Bear:

1. Does any part of the watershed contribute to a portion of a wolf pack's territory?

2. Are there any potential den and rendezvous sites in the watershed?

3. What is the status of the prey base population (elk and deer)? What is the percent of optimal thermal cover and the road density in deer and elk winter range?

4. What are the density and distribution of roads and trails in the watershed and in each sub-basin?

Larch Mountain Salamander:

1. Are there known Larch Mountain salamander populations in the watershed?

2. Are any of these sites located in areas that could be affected by future projects?

3. Is recreational use at these sites affecting habitat suitability?

Issue: Habitat Condition for C-3 and Cavity Dependent Species.

The watershed contains suitable, or potentially suitable habitat for C-3 species (North American lynx, forest bats, Van Dyke's salamander) and cavity-dependent species.

Key Questions:

Northern America Lynx

1. Is there any lodgepole or subalpine forest located in the watershed? If the lynx is present, in which sub-basins?

Forest Bats

1. Are there bridges or caves located in the watershed? If present in which sub-basins are they located?

2. Are there small ponds or wetlands located in the watershed that could provide foraging opportunities for bats?

Van Dyke's Salamander:

1. Are there known Van Dyke's salamander populations in the watershed?

2. Are any of these sites located in areas that could be affected by future projects?

3. Is recreational use at these sites affecting habitat suitability?

Cavity Excavators

1. Is there an abundance of snags located in the watershed? If so, in what sub-basins are they located?

Issue: Hydrologic Changes

Past disturbances such as wildfire and volcanic eruption in the analysis area may have influenced basin hydrology by increasing peak flows during fall and winter storms, and decreasing summer low flows. Human activities have occurred throughout the watershed and may influence the timing and quantity of runoff as well.

Key Questions:

1. What are the current watershed conditions influencing hydrologic response?

2. How do management activities and past disturbances influence streamflow regimes? Where are these influences occurring?

3. What is the history of floods and disturbance of hydrological significance?

4. What is the effect of changes in water available for runoff of flood peaks?

5. What is the future trend of the basin hydrology?

6. Are their any restoration and/or monitoring possibilities?

<u>Issue</u>: Water Quality and Key Habitat Attributes for Resident and Anadromous Salmonids.

Current aquatic habitat conditions are a result of past natural and human induced processes that have occurred in the watershed. Road building, dams, volcanic eruption and fire regimes, combined with timber harvest and increased human populations in the watershed have through time altered stream habitats and aquatic communities. Degraded water quality from sediment and high water temperatures may be affecting habitats for bull trout, rainbow trout, sculpins, suckers and cutthroat trout. State water quality regulations are in place to protect existing and designated uses of water (i.e., beneficial uses). Due to time and analysis information limitations the focus will be on fish spawning and rearing.

Key Questions:

1. What is the current and historic range, and species composition of salmonids in the analysis area.

2. What is the current condition of the following key habitat and beneficial use attributes: pools per mile, large woody debris per mile, stream temperature, channel configuration, sediment?

3. Are these habitat variables of concern given the current condition? If so, where are these areas of concern?

4. Is there any high quality and or unique habitat located in the analysis area (spawning, rearing, holding etc...)?

5. Where have natural flows through the aquatic system (salmonids, LWD, sediment, etc.) been altered by human activities? How has this affected the connectivity of the aquatic system?

6. Where are the current sources of large woody debris? What were the past sources of large woody debris?

7. Does canopy closure within the riparian reserve network maintain appropriate stream temperatures for aquatic species?

8. Are there habitat areas that have been degraded, that have a high potential for restoration and or monitoring activities?

9. What is the future trend of habitat quantity and quality for salmonids in this watershed?

Issue: Conflict Between Trail Users

Use of trails in the watershed is increasing. When different uses are mixed, such as hikers and mountain bike riders, or motorized use, an interference between non-mechanized and faster moving mechanized users may develop. These conflicts can degrade the recreational experience of users, and in some instances produce danger of collision and injury.

Key Questions:

1. What is the current mix of use allowed on trails?

2. What is the level of conflict between users (high, medium, low).

3. Do these conflicts create a hazard to users?

4. Is recreational experience degraded by these conflicts, and to what degree.

Issue: Demand For and Resource Impacts From Dispersed Camping

Road decommissioning within this and adjacent watersheds is removing access from dispersed camp sites, making them no longer available. Demand is particularly high during hunting season in the fall. This may influence the number of hunters able to use the area, and the appearance of new camps.

