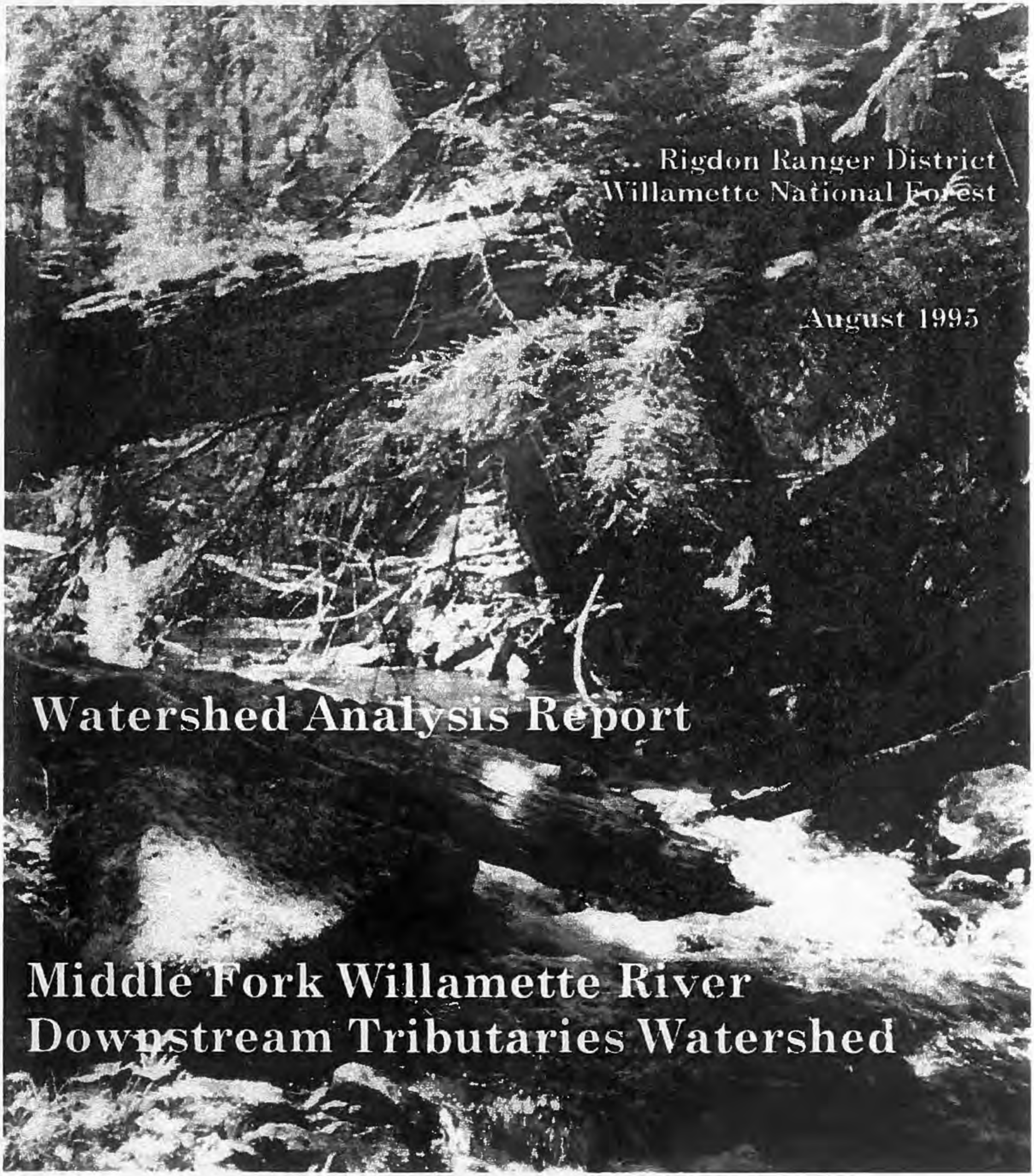
Rigdon Ranger District
Willamette National Forest
August 1995
Watershed Analysis Report
Middle Fork Willamette River
Downstream Tributaries Watershed

Watershed Analysis Report

Middle Fork Willamette River
Downstream Tributaries Watershed

Rigdon Ranger District
Willamette National Forest

August 1995

For further Information Contact: Rigdon Ranger District
Willamette National Forest
P.O. Box 1410
Oakridge, Oregon 97463
(503) 782-2266

United States Department Of Agriculture
Forest Service
Willamette National Forest
Oakridge Ranger District
46375 Highway 58
Westfir, Oregon 97492
Telephone (503) 782-2291

Caring for the Land and Serving People

Reply To: NFEM

Date: Feb. 9, 1995

Subject: Project Initiation Letter
Lower Middle Fork Willamette Watershed Analysis

To: Watershed Analysis Team

Proposed Action: Conduct a watershed analysis for the Lower Middle Fork of the Willamette watershed including appropriate private land.

Purpose and Need: The Amended Willamette N.F. Land and Resource Management Plan requires watershed analysis as the basis for project level analysis and informed decision-making to support a wide range of activities accomplishing ecosystem management.

Preliminary Issues: Major watershed processes, travel and access management, wood fiber production, and the integration of forest management activities with local Community Strategic Action Plans.

Information: Use the South Fork McKenzie Pilot Watershed Analysis, Staley Ck. Watershed Analysis and any other pilot Watershed Analysis as guides to develop our model. Use existing information, such as the Middle Fork Watershed Assessment completed in FY 94 as part of the watershed restoration program and any other appropriate materials wherever possible to meet the needs of this analysis. Limit collection of new information and/or inventories on the purpose of the analysis, desired products, available budget, and the timeline to complete the analysis.

Schedule: Complete the analysis and documentation by June 30, 1995. This timeline assumes that all funded, high priority projects dependent on this analysis can be accommodated. It further assumes that individual specialists will have this work as a top priority but will be available to work on other high priority projects. If work scheduling conflicts arise, that are likely to lead to priority work not meeting schedule, I want to be involved in the decision.

Product: A documented Watershed Analysis, following the guidelines in A Federal Agency Guide for Pilot Watershed Analysis including stratification of the watershed by key processes, functions and conditions; past and current watershed conditions; watershed trends; considerations for proposed future management; and documentation of assumptions. Insure that the product meets current Forest and Regional standards and is designed as a "living document".

Collect and document information necessary to support site specific project analysis, including recreation activities, access and travel management, watershed restoration and enhancement, vegetation management including timber sales. A process must be developed for the identification of specific areas to review and/or establish Riparian Reserve boundaries.

Due to time and funding constraints, you should consider applying different analysis emphasis to different geographical areas based on the key questions.

Team: Resources represented on the Core Team will include Wildlife (Ken Kestner), Fish (Denise Hann), Soils and Geology (Mark Leverton), Hydrology (Maureen Campbell), Social and Recreation (Frank Carson), Vegetation (John Agar), Information Management Coordinator (Hal Stadel), Writer/Editor and Team Coordinator (Leslie Heaton). Additional resources assigned to this project include GIS (Laura Hoffman), Fire (Chas Rassler), Botany (Ken Kestner), Transportation (Keith Wheeler), and Heritage Resources (Jane Agar). Additional skills may be assigned as needed. The COE has been invited to participate in this effort. To the extent they are able I want them to participate as full team members.

Potential Public and other Agency Information Sources: Community leaders, share cost partners and other private forest industry landowners, Oregon Department of Fish and Wildlife, U.S. Army Corps of Engineers, Oregon Department of Forestry, Soil Conservation Service/Resource Conservation and Development District, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Oregon State University, PNW Forest and Range Experiment Station, representatives from environmental and recreation user groups and partners.

Initial Activities: Discuss and understand this assignment, confirm Team composition, identify major tasks, identify additional skills necessary in addition to those specified, develop a rough timeline for activities, and identify funding needs. I would like this step done, as much as possible, prior to our joint meeting with Lowell and Oakridge Ranger Districts on Feb. 16.

Checkpoints with the District Ranger:

Identification of: Initial Activities including Schedule,*
Issues and Key Questions,*
Information Needs Analysis,
Public Involvement Plan
Step 4 of New Guidelines (Benchmarks)
Findings and conclusions.*

Periodic Updates.

The Forest Supervisor must be invited to participate in those items identified by an *.

ROBERT L. BARSTAD
District Ranger

RICK SCOTT
District Ranger

Table of Contents

Chapter 5 Intrepretation and Trends

Chapter 6 Recommendations

Abbreviations and Acronymns

APHIS	Agricultural Plant Health Inspection Service
BLM	Bureau of Land Management
C&H	Cattle and Horse
COE	Corps of Engineers
DEQ	Department of Environmental Quality
GIS	Geographic Information Systems
HEI	Habitat Effectiveness Index
LSR	Late-Successional Reserve
LSRS	Late-Succesional Reserve for the Northern Spotted owl
LWM	Large Woody Material
MFW	Middle Fork Willamette
MFWDT	Middle Fork Willamette River DownstreamTributaries Watershed
NF	National Forest
OCMWR	Oregon Central Military Wagon Road
ODFW	Oregon Department of Fish and Wildlife
PAOT	Persons At One Time
PSQ	Probable Sale Quantity
R6	Region 6
ROD	Record of Decision
RVD's	Recreation Visitor Days
S&MS	Survey and Manage Species
SIA	Special Interest Area
TE&S	Threatened, Endangered and Sensitive
TSI	Timber Stand Improvement
TSZ	Transitional Snow Zone
USBF	United States Bureau of Fisheries
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WNF	Willamette National Forest

Introduction

Middle Fork Willamette River Downstream Tributaries Watershed

This introduction describes the purpose, scope and objectives of the Middle Fork Willamette River Downstream Tributaries Watershed Analysis. It defines the issues addressed in the analysis.

Purpose Of The Watershed Analysis

The purpose of the Middle Fork Willamette River Downstream Tributaries (MFWDT) Watershed Analysis is to develop and document the processes and interactions occurring within this Watershed. This information will be the basis for future project level analysis. The analysis will assist the decision makers in selecting a wide range of activities that accomplish ecosystem management.

Scope And Objectives

The analysis will answer questions relating to the identified issues of concern for the MFWDT Watershed. The report will collect and document information necessary to support future site specific project analysis.

Potential Future Projects

- recreation activities
- an access and travel management plan
- restoration and enhancement projects
- vegetation management activities
- riparian reserve management activities

The report is in loose-leaf binder for ease in updating and revising the analysis as new or different information becomes available.

Tiering

At the Forest level, this analysis is tiered to, *The Willamette National Forest Land and Resource Management Plan, amended by the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl*, hereafter referred to as the Forest Plan (USDA,1994).

The Middle Fork Willamette Downstream Tributaries Watershed has had several recent analyses completed. *The Analysis of the Coast Fork and Middle Fork of the Willamette River* (USFS,1994) provides a view of the landscape at the river basin scale. The *1994 Preliminary Assessment of the Middle Fork of the Willamette River Watershed Restoration* (USFS,1994) was completed as part of an effort to provide local employment opportunities for the Jobs in the Woods program. *The Middle Fork Willamette River Downstream Tributaries Watershed Analysis* (USFS,1995) was completed as an abbreviated watershed analysis to provide management guidelines until a more intensive analysis is complete.

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Methodology

The draft document *Ecosystem Analysis at the Watershed Scale: The Revised Federal Guide for Watershed Analysis, version 2.1,* hereafter referred to as the Ecosystem Analysis Guide provided guidance for our analysis (USFS, et al,1995). A variety of sources, including GIS tools, PC programs and databases, were used in acquiring information for this document.

Definition of Issues

The issues were initially developed in conjunction with the North Fork Willamette Watershed Analysis Team on February 9, 1995. Several iterations of those original issues have occurred with the MFWDT Watershed Team. Chapter 2 describes the issues in detail. The following gives a brief introduction to the concerns in this Watershed.

Intensity And Pattern Of Vegetation Manipulation

The intensity and pattern of vegetation manipulation activities across the landscape have resulted in vegetation patterns outside the range of natural conditions.

Exclusion Of Natural Fire

The exclusion of wildfire has altered the vegetation pattern and diversity of the forest structure. The exclusion has allowed an increase in fuel loadings.

Transportation System

Many roads in this Watershed have exceeded their designed service life and are in varying stages of deterioration. This may create detrimental environmental conditions. Existing stream crossing structures that pose a substantial risk to riparian conditions are to be improved to accommodate at least a 100-year flood event. Roads affect the habitats of both plants and animals. Roads also provide a transport mechanism for non-native plants.

Introduction And Spread Of Non-Native Species

The introduction and spread of non-native species may affect the viability of Threatened, Endangered or Sensitive species and native natural habitats.

Infrastructure

The existing facilities and associated acitivities may affect the Watershed resource values and processes.

Hills Creek Dam And Lake

Hills Creek Dam has affected the hydrologic regime, terrestrial and aquatic ecosystem, and the stream channel and flood plain morphology. Bull trout distribution has been impacted. Spring Chinook spawning habitat has been impacted. Types of recreation use are affected by Hills Creek Lake pool levels.

Chapter 1

Characterization

Middle Fork Willamette River Downstream Tributaries Watershed

This chapter provides a description of the physical, biological and social features of the Watershed.

Physical Features

Location

The Middle Fork Willamette Downstream Tributaries Watershed is in eastern Lane County and northern Douglas County, Oregon. It is a portion of the headwaters of the Middle Fork Willamette Sub-basin of the Willamette Basin, which is part of the Columbia River system (Figure 1). It extends from the Calapooya Mountains to the city of Oakridge and from Staley Creek west to the boundary of the Umpqua National Forest. Included in this Watershed are the majority of Hills Creek Lake and Dam, a portion of the Middle Fork Willamette River (MFW), and the city of Oakridge. Four Subwatersheds compose the MFWDT Watershed (Figure 2).

Hills Creek Dam, on the north central boundary of the Watershed, controls the flow of the MFW River downstream. Construction began in 1959 and was completed in 1963. Hills Creek Lake has a storage capacity of 234,300 acre-feet and covers approximately 2,735 acres. The MFWDT boundary does not include the Hills Creek Arm of the lake.

The Watershed covers approximately 110,000 acres. Eighty-six percent of the land is the Willamette National Forest. The Corps of Engineers administers some land adjacent to and downstream of Hills Creek Dam.

The majority of the remaining land is the city of Oakridge and timber lands owned by Seneca Jones Timber Company. A contiguous block of about 9300 acres of Seneca land falls within the western portion of the Watershed.

The Forest Plan established various land allocations within the MFWDT. Figures 3 and 4 display the location of the areas. A Late-Successional Reserve (LSR) incorporates much of the western and southern side of the Watershed. LSR 0222 acreage includes the 100 acre LSRS's in Table 1. Riparian Reserves cover a large area of all of the allocations. The acres of Forest Matrix lands exclude the LSRS's. A summary of allocation acres is in Table 1.

Table 1: Acres by Allocation

FOREST PLAN ALLOCATION	ACRES
LSR and LSRS	44,300
Forest Matrix	47,960
Hills Creek Lake	2,240
Corps of Engineers	360
Private Land	15,140
Total Watershed	110,000