Key Questions:

1. Where is dispersed camping currently taking place?

2. Are unacceptable environmental impacts taking place at any camp sites?

APPENDIX D

LIMITATIONS OF THE ANALYSIS, CONFIDENCE IN THE ANALYSIS, DATA GAPS, AND IMPLICATIONS OF THESE LIMITATIONS FOR MANAGEMENT

APPENDIX D

LIMITATIONS OF THE ANALYSIS, CONFIDENCE IN THE ANALYSIS, DATA GAPS, AND IMPLICATIONS OF THESE LIMITATIONS FOR MANAGEMENT

Geology and Erosion Processes - by Jim Chamberlin, Geologist

Issue: Riparian Reserve Mass Wasting

Confidence: **Moderate to High**

Discussion: After reviewing the map it was determined that there were some errors in the mapping. The mud flow deposits from Mt. Saint Helens that flowed down the Muddy and Smith Creek should be considered stable and removed from the data layer. This will remove a portion of the unstable ground from the riparian reserve. The stream portion of these areas will still be buffered.

Data Gaps:

Continual updating of the unstable ground needs to be done as new data is identified.

Issue: Riparian Reserve - Wetlands

Confidence: **Moderate**

Discussion: The wetlands mapping was taken from the soils resource inventory and the veg layer. There have been some discrepencies between these layers that need to be worked out. The veg layer has some wetlands identified that are not on the ground. Remapping or atributing these areas will have to be done before the next iteration of this watershed analysis.

Data Gaps:

Double checking the layers for accuracy needs closer scrutiny.

Issue: Erosion from Roads

Confidence: Low to moderate

Discussion: The modeling to determine areas of surface erosion from roads uses many factors that are estimated because the actual data is not available. The traffic factor is high in the ranking and does not utilize the surfacing type very well. This would show that paved roads that have a lot of traffic would have higher erosion rates than they actually do. This is being looked into for future analysis.

Data Gaps:

Condition surveys of the road network needs to be completed to obtain the best information to put into the program.

Terrestrial Vegetation Analysis - By Chiska Derr, Botanist and Sue Macmeeken, Silviculturist

Confidence in Analyses

This section identifies concerns about the quality and accuracy of data that were used to analyze this watershed. All data came from GIS files, with some supplementary interpretations based on aerial photographs and timber harvest records. The GIS vegetation layers were created primarily from inventory data and photo interpretation. The GIS specialist estimated that more than half of the total Central Skills Center vegetation layer was based on photo interpretation, and has never been ground verified. These data are incomplete, contain many gaps, and are at a very coarse scale that is limited in its applicability. Unfortunately, as the only data we have, they were used to make the ecological interpretations within this document. Each issue is rated based on confidence in data, and data gaps and limitations.

Issue: Stand Structure and Composition

Confidence: LOW to MODERATE

Discussion: GIS generated data were supplemented by and compared with timber harvest databases and aerial photographs. This enhanced the quality of information available and interpretations. Because data collected for the GIS vegetation layer was primarily collected in conjunction with timber sale planning, information about non-timber production vegetation structure and composition is very weak.

Data Gaps:

* none of the GIS stand structure data were field verified

* none of the GIS stand composition (ecoclass) data were field verified

* no comprehensive plant inventories have been conducted

* data for non-timber production vegetation structure and composition is very weak

Issue: Stream Riparian Reserve Fragmentation

Confidence: LOW

Discussion: The Stream Riparian Reserves within this watershed have been shaped by a

complex combination of processes, including volcanic activity, wildfire and timber harvest. Historically, most stand structure and composition data was collected in conjunction with timber inventory. Consequently, Stream Riparian Reserve vegetation structure and composition was usually lumped with upland vegetation, and is not depicted in vegetation structure stage GIS layers. As a result, data on actual stand structure, hardwood components, large woody debris recruitment potential, and suitabilitly of riparian habitat to serve as dispersal corridors for plant and animal species is lacking. An analysis of aerial photographs to evaluate Stream Riparian Reserve habitat and fragmentation would supplement available information, and should be done during project level analyses. This level of analysis was unfeasable given the timeline for the watershed analysis process.

Data Gaps:

*stand structure and composition data within Stream Riparian Reserves is not available from GIS because this information has been lumped with upland vegetation conditions

*there was not enough time to interpret aerial photographs for information about Stream Riparian Reserve habitat, structure, composition, and functions

*baseline data on intact stream and wetland riparian functions are lacking for comparison with riparian areas whose functions we will be "restoring"

*baseline data on many riparian-dependent vascular plants and lichens, bryophytes and fungi species are lacking

Issue: <u>TES and C-3 Species</u>

Confidence: LOW to MODERATE

Discussion: The lack of data on C-3 bryophyte, lichen, fungi and vascular plant species on all lands except those within Cedar Flats Research Natural Area constitutes a data gap. The lichen inventory in Cedar Flats Research Natural Area was preliminary and should be conducted at a more thorough level. Because some data exist for TES species, confidence in that analyses is low to moderate.