Figure 1: Middle Fork Willamette Downstream Tributaries

Vicinity Maps

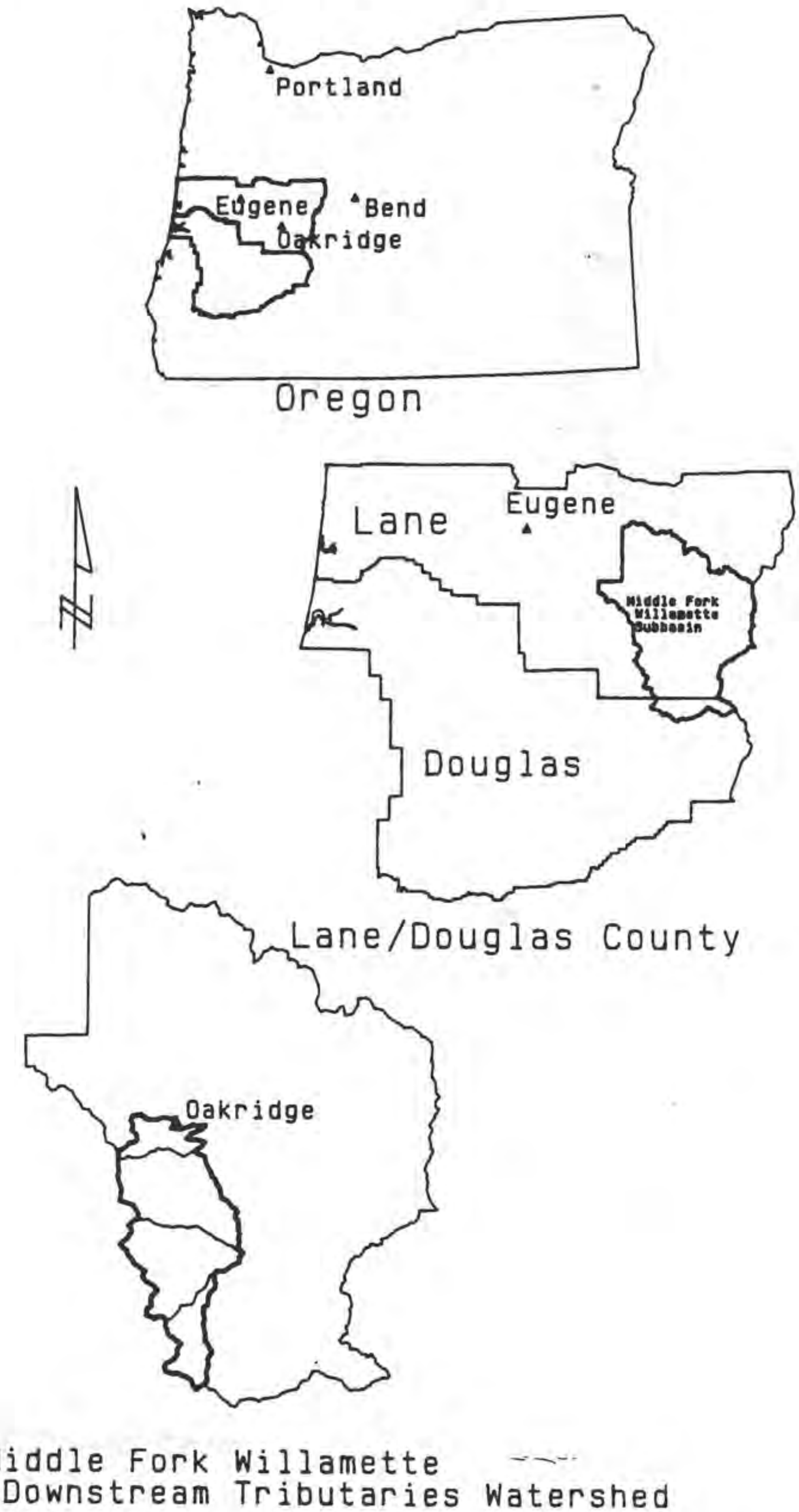


Figure 2: Middle Fork Willamette Downstream Tributaries

Subwatersheds

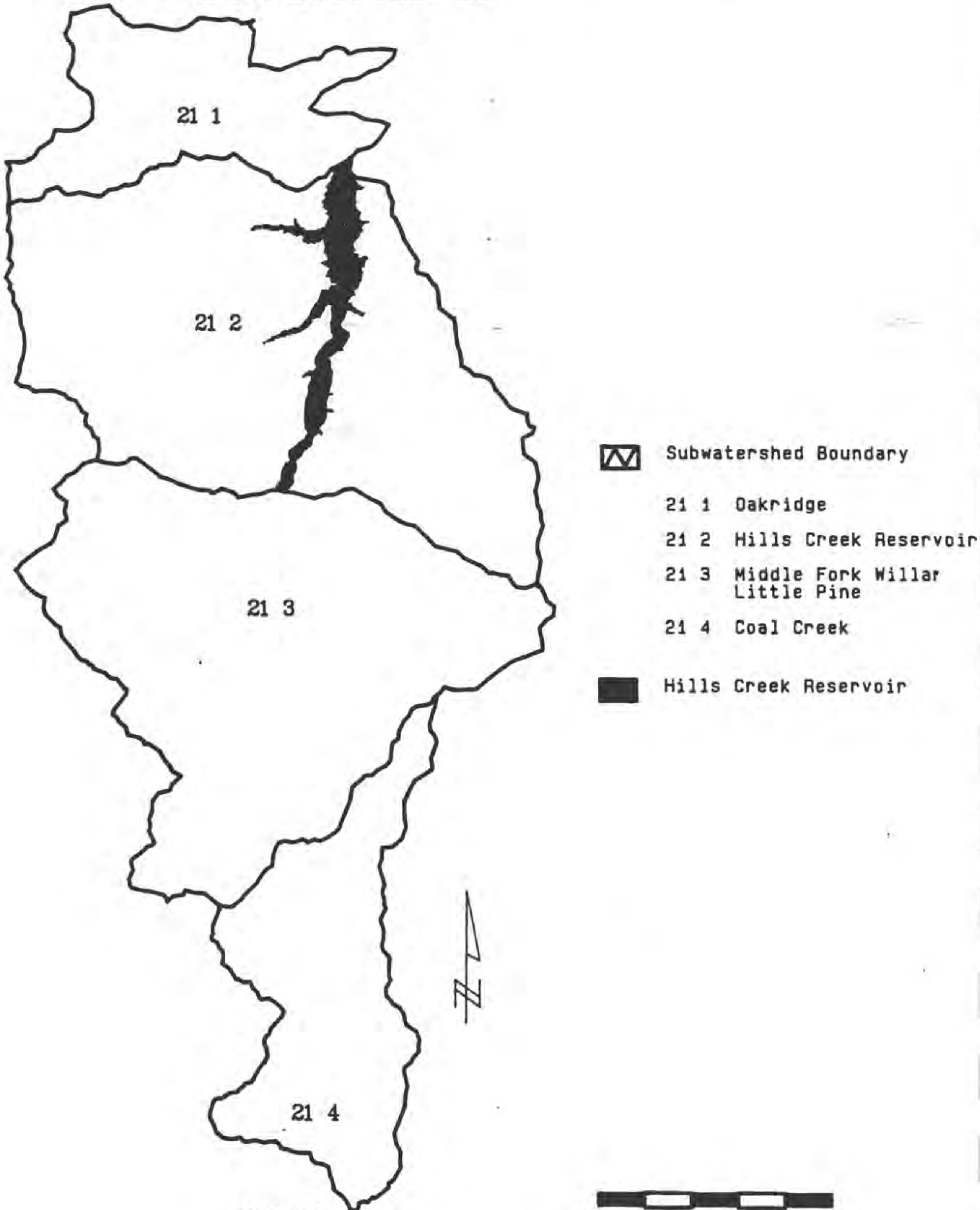


Figure 3: Middle Fork Willamette Downstream Tributaries

Ownership Pattern

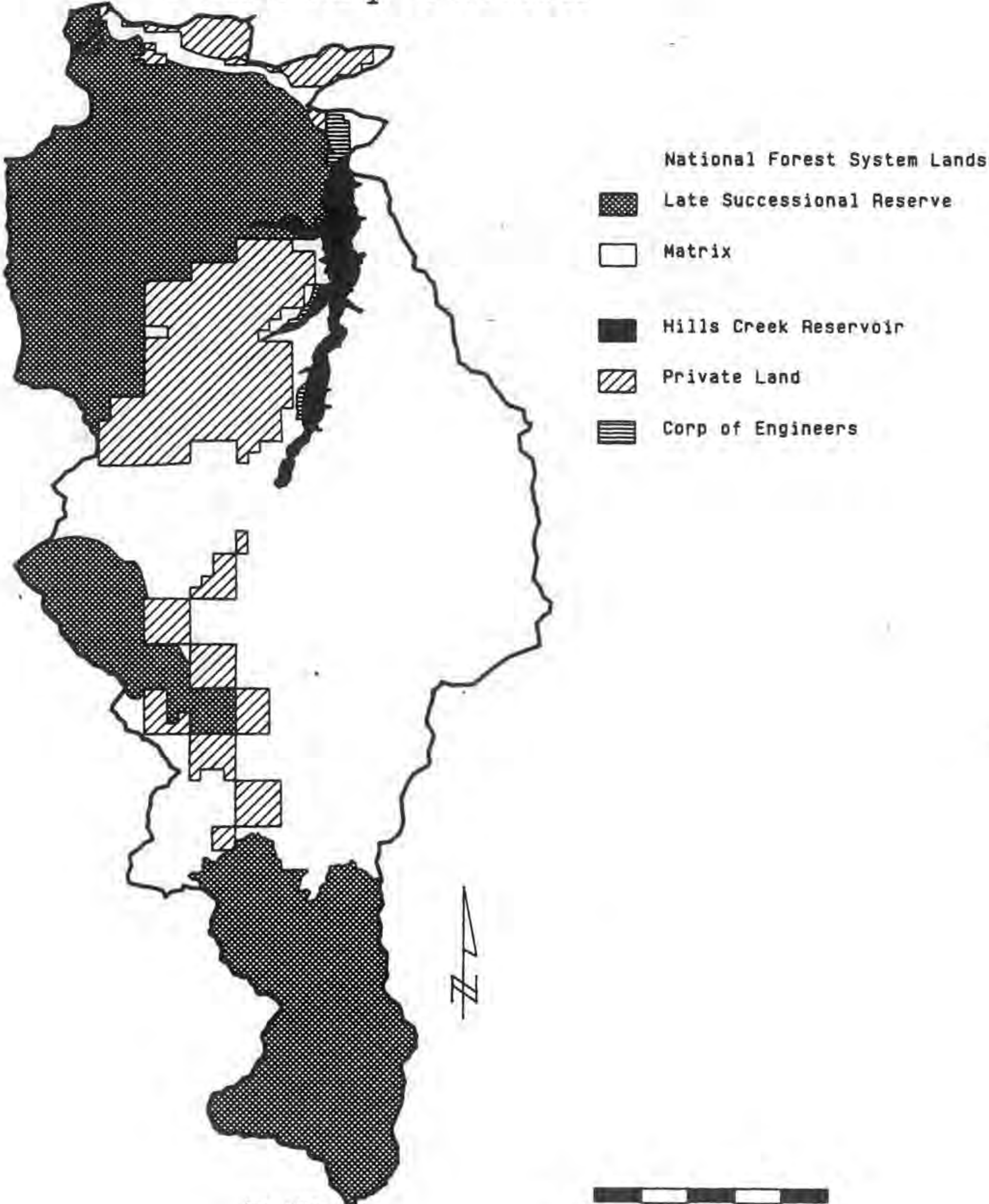
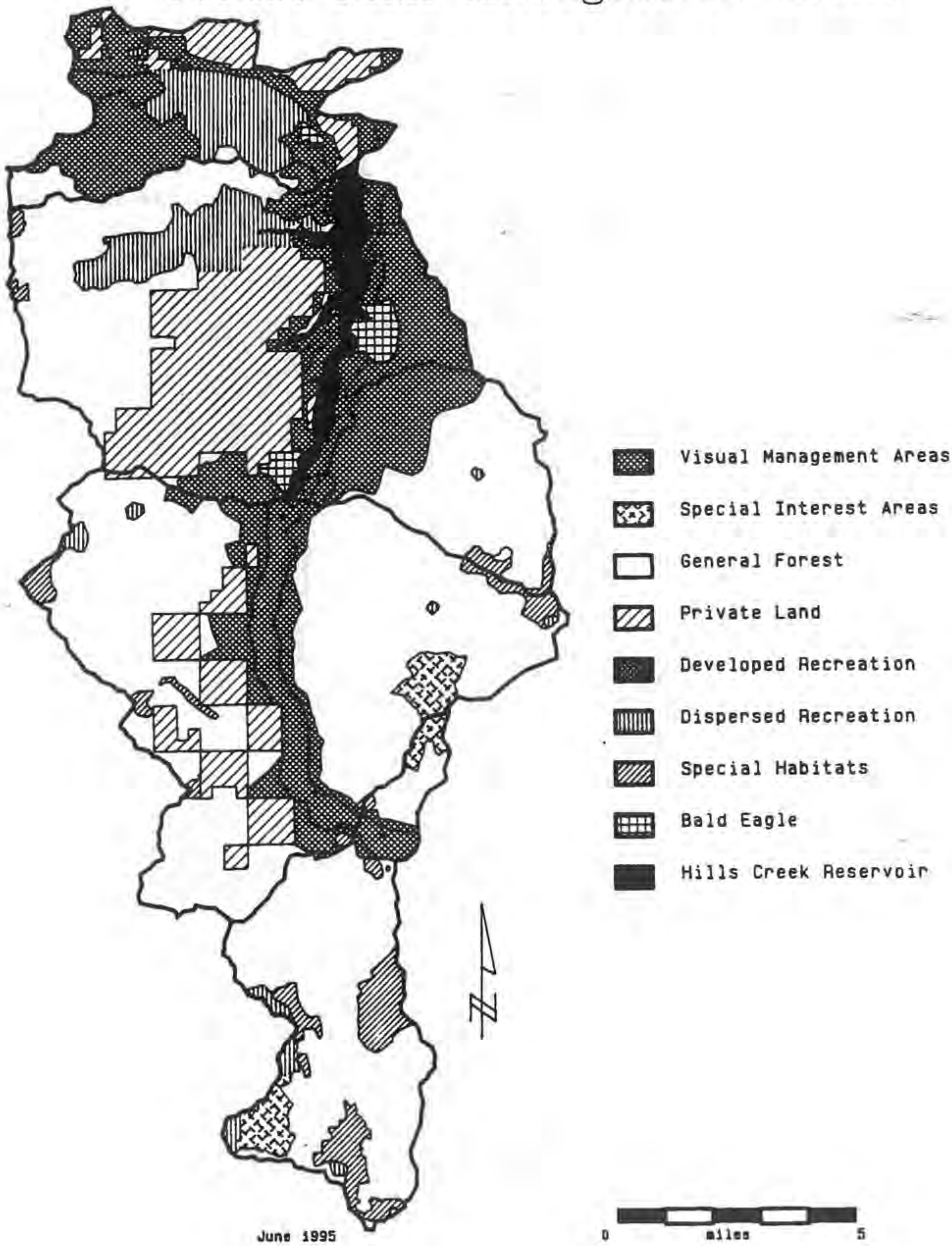