Data Gaps:

* few general surveys for TES species have been conducted

* None of the watershed outside of Cedar Flats Research Natural Area has been surveyed for C-3 bryophyte, lichen, fungi and vascular plant species. Because the lichen survey in

Cedar Flats was preliminary, a more comprehensive survey should be conducted.

* ecological and distributional data are lacking for TES and C-3 species

Issue: <u>Cedar Flats Research Natural Area</u>

Discussion: The 275 hectare (680 acre) Cedar Flats Research Natural Area (RNA) was established in 1946 to exemplify the western red cedar stands found on valley bottom habitats in the Cascade Range of Washington (Franklin et al. 1972). It represents four components of the Western Hemlock Zone of the Western Slopes and Crest Physiographic Province: (1) old-growth Douglas-fir/western hemlock forest; (2) old-growth western red cedar forest; (3) marsh and swamp ecosystem; and (4) western red cedar swamp (Dyrness et al. 1975). The Research Natural Area Management Plan for Cedar Flats that was initiated in the early 1990's has never been completed.

Data Gap:

*Currently there is no Research Natural Area Management Plan for Cedar Flats RNA. A Management Plan for Cedar Flats RNA was initiated in the early 1990's, but was never completed. The guiding principle in management of this and other RNAs is to prevent unnatural encroachments, activities which directly or indirectly modify ecological processes on the tracts (Franklin et al. 1972).

Terrestrial Species Analysis - by Vaughan Marable, Wildlife Biologist

Confidence in Analysis - Low to Moderate

My confidence in the acreage figures of the different vegetation structure stages, the foundation for determining species presence and assessing habitats, within the watershed is moderate. This is because a majority of the vegetation data has not been verified on the ground. However, I think the data is sufficiently accurate to be able to make the conclusions in the analysis, and these conclusions would not significantly change if more accurate data were available.

Issue: Habitat conditions for threatened, endangered and sensitive animal species

Confidence: Low to Moderate

Discussion: My confidence in the abundance and quality of suitable habitat for TES species is similar to what was discussed in the previous paragraph. Data gaps are present in the ground varification of the vegetation data and in surveying for species presence. My confidence in road density data is moderate, because it's likely that there are roads that are no longer driveable after the flooding in 1995 and 1996. In this analysis the assumption was made that all roads were open and driveable.

Data Gaps: few surveys for TES species have been conducted with the exception of the northern spotted owl. However, many of the spotted owl sites have not been varied in more than five years.

Spencer Butte cliff has not been surveyed to determine if it is a highly suitable peregrine eyrie.

A site located in sub-basin 2 has not been surveyed to determine if there is an active bald eagle nest site.

Determine use occurring on open roads and driveability of roads.

Determine how well Riparian Reserves are functioning as conductivity corridors for late successional / growth species.

Issue: Habitat conditions for C-3 and "species of interest"

Confidence: Low to moderate

Discussion: My confidence in the abundance and quality of suitable habitat for C-3 species and species of interest is similar to what was discussed in the opening paragraph. Data gaps are present in ground verifying the vegetation data and in surveying for species presence. My confidence in the analysis of the carrying capacity for cavity excavators is low because it's based on a model that has not been tested, and it's based on stand age data with little knowledge about what management may have occurred in the older stands (i.e., salvage and snag removal).

Data Gaps: The abundance and distribution of suitable habitat for Larch Mountain salamanders,.

The four forest bat species and cavity excavators.

Few surveys for C-3 species, except for the Van Dyke's salamander. these surveys have been limited to the headwaters of Clearwater and Bean Creek .

A model predicting the carrying capacity of deer and elk biological winter range as scheduled timber harvest is reduced.

Hydrologic Condition - by Mark Kreiter, Hydrologist

Confidence in analysis - Moderate

Limitations of the analysis - Limitations of this analysis include:

- Entire analysis was modeled using GIS data. No field verification of vegetation data was done to determine the accuracy of the information.

- Coefficients for the model were regional coefficients in some cases. Using coefficients that are not generated from the analysis area lowers the models accuracy.

- Assumptions in the model decrease the reliability of the resulting data. The model makes assumptions like the two year storm is responsible for the 2 year flood. This is rarely true in this area.

- The peak flow portion of the beneficial use analysis could not address channel bed scour, which is very important in determining quality of spawning and rearing habitat.

- Confidence is low for analysis in sub-basins 1 and because DNR model only considered National Forest land due to lack of vegetation data for private and other land in the geographic information system database.

Data Gaps

- There is a need for field verification of the vegetation layer to improve the accuracy of the data.

- Field data that was pertinent to hydrologic interpretations such as width/depth ratios, pebble counts, v* was missing. This needs to be collected as part of stream surveys.

- There is a need to complete level II road surveys so possible restoration opportunities can be identified and more site specific information concerning culvert spacing can be used in the extension of the stream channel mileage model.

- A detailed review of the location of class IV streams is needed.

- There is a need to collect vegetation data (crown closure, DBH, tree species) for non-National Forest lands.

Implications for Management:

Management decisions relating to activities such as restoration or timber harvest may not be as fully informed using this general information. Accurate identification of priority restoration areas may be less likely without the more specific information, due to the lack of establishment of cause and effect relationships. We might focus restoration for sediment control in a sub-basin that has high activity levels and generates some sediment, and miss the sub-basin that has less activity but generates large amounts of sediment.

Key Aquatic Habitat Attributes, and Aquatic Habitat Fragmentation

Confidence Estimates

Following is a discussion of the confidence in the analysis, limitations of the analysis, data gaps, and implications of these limitations for management. This discussion is presented by analysis group (LWD/Mile and LWD recruitment, Primary Pools/Mile, Sediment and Stream Temperature, and Aquatic Habitat Fragmentation).

LWD/Mile - by Deborah Haapala, Fisheries Biologist

Confidence in analysis: Low - High

Limitation of the Analysis include:
Data for this analysis came from the district's stream survey files and database. There is a moderate confidence in the original data collected due to the protocol used to identify large pieces of wood (i.e., visual estimation of size) during the stream surveys. This is an acceptable level of confidence; however, data are only available for approximately 40 percent (33 miles) of the fish bearing streams in the Watershed on National Forest lands. The lower portion of the Muddy River on private land has been surveyed. Survey data from the Clearwater was not available from researchers due to it's unpublished form. Using this limited amount of data compromises the confidence.

Standards have been set at the Regional level; however, no watershed or basin wide analysis has been completed to verify these standards for this area. The stream channels in this area are high gradient channels that transport material such as wood and sediment fairly quickly. A standard of 80 pieces per mile may be too high, based on the channel morphology of this watershed.

<u>LWD Recruitment</u> - by Deborah Haapala, Fisheries Biologist

Limitation of the Analysis include:
Recruitment potential of LWD was based the percent streamside riparian area harvested. GIS data were used for National Forest lands. The confidence in this portion of the analysis is high. Aerial photos were examined to estimate the percent riparian harvest on non-National Forest lands. While confidence in using this technique is moderately high, the aerial photos used were from 1989. It is known that a great deal of additional harvest has occured to date on non-National Forest lands, so we have probably underestimated riparian harvest. Therefore, the overall confidence for LWD recruitment potential on non-National Forest lands is low.

Data Gaps:

- Stream surveys cover primarily fish bearing sections of stream. Class IV channel tributaries and many Class III tributaries are not surveyed. Only 40 percent of all the fish-bearing streams in the watershed have been surveyed.
- No watershed or basin wide standards for habitat quality.
- No riparian area specific vegetation inventories are available
- No pristine stream survey data to develop relationships between current conditions in managed sub-basins with those in un-managed sub-basins.
- Little data have been collected on Private Land within the watershed.
  Survey data from the Clearwater was not available from researchers due to it's unpublished form.

Implications for Management:

Managers need to consider the small amount of data and the lack of data available for this analysis, and recognize that this analysis is not complete and needs to be verified in the field at the sub-basin level, before management decisions are made.

<u>Primary Pools/Mile</u> - by Deborah Haapala, Fisheries Biologist

Confidence in analysis - Low - Moderate

Limitation of the Analysis include:

Data for this analysis came from the district's stream survey files and database. There is a moderate confidence in the original data collected due to the protocol used to identify pool size (i.e., visual) during the stream surveys. This is an acceptable level of confidence; however, data are only available for approximately 40 percent (33 miles) of the fish bearing streams in the Watershed on National Forest lands. The lower portion of the Muddy River on private land has been surveyed. Using this limited amount of data compromises the confidence.

Standards have been set at the Regional level, however, no watershed or basin wide

analysis has been completed to verify these standards for this area. The stream channels in this area are high gradient channels with many small pocket pools that may not meet the requirements of a primary pool as identified in the survey protocol. The standard is based on the width of the stream channel however, gradient and channel morphology are not considered.