Figure 4: Middle Fork Willamette Downstream Tributaries

Forest Plan Management Areas



Geology and Soils

The Watershed lies within the Western Cascades subprovince of the Cascade Range. The area divides into a north and south section by imagining a line connecting Bearbones Mountain, Joe's Prairie and Buck Mountain. Pyroclastic rocks with minor amounts of lava flows and intrusions primarily compose the northern area. The southern area is predominantly of basaltic and andestic lava flows.

Remnants of alpine glaciation are evident in the southern reaches of Coal Creek and the upper end of Buck Creek in the Warner Mountain area. Broad U-shaped valleys are being reshaped by streams that are modifying the valley configuration by either incising downward as in Coal Creek or eroding headward as in Buck Creek. Another less obvious remnant of alpine glaciation is the tremendous amount of cobble and boulder-rich alluvium that occupies the Middle Fork Willamette River channel and sideslopes.

Road construction has had a great impact in activating mass movements beyond the natural erosion cycle. The highest frequency of road related failures on the Rigdon Ranger District occur within the MFWDT Watershed.

Climate

The Watershed has the typical Pacific Maritime climate with wet, cool winters and dry, warm summers. The southern portion of the MFWDT exhibits more dry site conditions than the rest of the WNF due to the influcence of the Calapooya Mountains. Elevation ranges from 1200 feet at Oakridge to 6130 feet near the southern portion of the Watershed. Average rainfall is approximately 40 inches per year in the city of Oakridge. The higher elevations receive up to 70 inches of rainfall per year (WNF,1981).

Hydrology

The Middle Fork Willamette River Downstream Tributaries is typical of many western Cascades Watersheds. Approximately 78% of the MFWDT is in the transitional snow zone (TSZ) where rain-on-snow events are common. This high percentage makes rapid flood peaks and high flows associated with rain-on-snow events a dominant hydrologic process in the Watershed.

Biological Features

Terrestrial Vegetation

The MFWDT Watershed has the 5 major conifer series that exist on the Willamette National Forest. The series, listed in order from the most common to the least common, are: Western hemlock, Douglas-fir, Pacific silver fir, grand fir, and mountain hemlock. The understory species are typical of Western Cascade forests. Rigdon Ranger district has significantly drier climatic conditions than the rest of the Willamette National Forest.

The Western hemlock series is located throughout the entire Watershed at low to mid elevations.

Douglas-fir series occur on warm, relatively dry sites at lower elevations on south and west slopes. This series is a northern extension of the Sierran mixed conifer forests common in the southwestern Oregon Cascades, Siskiyou Mountains, and Sierra Nevada Range (Franklin and Dyrness,1973). This is the driest environment capable of supporting a closed forest canopy on the Willamette and is rare north of the McKenzie River. A unique feature for this series in the MFWDT is the ponderosa pine band in the lower Youngs and Deadwood Creek area. The ponderosa pine band follows a lower precipitation area that goes up the MFW River.

Pacific silver fir series dominate the upper slopes above 4000 feet. This series is predominate in the Warner Mountain-Groundhog area, Bristow Prairie, Gertrude Lake area and Steeple Rock.

Grand fir series tend to dominate the relatively well drained and dry slopes from 1800 to 4500 foot elevation. Mountain hemlock series dominate the cool, wet upper ridges and flats as in Upper Coal Creek.

Non-forested habitats contribute significantly to plant and animal diversity across the MFWDT. Concentrations of rock outcrops, rock gardens, meadows and ponds are in the higher elevations.

Vegetation and Fire

Past forest fires were instrumental in shaping the pattern of vegetation in the MFWDT. Approximately 80 percent of the Watershed has had some type of fire at one point in time. Stand replacement fires are now significantly less frequent and smaller than they were between the years of 1680 through 1918. The exclusion of wildfire from the ecosystem through modern fire suppression techniques changed the vegetative pattern of the landscape and increased fuel loading due to less frequent underburning. The most recent large fire was

Shady Beach Fire. It burned over 9,000 acres in the fall of 1988. Approximately 3,300 acres are in this Watershed.

Riparian Conditions

Riparian vegetation conditions vary on National Forest lands because of past management practices, floods, mass movement events, and fire history. Past timber management practices have been a factor in the decrease of the large wood component of the stream system and the removal of riparian vegetation. Maximum stream temperatures on many streams do not meet Oregon water quality standards, primarily due to removal of shade producing riparian vegetation and channel widening (USFS,BLM,COE,1994).

Reforestation history

Incidental harvesting of timber began with early settlements in the 1850's. Harvest concentrated along the Free Emigrant Route that later became the Oregon Central Military Wagon Road (OCMWR). Increased harvest began in the late 1940's with associated increase in the transportation system. Heavy harvest of the east 1/3 of the Watershed occurred because of easy accessibility.

Harvest levels were about 2500 acres by decade in the late 1940's and 1950's and rose to a peak of 7900 acres in the 1980's. Regeneration cuts were mainly clearcuts with broadcast burning used for site preparation. Burning has been reduced to meet air quality standards. Regeneration harvest with reserves have replaced clearcuts as the method of harvest.

Early reforestation was natural or aerial seeding. Planting of seedlings replaced the early techniques to increase reforestation success.

Botanical Species

The MFWDT has two known sites of Thompson's mistmaiden, an R6 Sensitive Species. This is an annual mistmaiden found in rock garden and rock outcrop habitats (Dimling,1995).

Several rare and unique species are in the Watershed. Of special interest are species usually found in the desert foothills and mountains on the east side of the Cascade Mountains. Other species of interest are those with populations reaching the ends of their range. A mountain mahogany, from the Moon Lake Special Interest Area, wapato from the edge of Bradley Lake and the large-flowered brickellia are the only known populations of these species on the Willamette National Forest (Dimling,1995).

A Survey and Manage Species (S&MS), the candystick, is an old-growth dependent species found in the MFWDT.