Data Gaps:

- No pristine stream survey data to develop relationships between current conditions in managed sub-basins with those in un-managed sub-basins.
- Some data has been collected on Private Land within the watershed.
  Survey data from the Clearwater was not available from researchers due to it's unpublished form.

Implications for Management:

Managers need to consider the small amount of data and the lack of data available for this analysis, and recognize that this analysis is not complete and needs to be verified in the field at the sub-basin level, before management decisions are made. Consideration also needs to be given to the fact that until pool standards are developed at the watershed scale for each watershed in the Forest we will not have an accurate picture of the severity of the existing situation.

Sediment and Stream Temperature - by Mark Kreiter, Hydrologist

Confidence in analysis - Moderate-High

Limitations of the analysis - Limitations of this analysis include:
Reference conditions were determined primarily from 1959 air photos. Some information from other sources such as REAP was used to supplement the air photo information. This leads to fairly good relationships back to the mid-1940's, but very unclear prior to this time.

Stream temperature analysis only used existing data available at the time of the analysis. This was limited to two stations in the analysis area.

Data Gaps:
Stream temperature data was not available for a majority of the streams in the analysis area.

Field data that was pertinent to hydrologic interpretations such as width/depth ratios, pebble counts, v* was missing. This needs to be collected as part of stream surveys.

Historic and reference information on stream temperatures and other physical stream

nel parameters such as pools per mile and amounts of LWD is lacking for this area.

here is a need to complete level II road surveys so possible restoration opportunities as vell as potential sediment sources can be identified.

Implications for Management:
Management decisions relating to activities such as restoration or timber harvest may not be as fully informed using this general information. Accurate identification of priority restoration areas may be less likely without the more specific information, due to the lack of establishment of cause and effect relationships. We might focus restoration for sediment control in a sub-basin that has high activity levels and generates some sediment, and miss the sub-basin that has less activity but generates large amounts of sediment.

Aquatic Habitat Fragmentation - by Deborah Haapala, Fisheries Biologist

Confidence in analysis - Moderate - Low

Limitation of the Analysis include:
This analysis was done using GIS data for road/stream crossings. It assumes that every stream crossing fragments the aquatic habitat. It assumes that none of the crossings are bridges which would presumably have less of an impact to the aquatic enviroment, and would allow a natural flow of sediment, wood, and organisms. It also assumes that all the roads and streams are present in the database. There are however, many small spur roads that are not currently in the database. There may be streams that are missing, from the database, however, this GIS layer was recently updated. The analysis divided the Muddy River Watershed into thirds to assign values into the low, medium, and high categories. However, there is no basis for these values in the literature. The Muddy River Watershed is less fragmented than other Lewis River Watersheds. When comparing the Muddy River Watershed stream fragmentation values to the entire Lewis River Watershed, only 6% of the Muddy River stream fragementation values were in the "high" category (highest 1/3 of stream fragmentation values).

Data Gaps:
- Database without all the roads present
- Database without all the streams present
- Information on culverts and whether they pass fish is not available.
- Information on the condition of roads on Private Land within the watershed is not available.

Implications for Management:
This analysis is a surrogate for quantifying the amount of impact created by the number of roads in the watershed on the aquatic ecosystem. The analysis is logical, and serves a purpose for identifying the impacts, however it is a surrogate and has many assumptions about the impacts that roads and their management have. It should also be noted that this surrogate is intuitive in nature and has not been peer-reviewed or evaluated under strict scientific standards.

APPENDIX E

VEGETATION STAND STRUCTURE DEFINITIONS

STAND STRUCTURE DEFINITIONS FOR GPNF

Chiska Derr, Mt. St. Helens Botanist
10 July 1996

Stand structure/seral stage definitions have been developed for Western Oregon and Washington based on a number of different criteria (Hall et al. 1985). Structure definitions based in part on above work combined with Forest stand data available in the vegetation database are briefly described below (as based on the 1/11/95 seral meeting). Ecoclasses are specified based on potential plant associations (Brockway et al. 1983: Topic et al 1986; Topic 1989). Major tree species can be a single species or combinations of conifer species present on the Gifford Pinchot National Forest, and are not specified.

Acceptable ecoclass codes for below stages are for coniferous forest only (codes that start with "C").

Grass/Forb /Seedling

Early seral. **Conifer openings** dominated by grasses, forbs, some shrubs and conifer seedlings less than 4.5' tall (or diameter breast height (dbh) less than 1.0 inches), either of natural or human origin. Pioneer species dominate and species richness is often high. Provides foraging opportunities but no cover. Condition typically lasts two to five (occasionally 10) years.