Moon Point and Bradley Lake are two Special Interest Areas (SIA) in the MFWDT. Both were designated SIA's because of their botanical richness.

Non-Native Species

A number of established populations of noxious weeds are in this Watershed. They include Scotch broom, tansy, St. John's-wort and thistles. Little Groundhog Meadow is an extreme example of St. John's-wort outcompeting the native species. This has caused a severe reduction in the biological diversity of the site. Newly invading weeds include spotted and diffuse knapweed and giant knotweed.

Bullfrogs and barred owls are non-native wildlife species of concern in the MFWDT.

Calapooya Mountains

The Calapooyas are a unique feature in the Watershed. They essentially ring the southwestern and southern part of Rigdon Ranger District. They form a physical and climatic barrier for plant species migrating south, north and west. The Calapooyas could act as a refugia for species during global climatic change because of the range of habitat types and species (Dimling, 1995). They function as a rain shadow allowing establishment of dry site species.

Terrestrial Wildlife

Habitat conditions are the prime determinants of wildlife species and numbers. Species of concern found within the MFWDT are Northern Spotted owls, Bald eagles, Peregrine falcons, western pond turtles, red-legged frogs, and tailed frogs. The Townsend's big-eared bat, the Great Gray Owl, and the Harlequin duck have been seen or heard within the Watershed but without a confirmed nest site.

Roosevelt elk utilize the east side of the Middle Fork Willamette River and the Coal Creek drainage more than other areas in the MFWDT. All three management classifications of emphasis areas occur within the Watershed.

Aquatic Wildlife

Important endemic fish species in this Watershed are Spring Chinook salmon, Bull trout, and resident cutthroat trout.

Spring Chinook were the only endemic anadromous fish in the MFWDT. The Watershed historically supported about 20% of the native Spring Chinook run for the entire Willamette Basin. Blocked passage is from Hills Creek Dam in this Watershed and downstream by Dexter and Lookout Dams.

There was a historical distribution of Bull trout in the Willamette Basin. There are reports of a small adfluvial population of adults and sub-adults from Hills Creek Lake to approximately 16 miles upstream on the MFW River (Unthank and Sheehan,1992).

Resident cutthroat trout are present in most Class II streams. The status of these populations is unknown.

Social Features

Human Use

The MFWDT has a diversity of resources ranging from abundant fish, small mammals, big game and prolific vegetation. This provided choice human habitat for at least 6,000 years. Ethnographic evidence from low elevation sites suitable for year round use, to aboriginal trails providing travel routes accessing a multitude of diverse upland resources currently remain in this Watershed.

Native Americans

Beginning at least 1,500 years ago, Kalapuyans occupied the Upper Willamette Valley and its tributaries, including the MFWDT. The Southern Molalla migrated into the Upper Willamette, pushing out the Kalapuyans after AD 1600 (Swanton 1968). The horse, acquired at white contact, enabled the Klamath Indians to travel over the Calapooya Divide via Staley Ridge and down the Middle Fork.

By 1855, most of the Indians who survived the influx of disease brought by white settlements, were relocated to reservations at Grand Ronde and Warm Springs.

Early Settlers

During the early 1800's Euroamericans began moving into the Willamette Valley. By mid-century, settlements were developing along the MFWDT.

Records indicate that several cabins existed in the area of Oakridge. To gain access to the Calapooya Divide, settlers widened existing Indian trails for their herds of livestock. Some of the trails included the Staley Ridge Trail and the trail that later became the Oregon Central Military Wagon Road (OCMWR).

The OCMWR is the most completely documented route of 19th century travel in Oregon. Initial interest in this route began in the spring of 1852 when residents of the upper Willamette Valley explored the Middle Fork trying to find a route over the Cascades. The road was to become a major route of emigration for the second generation of Oregon pioneers

By the 1870's, interest in the economic potential of the timber available in the Cascades resulted in utilization of the Middle Fork Willamette River to drive logs to mills in the Eugene area (Mason 1973).

In 1893, the Cascade Range Forest Reserve was established under the auspices of the U.S. Department of the Interior. Initially it was a closed area, but by 1897 the land reopened to settlers, miners, ranchers and lumbermen.

Early Twentieth Century

In 1908, the U.S. Forest Service created the Umpqua National Forest in the Cascade Mountains from the Cascade Reserve. In 1911, lands north of the Calapooya Divide were placed under the jurisdiction of the Cascade (now Willamette) National Forest that later included the Oakridge Ranger District. In 1947, some of the Oakridge Ranger District became the Rigdon Ranger District.

Advent of the contemporary road system and the logging truck expedited development of the Upper Willamette Valley. In the 1920's, the Westfir Lumber Company Sawmill was constructed.

Current Situation

Economics

Timber harvest volumes began to rise in the late 1960's and peaked in the middle 1980's. The economies of both Westfir and Oakridge were driven by the operation of the Edward Hines Lumber Mill and the later operation of Pope & Talbot, Inc. Lumber mill. In the early 1980's the Edward Hines Lumber Mill ceased operation. In the late 1980's, Pope & Talbot, Inc. removed all of their standing timber and divested itself of their Oakridge holdings. These mill closures ended the reliance on primary wood products. As the mills were major employers in this area, many families left in search of similar employment. The economy began diversifying with establishment of secondary wood products industries, small business manufacturing and tourism efforts.

Recreation

There has been an extensive effort by the City of Oakridge to promote the city as "A recreation paradise". The MFWDT is key to that idea as the majority of the campgrounds and dispersed campsites of the Rigdon Ranger District are within this Watershed. Most of the district's recreation use occurs here during spring, summer and fall. Activities include developed and dispersed camping, driving for pleasure, sightseeing, hiking, mountain biking, fishing and hunting.

Hills Creek Lake and the Middle Fork Willamette River provide a significant recreation area for water sports in the MFWDT. Sports such as water-skiing, sailboarding, kayaking, canoeing, and late winter fishing are very popular.

The reach of the Middle Fork Willamette River from Sand Prairie Campground to Echo Creek was determined to be eligible as a recreation river for inclusion into the National Wild and Scenic River System. The Outstandingly Remarkable Values are recreation, geologic and hydrologic, and wildlife resources.

Diamond Drive is a back country drive that begins on Highway 58 and continues on FS Road 21 in the northern portion of the Watershed. The drive highlights the scenic value of this area. Plans are to nominate it for inclusion into the State of Oregon's Scenic Drive system.

Chapter 2

Issues and Key Questions

Middle Fork Willamette River Downstream Tributaries Watershed

This chapter discusses the issues of concern for this Watershed. It also identifies the key questions used by the Watershed Team to assist in the analysis.

ISSUES AND KEY QUESTIONS

Initial development of the issue statements and key questions was in conjunction with the North Fork Watershed Analysis Team on February 9, 1995. Several iterations of these original thoughts have refined the issues. The issues and questions are coded to facilitate reference to them throughout the document. An alphabetical coding is used to identify the issue. The questions are listed by the alphabetical coding and then a number.

ISSUE VM Intensity And Pattern Of Vegetation Manipulation

Intensity and pattern of vegetation manipulation activities have altered the landscape processes. Timber harvest and the associated reforestation activities have played a significant role in shaping the vegetation patterns within this Watershed. Precommercial thinning and vegetation manipulation activities for resource enhancement projects have also altered the landscape. The resulting landscape pattern may be outside the range of natural variability. The intensity of these activities has exceeded the natural level of disturbance.

Fragmentation of the interior habitat has affected the composition of plant and animal species within the MFWDT Watershed. Fragmentation of late-successional forests and isolation or removal of riparian forests, affects the dispersal of organisms across the landscape by reducing habitat connectivity.

Early management activity has simplified the forest structure inside and outside riparian reserves, within the floodplain and the stream channels. Salvage done throughout the Watershed, left few snags for structure and future large woody material available for nutrient recycling.

The intensity of harvest activities has had a range of effects on processes within the MFWDT. The amount of vegetation disturbance has affected surface erosion and mass movement rates, altered timing and duration of peak flows, decreased water quality, and has altered floodplain and stream channel conditions, processes, and aquatic habitat.

KEY QUESTIONS

- **VM1** Compared to natural conditions, where have the intensity and pattern of vegetation manipulation affected plant and animal habitat diversity, species composition, amount of interior habitat, and habitat connectivity?

- **VM2** Compared to natural conditions, where have the intensity and pattern of vegetation manipulation affected ecological site productivity?

- **VM3** Where and to what extent have the changes in spatial and temporal distribution of vegetation influenced water yield, and peak flow? Where have these changes in hydrology affected channel function and habitat condition?

- **VM4** What are the most important delivery mechanisms for sediment generated by vegetative disturbances in this Watershed? What are relative rates of delivery by land form or slope to stream? Where are the high risk areas for generating, delivering or depositing sediment?

- **VM5** Where and to what extent has vegetation manipulation affected riparian and aquatic habitat complexity?

- **VM6** Given current Forest Plan direction, where and how many acres are available for vegetation manipulation?

ISSUE NF Exclusion Of Natural Fire

Modern day fire suppression has effectively reduced wildfire as a major factor in shaping the vegetation landscape patterns and processes. This reduction has resulted in increased fuel loadings and has altered the diversity of the forest structure. Suppression may have altered the habitat or abundance of Threatened, Endangered or Sensitive species or fire dependent species.

Increased fuel loadings may be of special concern within the Late-Successional Reserve (LSR) where there may be less opportunity for vegetation management activities to modify fuel accumulations.

KEY QUESTIONS

- **NF1** What is the comparison of the fire pattern, fire behavior and burn intensity between the current fuel loading conditions and the conditions before modern day fire suppression activities?

- **NF2** How has habitat diversity changed with modern day fire suppression?

- **NF3** How have fire pattern and behavior affected Threatened, Endangered and Sensitive species, and fire dependent species?

ISSUE TR Transportation System

- Roads

This Watershed has an extensive transportation system. Some of the roads in the MFWDT are past their designed service life and are in varying stages of deterioration. These roads were designed for periodic maintenance using forest management activity receipts.

The Forest Plan requires that existing culverts, bridges, and other stream crossing structures posing a substantial risk to riparian conditions are to be improved to accommodate at least a 100-year flood event. The May, 1995 Culvert Assessment Survey indicate many stream crossing structures in this Watershed do not meet the 100 year flood standard.

Roads affect habitats for both plants and animals. Road traffic can be a disturbance mechanism for wildlife sensitive to noise or human presence. Roads also provide a transport mechanism for non-native plants.

Trails

The location and use of trails may be a factor in contributing sediment into the stream system.

Access

The transportation system in this Watershed allows extensive administrative and recreation access. Altering the system changes traffic patterns, recreational and administrative uses. Local economies, depending upon accessibility to large amounts of land, can be affected.

KEY QUESTIONS

Roads

- **TR1** Where and to what extent have the density and condition of roads influenced natural and management induced disturbances?

- **TR2** What sections of roads are currently introducing or have the potential to introduce excessive amounts of sediment into the stream system? Where and to what extent does the influx of sediment influence channel conditions?

- **TR3** Where and to what extent have the density and configuration of roads affected surface and subsurface hydrology.

- **TR4** Where are high risk or high priority stream crossings that do not have drainage structures designed to withstand 100 year events?

- **TR5** What are the possible resource effects of maintaining system roads at expected funding levels?

- **TR6** Where and to what extent have roads affected fish passage and riparian reserves?

- **TR7** Where and to what extent are the road locations and their use affecting wildlife and botanical species and special habitats

Trails

- **TR8** Where and to what extent has the condition and use of trails altered earth movement disturbances?

Access

- **TR9** How and to what extent does changed travel access influence potential human caused fire ignitions and suppression response time?

- **TR10** How does changed travel access effect public and administrative use of the forest and local economics?

ISSUE NS Introduction And Spread Of Non-Native Species

Introduction of a number of non-native plant and animal species occurred during the period of European occupation. These introduced species may be successfully competing against the native plants and animals. Disturbance from human activities allow these non-native species to persist.

The Forest Plan emphasizes management of native plants and animal species over non-native species. Introduction of non-native species was either accidental or on purpose for a variety of reasons. Some introduced species are deliberately chosen for resource management activities such as big game forage and stabilization of cutbanks. The extensive road system in the Watershed allows for continued dispersal and colonization. The Oregon State Department of Agriculture has classified some of these plants as noxious weeds. Some non-native plants are not noxious weeds but spread easily with frequent ground disturbing activities and may impact native species.

There is particular concern when the existence and spread of these non-native plants and animals have the potential to affect the viability of Threatened, Endangered or Sensitive species. Some wildlife species of concern are western pond turtles, native amphibians, and Northern spotted owls.

KEY QUESTIONS

- **NS1** Where and to what extent has introduction of non-native species affected native flora and fauna?

ISSUE EI Infrastructure

A number of administrative, community oriented, and industrial infrastructure facilities occur within the MFWDT Watershed. These facilities include a portion of the city of Oakridge, power lines, road rights-of-way, a railroad, four developed campgrounds, two day use recreation sites, numerous dispersed recreation sites a sewage treatment plant, one fire lookout, various helispots, and water sources used for administrative activities. These facilities may or may not have effects on the resource values of this Watershed.

KEY QUESTIONS

- **EI1** Where are existing and potential infrastructure land uses?
- **EI2** Does the presence and use of these facilities affect the Watershed resources?

ISSUE HL Hills Creek Dam and Lake

Hills Creek Dam is one of 13 projects constructed for the purpose of controlling Willamette Valley flooding. During the rainy season from November through early February, a maximum of flood control storage space is provided.

There are several processes associated with the filling of Hills Creek Lake that changed the MFWDT. They include: 1) Changing the terrestrial and aquatic riparian habitat quality from a floodplain riparian complex to an upland riparian complex; 2) Changing aquatic species composition with the introduction of exotic fish; and 3) Blocking migration passage for Spring Chinook and bull trout.

The lake system established new processes. These include: 1) Lake turbidity from a fluctuating drawdown zone; 2) A change in downstream stream habitat complexity, and 3) recreation uses.

KEY QUESTIONS

- **HL1** How has the change from a river system to a lake (reservoir) system affected the aquatic ecosystem? What are the fish and wildlife species that have blocked or disrupted migration patterns?

- **HL2** How has the species composition changed with the filling of the lake? What are management opportunities?

- **HL3** What is the affect of the lake drawdown on lake turbidity? What are the restoration opportunities?

- **HL4** How has the channel downstream of the dam been altered since the construction of the dam? How has this alteration affected the aquatic ecosystem?

- **HL5** To what extent has the dam modified the average flows during all times of the year, and the average annual peak flows? How have these modified flows affected flood plain processes, functions, and their associated riparian area habitat?

- **HL6** How has the dam affected the sediment distribution and transport capability of the channel downstream of the dam?

- **HL7** How has the cooler water released from the dam in the spring and early summer affected aquatic species? How has the warmer water released from the dam in the late summer and early fall affected aquatic species?

- **HL8** What recreation opportunities are provided by Hills Creek Lake? How can these opportunities be enhanced? What is the affect on local economy?

Issues Identified But Not Analyzed

The following two issues were originally identified for the Middle Fork Willamette Downstream Tributaries Watershed Analysis but were not carried forward.

- **Need to restore and maintain habitat for future reintroduction of Spring Chinook salmon and bull trout.** This is a concern within the Watershed but is addressed under the vegetation and Hills Creek Dam issues. The results of this analysis will help us meet the objectives of the Aquatic Conservation Strategy Plan.

- **Demand for specialty forest products.** Demand for these products has recently increased and may continue to increase in the future with the potential of causing resource impacts. This is a management issue covered with Amendment No. 23 to the Forest Plan (USFS,1993) and the Special Forest Products Environmental Assessment (USFS,1993). The issue is not a key issue.

Chapter 3

Reference Conditions

Middle Fork Willamette River Downstream Tributaries Watershed

This chapter describes the historical physical, biological and social conditions of the Watershed.

The discussion about the reference conditions of the Middle Fork Willamette River Downstream Tributaries is specific to the major issues identified for the Watershed. Each issue discussion will answer key questions that relate to processes and functions in the Terrestrial, Aquatic and Social Domains. The parameters chosen represent a changing process or function in the MFWDT. They represent single measurements out of complex ecological processes. The summary chart is to help the reader get an overview of the interrelationships.

Issue (VM) Vegetation Manipulation

The timeframe for the historical setting of the MFWDT for vegetation manipulation is from 1835 until the late 1940's. Harvest of timber replaced natural fire as the largest factor shaping the landscape in the late 1940's.

Table 2: Reference Functions/Processes For Vegetation Manipulation

Domain	Question	Function Process	Mechanism/Cause	Parameter Measured
Terrestrial	VM1	Habitat Diversity	Natural Disturbances	% Seral Or Developmental Stage Species Composition
	VM1	Habitat Connectivity	Natural Disturbances	Distribution And Size Of Vegetation Patches
	VM1	Interior Habitat	Natural Disturbances	Distribution And Size Of Vegetation Patches
	VM2	Ecological Site Productivity	Fire Disturbances	Large Woody Material (LWM)
	VM5	Riparian Habitat	Natural Disturbances	Riparian Uses
	VM6	Vegetation Manipulation Potential	This Will Be Shown In Recommendations	
Aquatic	VM4	Landslides	Natural Disturbances	Debris Flow & Mass Movement Location & Occurrence
	VM3	Hydrologic Recovery	Natural Disturbances	% Riparian In Seral Stage < 35 Years Age Water Yield Flow Regime
	VM5	Wood Recruitment & Shading	Natural Disturbances	% Riparian Seral Stage >55 Years Stream Temperatures
	VM5	Habitat Complexity	Flood Events	Ave. Stream Width And Depth # Pools Per Mile Substrate Composition
Social	No Question			Social Relevance Is In Characterization

Terrestrial Domain

The important processes for the Terrestrial Domain are: Habitat Diversity, Habitat Connectivity, and Interior Habitat (VM1); Ecological Site Productivity (VM2); Riparian Habitat (VM5); and Vegetation Manipulation Potential (VM6). Chapter 5 and 6, Interpretations and Findings and Recommendations, address the potential acres available for vegetation manipulation.