Shrub/Seedling

Early seral. **Coniferous** stands dominated by shrubs, and a mixture of conifer seedlings and saplings (0-20' tall, 0 to 4.9 inches dbh); natural or human origin. Pioneer species dominate and species richness is high. Provides foraging opportunities but no hiding/thermal cover. Condition typically lasts 3 to 10 years, but may persist 20 to 30 years if tree regeneration is delayed. **May provide hiding cover depending on height and density of shrubs and trees.**

Remnant Forest (Light Forest)

Early seral; ecoclass either western hemlock, Douglas-fir, or western red cedar. Stands with little understory development (grass and forbs present) and an open canopy (0% to 40% cover) of large trees. Cover results from residual conifers larger than 21 inches dbh. These stands are commonly a result of recently harvested shelterwood, or green tree retention units. Provides foraging opportunities, limited thermal protection, and may provide hiding cover. Also provides propagules of C-3 lichens and bryophytes, as well as habitat for C-3 lichens, bryophytes, fungi, arthropods and mollusks.

Open Sapling/Pole

Early seral. **Coniferous** stands with an open canopy (0% to 40% cover) that are dominated by sapling and pole-sized conifers of 4.5 feet tall up to 9" dbh. A shrub dominant understory is common. Provides some forage and limited

hiding/thermal cover. Condition may last from 8 to 20 years, sometimes longer, depending on tree crown closure and subsequent stand treatment.

Closed Sapling/Pole

Early to mid seral. **Coniferous** stands with a closed canopy (40% to 100% cover) that are dominated by sapling and pole-sized conifers of 4.5 feet tall up to 9" dbh. Ground vegetation dwindles during this stage as crowns of individul trees coelesce. Tree live crown ratios become reduced as lower limbs die back from lack of sunlight. Plant diversity is generally low at this stage as dense tree cover shades out many remaining pioneer species. A shift towards shade tolerant species may become more evident later in this structure stage. Structural diversity is also quite low. The scarcity of ground vegetation limits forage, and crowded trees can reduce accessability of stand to wildlife for cover, **but can provide some hiding cover.** This stand condition can persist between 40 and 100 years.

Open Small Tree

Early to mid seral. **Coniferous** stands with less than 70% canopy closure AND meeting one of the following size criteria:
1) Ecoclass either western hemlock, Douglas-fir, western red cedar, or grand fir and dominated by trees with stand average dbh between 9 and 20.9 inches,
OR: 2) Ecoclass silver fir, mountain hemlock, lodgepole pine, park-like mountain hemlock/subalpine fir, or Engelmann spruce, with stand average dbh between 9 and 18 inches.
The open canopy enhances understory development and wildlife forage and cover; **stands with over 40% canopy cover provide dispersal habitat for spotted owls. Stands with 60-70% canopy closure provide thermal cover.**

Closed Small Tree

Early to mid seral. **Coniferous** stands with 70% or greater canopy closure AND meeting one of the following size criteria:
1) Ecoclass either western hemlock, western red cedar, Douglas-fir, or grand fir and dominated by trees with stand average dbh between 9 and 20.9 inch dbh,
OR: 2) Ecoclass silver fir, mountain hemlock, lodgepole pine, park-like mountain hemlock/subalpine fir, or Engelmann spruce, and stand average dbh between 9 and 18 inches.
Poor understory development and tree density limit wildlife habitat usefulness, **although some thermal cover and dispersal habitat for spotted owls is provided.** Ground vegetation is minimal. Length of time in this condition may range from 40 to 100 years or even longer in high elevation stands.

Large Tree Single Story

Mid to late seral. Closed **coniferous** canopy (between 40% and 100%) with only one canopy layer AND one of the following two criteria:
1) Ecoclass either western hemlock, western red cedar, Douglas-fir, or grand fir and stand average dbh greater than 21 inches,

OR: 2) Ecoclass silver fir, mountain hemlock, lodgepole pine, park-like mountain hemlock/subalpine fir, or Engelmann spruce, and stand average dbh greater than 18 inches.

These stands are the result of large-scale disturbances (fire, windthrow, volcanic activity, timber harvest) and have limited understory development. Typically they lack snag development and downed woody material limiting their **current quality** as wildlife habitat (Hall et al. 1985), **although they do provide thermal cover and dispersal habitat. These stands have excellent potential for restoration activities to mimic old-growth conditions.**

Large Tree Multi-Storied

Mid to late seral. Closed **coniferous** canopy (between 40% and 100%) with two or more canopy layers AND one of two following size criteria:
1) Ecoclass either western hemlock, western red cedar, Douglas-fir, or grand fir and stand average dbh greater than 21 inches,
OR: 2) Ecoclass silver fir, mountain hemlock, lodgepole pine, park-like mountain hemlock/subalpine fir, or Engelmann spruce, and stand average dbh greater than 18 inches.