Habitat Diversity

For effects to wildlife and plant species, the conifer series are grouped in forested habitat types. The **dominant forested habitat types** found in the MFWDT are Western hemlock/Douglas-fir, Mountain hemlock/True fir, and hardwoods.

Western hemlock/Douglas-fir forests composed the largest habitat type. This habitat type consisted of subsets of early seral forest, pole-size and small timber, mature and old-growth, ponderosa pine/Douglas-fir, pure conifer, and mixed hardwood and conifer habitats. Stands east of the MFW River showed a characteristic pattern of underburning and open mature, old-growth forest. Steeper south aspects had a higher percentage of open early seral forest habitats created by stand replacement fires.

The ponderosa pine/Douglas-fir habitat subset was notably different in species composition and habitat structure than the western hemlock/Douglas-fir habitat type. Pines were more prevalent in the Youngs Creek - Deadhorse Creek area. Sugar pine intermixed with the Douglas-fir habitats more commonly in the Buck Creek to Estep Creek area. This habitat is a dry site Douglas-fir and rarely has Western Hemlock in the stand.

Mountain hemlock and the true firs dominated the smallest area of the Watershed. These habitat types were at the higher elevations along the Calapooya Ridge, upper Coal Creek, and from the Warner Mountain area to the Groundhog Mountain area. Grand fir gained its own habitat type in upper Gold Creek where a small stand of old-growth still exists.

The major ridgelines extending westward from the main Cascade Crest provided disjuncted stands of mountain hemlock and true fir habitat types into the Watershed. This would have added diversity and range of wildlife species.

True fir habitats had infrequent fires of various intensities. This created early seral habitat underneath a scattering of residual old-growth. Moderate intensity fires characterize the true fir habitats in upper Coal Creek and the Calapooya Ridge. This left early seral habitat with a sparse residual overstory.

Riparian hardwood habitats formed by the edges of the Middle Fork Willamette River and many class II streams. Brush and hardwood trees were important components in the habitat diversity and determined the habitat suitability for many wildlife species. Small stands of white oaks (<2 acres) existed in the lower Packard Creek area. The assumption is that scattering of individual oaks were more common than seen today.

Four **seral stages** used in the analysis are Stem Initiation, Stem Exclusion, Understory Reinitiation and Old-growth as defined by Oliver and Larson, 1990. The stages indicate stand development that change over time by succession and disturbances. The length of time required to pass through each of these stages vary by species and habitat conditions.

Table 3 shows the vegetative stages from 1835 through 1947 for both public and private lands. The information was extrapolated from the 1947 Historical Vegetation map.

Table 3: Historical Seral Stage

Seral Stages Habitat Types	DBH In Inches	1835 – 1855 in Acres (Percent)	1876 – 1915 in Acres (Percent)	1947 in Acres (Percent)
Stem Initiation Early Habitat	1.0 -- 4.9	23,000 (21%)	18,447 (17%)	370 (<1%)
Stem Exclusion Pole Small Timber	5.0 -- 20.9	1,000 (<1%)	19,550 (18%)	11,568 (11%)
Understory Reinitiation Mature Timber	21.0 -- 31.9	82,328 (75%) This includes Mature Old-growth	67,581 (61%) This includes Mature, old-growth	16,333 (15%)
Mature, Old-Growth	>32.0	Acres Included in Mature Timber	Acres Included in Mature Timber	77,660 (71%)
Unsuited Non-forested		1132 (1%)	1132 (1%)	1132 (1%)
Meadows		1763 (2%)	1763 (2%)	1410 (1%)
Water		777 (<1%)	777 (<1%)	777 (<1%)
City		Unknown	378 <1%)	378 (<1%)
Other*		Unknown	372 (<1%)	372 (<1%)
Total		110,000	110,000	110,000

*Other is Roads, Administrative Sites and Special Use

Fires were the predominant disturbance mechanism for historical vegetation conditions. Between 1835 and 1855, most of the stem initiation forest habitat acreage was in large blocks. These blocks were in upper Packard Creek drainage and upper Coal Creek drainage. Most of the remaining few hundred acres of early seral habitat were east of the MFW River. Pole-size and small timber habitats evolved in areas of the 1850's fires.

The series of fires around the turn of the century created stem initiation forest habitats in a more mosaic pattern instead of in a large block. These fires concentrated heavily in the Larison and Packard Creek area.

In the early 1900's, emphasis on fire suppression resulted in a substantial reduction in early seral forest habitats. There was a gradual loss of meadow size and of open forest habitats as ingrowth of understory occurred.

The analysis for the MFWDT focuses on dominant habitat types. Within each dominant habitat are many subsets. Table 3 shows the relationship between seral stages and habitat types. Pure conifer habitat, mixed hardwood/conifer habitat, open forest habitat and dense forest habitat further define habitat types. Guilds of wildlife species are being developed for the Western Cascades.

The assumption is that most of the habitat types found in the Watershed today were in the Watershed prior to the 1940's.

Plant and wildlife species composition are directly linked to habitat types suitable for species to live and reproduce. No general regional surveys or site-specific surveys have been conducted for survey and manage species. The number of populations of riparian and old-growth dependent species were probably higher historically because more habitat existed for them.

Although only comprising 1% to 2% of the MFWDT, Special habitats contribute to the overall biodiversity of the landscape. The prevalent special habitats in the Watershed are dry rock gardens, mesic meadows, dry meadows, wet meadows and rock outcrops. The main processes affecting special habitats were slope instability, flood events, and fire. Fire played a large role in maintaining meadows. Fire suppression and grazing cessation may have resulted in gradual tree encroachment on dry and mesic meadows resulting in loss of meadow size (Walstad,1990).

The Calapooya Mountains are high in botanical diversity. Holland Meadows, Johnson Meadows, Gertrude Lake, Bristow Prairie, Bradley, and Loletta Lakes are some of the various meadows found between the high rocky talus ridgetops.

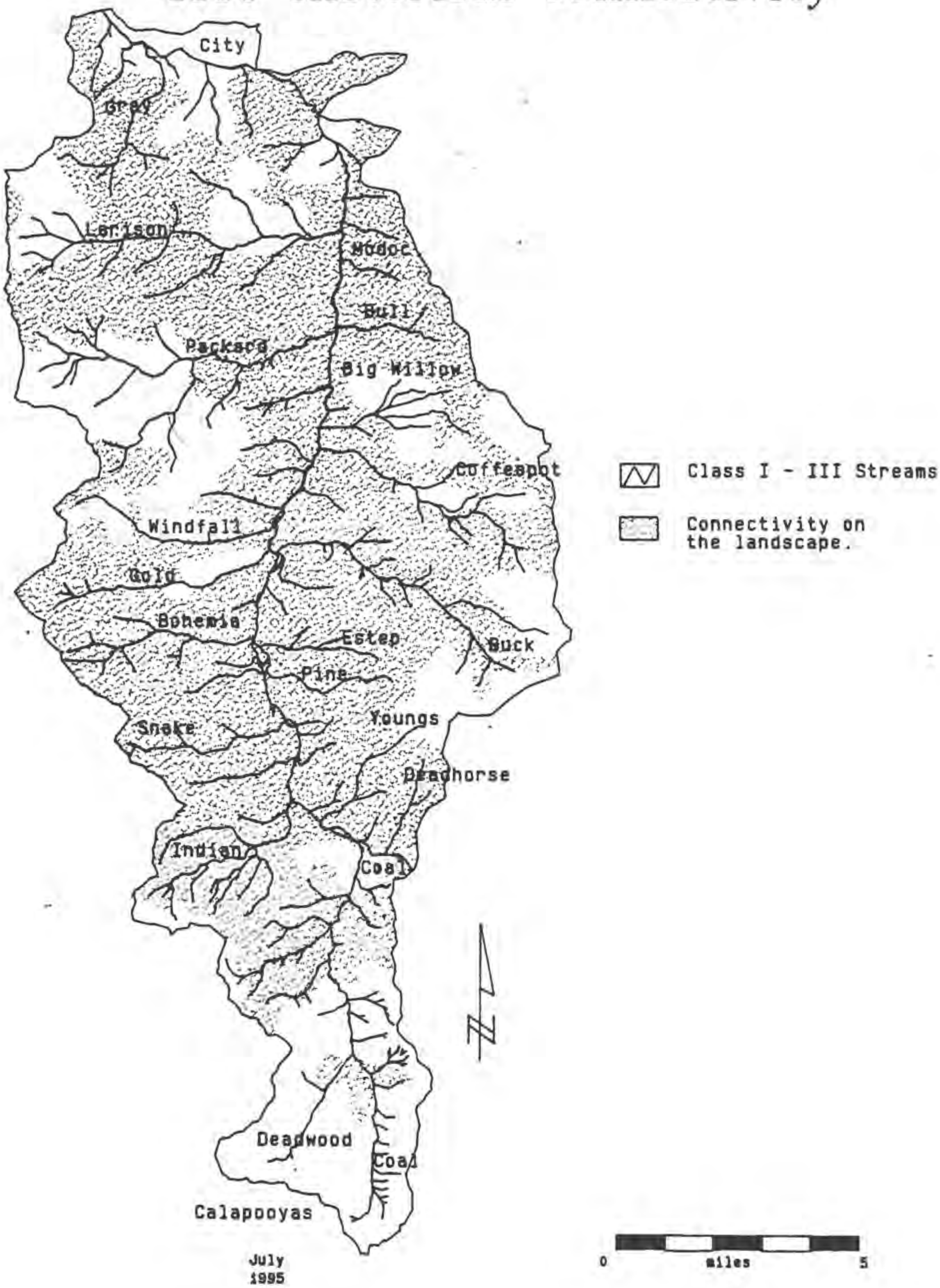
The area of the Watershed that is now a part of the designated Late Successional Reserve (LSR-0222) was mostly mature and old-growth forest. The area had the same distribution of western hemlock/Douglas-fir habitat types and Mountain hemlock and Noble fir/Pacific silver fir habitats as the rest of the MFWDT.