Stand structure is high in these stands (various size and layers of trees, snags, down wood). Plant diversity is also high in many cases and strongly favors shade tolerant species. Stands of old-growth are included in this category. When this stand structure is present and Douglas-fir and western hemlock codominate, optimum wildlife habitat conditions can be met (Hall et al. 1986), including thermal cover, snow interception, and optimal nesting, foraging and roosting habitat for owls.

Hardwood Shrub/Seedling

Early seral, areas where ecoclass is a hardwood type ("H" codes). Does not include areas that are of coniferous forest climax that currently have an abundance of hardwoods. Dominated by hardwood species less than 4.9 inches dbh. Typically occuring on wet or bottomland soils and/or those closely associated with riparian areas and channel disturbance regimes. When alder is present, soil **is** enriched by nitrogen input. Provides good habitat for birds and other small wildlife species. When deciduous shrubby hardwood pockets are interspersed within larger conifer stands, they provide valuable seasonal canopy gaps and enhance C-3 lichen and bryophyte habitat and diversity (Neitlich & McCune 1995).

Hardwood Sapling/Pole

Early seral. Areas where ecoclass is a hardwood type ("H" codes). Does not include areas that are of coniferous forest climax that currently have an abundance of hardwoods. Stands are dominated by young hardwood trees between 4.9 and 8.9 inches dbh; small conifers may be present, but are not dominant. Typically occuring on wet or bottomland soils and/or those closely associated with riparian areas and channel disturbance regimes. When alder are present, soil is enriched by nitrogen input (up to 320 kg/ha/yr; Pojar & MacKinnon 1994). Provides good habitat for birds and other small wildlife species. When pockets of deciduous hardwood saplings and poles are interspersed within larger

conifer stands, they provide valuable seasonal canopy gaps and enhance C-3 lichen and bryophyte habitat and diversity (Neitlich & McCune 1995).

Hardwood Trees: Large & Small

Mid seral. Areas where ecoclass is a hardwood type ("H" codes). Does not include areas that are of coniferous forest climax that currently have an abundance of hardwoods. Hardwood trees with dbh 5 inches and larger. Conifers may be present, but are not dominant. Typically occuring on wet or bottomland soils and/or those closely associated with riparian areas and channel disturbance regimes. When alder are present, soil is enriched by nitrogen input. **Important habitat for many neotropical migrant birds; provides ungulate forage and hiding cover.** When pockets of deciduous hardwood saplings and poles are interspersed within larger conifer stands, they provide valuable seasonal canopy gaps and enhance C-3 lichen and bryophyte habitat and diversity (Neitlich & McCune 1995). Bigleaf maple host the largest biomass of canopy epiphytes in the Pacific Northwest (Pojar & MacKinnon 1994), and can function as epiphyte refugia as conifer development increases.

Water

Water covered areas including lakes, ice, running water, and intermittent streams and rivers.

Wet/Mesic

Non-forested wetlands including wet/moist shrub, forb, grass meadows. Wetlands contribute to biodiversity by providing habitats for unusual plants and animals; they also play many important hydrologic roles.

Dry Meadow/Shrub

Non-forested dry habitats including dry grasslands, meadows, shrublands, and alpine meadows and shrublands with less than 10% conifer canopy. These are naturally occuring habitats that provide valuable foraging habitat, travel corridors and connectivity between habitats.

Rock

Non-vegetated land with less than 10% potential plant cover. Can provide travel corridors and connectivity between habitats.

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APPENDIX F

MUDDY RIVER WATERSHED RESEARCH

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MUDDY RIVER WATERSHED RESEARCH

Following the 1980 eruption of Mount St. Helens numerous research projects were initiated and study plots established in the Muddy River watershed. Principal investigators include scientists from a number of federal and state agencies, and universities. Study topics include an impressive array of disciplines from both the biological and physical sciences. Most of these studies were established during the early 1980's and since the late 1980's and early 1990's many have been discontinued or remeasurement interval has increased dramatically. By 1990 only a handful of the original projects are still in existence. The remainder have value beyond their period of record as they could provide a baseline or benchmark of conditions that could be used for comparative purposes should the study be reactivated. Listed below are the general topic areas, study names and Principal Investigators.

Biological Sciences

I. Vegetation:

- **Natural Revegetation of Upland Portions of the Blast Zone**, Jerry Franklin, University of Washington, Peter Frenzen, Mount St. Helens NVM

- **Recovery of Riparian Vegetation at Mount St. Helens** (streams & lakes), Art McKee, Oregon State University

- **Conifer Species Selection and Planting Technique Trials Within the Mount St. Helens Ashfall**, Pete Owston, PNW-FSL, Corvallis, OR

- **Herbaceous Evaluation: Seeding and Planting Trials**, Glen Klock, G.O. Klock & Assoc., Wenatchee, WA.

- **Herbaceous Evaluation: Seeding and Planting Trials**, Paul Heilman & Shiou Kuo, Western Washington Research and Extension Center, Puyallup, WA.

- **Forest Plant Associations**, Nancy Diaz, Mount Hood National Forest

- **Natural Reestablisment of Conifers on Lahar Surfaces**, Charlie Crisafulli and Peter Frenzen, Mount St. Helens NVM.

II. Fungi:

- **Fungal Succession and Mychorrizal Establishment**, James Trappe, PNW-FSL, Corvallis, OR.

- **Reestablishment of VA Mycorrhizae and Fungal Propagule Dispersal Vectors**, Michael Allen, San Diego State University and Charlie Crisafulli, Mount St. Helens NVM.

III. Mammals:

- **Reassembly of Small Mammal Communities Following Large-Scale Catastrophic Disturbance**, James A. MacMahon, Utah State University, Charlie Crisafulli, Mount St. Helens NVM.

- **Role of Ungulates in the Reestablishment of vegetation following Natural Disturbance**, Charlie Crisafulli and Peter Frenzen, Mount St. Helens NVM

IV. Birds:

- **Reorganization of Avian Communities Following Large-Scale Natural Disturbance,** Charlie Crisafulli, Mount St. Helens NVM and James MacMahon, Utah State University

- **Avian Community Composition and Guild Structure in a Patchy Landscape,** Charlie Crisafulli, Mount St. Helens NVM

V. Amphibians:

- **Resistance and Resilience of a Herpetofauna to a Large-Scale Natural Disturbance,** Charlie Crisafulli, Mount St. Helens, NVM and James MacMahon, Utah State University

- **Recovery of Stream Amphibians Following the 1980 Eruption of Mount St. Helens,** Chuck Hawkins, Utah State University and Charlie Crisafulli, Mount St. Helens NVM

VI. Fish:

- **Impact of the 1980 Eruption of Mount St. Helens on Montane Lake Fisheries**, Bruce Crawford, Washington Dept. of Fish and Wildlife

- **The Role of Large Woody Debris and Riparian Vegetation on Fish Habitat Following the 1980 Eruption of Mount St. Helens**, Jim Sedell, PNW-FSL, Corvallis and Chuck Hawkins, Utah State University

- **Lake Recovery Following the 1980 Eruption of Mount St. Helens**, Jim Sedell, PNW-FSL, Corvallis, OR and Cliff Dahm, University of New Mexico

VII. Insects:

- **Arthropod Recolonization of Mount St. Helens**, John Edwards and Patrick Sugg, University of Washington

- **Aquatic Macroinvertebrate Recolonization in Volcanically Impacted Streams,** Chuck Hawkins, Utah State University and, Norman Andersen and Richard Meyerhoff, Oregon State University

- **Community Reassembly following Volcanic disturbance: the ground-dwelling beetles (*Coleoptera*),** Robert Parmenter, University of New Mexico, Charlie Crisafulli, Mount St. Helens NVM and James MacMahon, Utah State University

VIII. Woody Debris:

- **Animal Use of Dead and Down Timber**, Kermit Cromack, Oregon State University

PHYSICAL SCIENCES

I. Erosional Processes, Geomorphology and Geology:

- **Stream Geomorphology, Riparian Vegetation and Fisheries**, Fred Swanson and Jim Sedell, PNW-FSL, Corvallis, OR

- **Stream Geomorphology**, Richard Janda (deceased), USGS, Cacades Volcano Observatory, Vancouver, WA

- **Hillslope Erosion Following the 1980 Eruption of Mount St. Helens**, Fred Swanson, PNW-FSL, Corvallis, OR

- **Bedrock Geology of the Spirit Lake Basin**, Paul Hammond, Portland State University

II. Nutrient Dynamics:

- **Nitrogen Dynamics in the Rhizosphere of Some Early Successional Herbs in the Mount St. Helens Blast Zone**, Joe Means, PNW-FSL, Corvallis, OR

III. Photo Points:

- **Permanent Photo points**, Peter Frenzen, Mount St. Helens NVM