Habitat Connectivity

Connectivity is addressed in terms of mature and old-growth forest habitats and associated wildlife species. Functions of the habitat are foraging, dispersal of offspring, genetic interchange between populations, recolonizing areas, and expansion and retraction in population distribution or range. A way to measure connectivity is in the **distribution and size of the vegetation patches** (Figure 5).

Figure 5: Middle Fork Willamette Downstream Tributaries

1850 Historical Connectivity



Mature and old-growth habitats have been the dominant, long-term habitats on the landscape. Except for special habitats, early seral forest habitats were relatively short-term (15-25 years) at any given location.

Large blocks of interior habitat, existing after the turn of the century fires, were still interconnected with mature and old-growth forest habitats distributed across or around early seral habitats. In most situations, the mature and old-growth habitats' interconnectors were of adequate size and depth to serve as interior forest habitats. However, four riparian areas and their associated low saddle ridges which served as dispersal corridors into adjacent Watersheds were notably affected. The areas were: 1) Coal Creek mid and upper reaches, 2) Buck Creek upper-most reach, 3) Big Willow Creek mid and upper-most reach, and 4) Packard Creek upper-middle reach.

The saddle ridge routes were likely important for species associated with Class III and IV streams, seeps and similar riparian habitats higher on the slopes.

Overland dispersal occurred across the landscape over steep and gentle terrain. The gentler gradient terrain likely served the greater number of species. Dispersal across steeper gradient terrain was likely an essential factor for species as the tailed frog.

The Calapooya Mountains act as a high ridgeline corridor along which species can disperse and migrate. It can also act as a barrier for some species moving upslope.

Interior Habitat

Interior habitat is measured by the **distribution and size of vegetation patches.** After the stand replacement fires around 1850, large blocks of mature and old-growth interior forest habitats remained. These habitats probably had small, early seral openings resulting from previous underburn fires. On the landscape, these large blocks of mature and old-growth habitats functioned as contiguous forests (Table 4, Figure 6).

Table 4: Large Blocks of Interior Habitat after 1850

Area	Approximate Acres
Dinner Ridge, Larison Creek, Lower Packard, Lower Windfall Creek	13,440
Gold Creek South To Lower Coal Creek	19,200
Buck Creek To Youngs Creek	10,880
Modoc Creek, Bull Creek Area	2,560

Many of the remaining mature, old-growth habitats were interior habitats ranging in size between 2,000 acres to 100 acres and were distributed across the landscape. Areas such as Youngs Creek periodically burned. The sparseness of residual overstory canopy might have resulted in this area being characterized more of an open woodland, instead of interior forest habitat.

The 1876 - 1915 fires substantially reduced acreage sizes of interior mature, old-growth habitats. Table 5 shows the large blocks of interior mature, old growth habitats remaining around 1900. Numerous smaller interior habitat blocks, ranging in sizes of 1000 acres and less, were distributed across the Watershed.

Table 5: Large Blocks of Interior Habitat After 1876 - 1915

Area	Approximate Acres
Lower Packard Creek Drainage	7,600
Upper Dinner Ridge, Larison Creek	1,280
Mid. Larison Creek Area	1,920
Lower Pine Creek to Youngs Creek Area	4,500
Indian Creek, Lower Coal Creek Area	7,040
Upper Buck Creek Area	2,300
Cone Creek Area,	2,200

See Figure 7, the Interior Habitat after 1876--1915 map for a perspective of interior habitat.

Ecological Site Productivity

Ecological site productivity as addressed in this document relates to the functions of **large woody material (LWM).** Between 60 to 70 percent of the Watershed was of mature and old growth forest habitats that provided some level of LWM.

Fire, wind, insects, and disease were the main factors in creating LWM in the MFWDT. Fires affected thousands of acres and produced varied levels of LWM. Wind, insects, and disease affected small areas and produced varied levels of logs and snags.

In areas of stand replacement fires, levels of LWM remained high for many decades. The level gradually lowered until the forest matured and supplied a recruitment of new large logs and snags. The stand replacement fires of the mid-1850's and the turn of the century fires provided high levels of LWM. The overlap of the 1850 and 1900 fires in the Larison and Packard drainage's, left a low level of LWM.

The frequency and locations of underburning are not known. Assumptions are that areas of infrequent underburning gradually increased the level of LWM. Areas of frequent underburning probably had low levels of LWM.

Riparian Habitat

Riparian areas of the river, streams and wetlands **provide some of the most important habitat** for wildlife and plant species. Many of the wildlife species that either feed or reproduce in the aquatic area of the riparian are directly dependent on the adjoining riparian habitats.

Riparian areas also serve a landscape function of connectivity, for dispersal and genetic interchange of riparian associated species.

Fires, floods, debris slides, and deep-seated mass movements were factors affecting riparian habitats. Deep-seated mass movements occasionally created "slump" ponds and wetlands, with resulting riparian habitats around them. In the lower gradient river system, floods tended to cause changes in channel alignment, resulting in some loss of forested riparian habitat while the abandoned channel alignment revegetated. Floods also maintained a complex of side channels. Many of these provided ideal conditions for beavers to dam and create wetlands. The wetlands then provided habitat for associated wildlife and plant species. Photos from 1946 show evidence of this riparian condition.

The MFW River's average stream gradient is 2%. In 1946, the river had an alternating single to double thread channel from one bend to the next. The active floodplain width was roughly 2 to 5 times the wetted channel width. Islands of mature timber were present within the active channel. Mature conifers dominated the riparian area with hardwoods along the edge.

Aquatic Domain

The important processes for the Aquatic Domain are: Landslides (VM4); Hydrologic Recovery (VM3); Wood Recruitment and Shading (VM5); and Habitat Complexity (VM5).

Landslides

A review of older air photo sets (1946, 1955 and 1959) established reference conditions. Most of the analysis area was unroaded, particularly in the upper reaches of streams and on the ridgelines. Exceptions were Big Willow Creek, Coffeepot Creek, Buck Creek and the privately owned parcels in the lower reaches of Indian Creek.

Debris flow locations and occurrences were the primary evaluation mechanism for determining the reference or baseline condition of the MFWDT. Debris flows typically occur on steep ground with shallow, rocky soil. 66% of the Watershed meet these criteria. These soils are evenly distributed throughout the analysis area.

A comparison was made between debris slides that occurred in unroaded, unharvested areas that appeared in sequentially younger air photo sets. Of the 10 events noted, 9 appeared between 1959 and 1967, presumably in conjunction with the 1964 flood (a 100-year event). The single debris slide noted in the 1959 photos is not clearly natural. Road construction activity was nearby and equipment may have been driven up the channel. There was evidence of numerous pre-historic debris flows. There was no clear means of determining whether they occurred 100 years ago or 1000 years ago.

Bohemia Creek drainage contained 4 of the 10 naturally occurring debris slides. The remaining 6 were distributed evenly among Estep, Gold, Snake, Indian, Coal and Deadwood Creeks. None of the pre-historic debris flows were reinitiated and the areas that had the highest frequency of pre-historic events had no new initiations during this time span.

Since all but one of the slides occurred in conjunction with a non-periodic storm event, a further attempt was made to determine the frequency of debris slide events. This was done by enlarging the reconnaissance area to include the entire Rigdon Ranger District. Again, no recent naturally occurring debris slides were noted prior to the 1964 flood.

With two exceptions, active slope movements involving deep-seated failure mechanisms were not apparent. Field experience in the analysis area has shown that there are numerous deep-seated landslides that have been active during the span of time covered by the photo sets. The rate or size of movement was not great enough to exhibit signs obvious enough to been seen in the photos. The exceptions are large landslides located at the confluence of Powder Creek and Buck Creek; and the vicinity of Windfall Lake.

Hydrologic Recovery

The geology of the Western Cascades has determined the drainage network and **water yield characteristics** of the Watershed. This geologic character determines the rate at which water enters the groundwater and surface water systems. This is discussed under the section on water yield. Modification of this interaction occurs with a change in vegetation pattern.

Historically a change in vegetation occurred through natural fire and/or disease and bug infestation, all of which can result in reduced crown closure. Open areas with **trees less than 35 years** of age evapotranspire less water than do forests with full canopy closure below a certain threshold of storm intensity. This introduces more water into the soil which can affect earthflow rates and surface erosion associated with ground water seepage. Open areas also accumulate greater quantities of snow than forests with full canopy closure. Snow accumulation and rain on snow events can cause rapid snow melt and high peak flows within the channel networks.

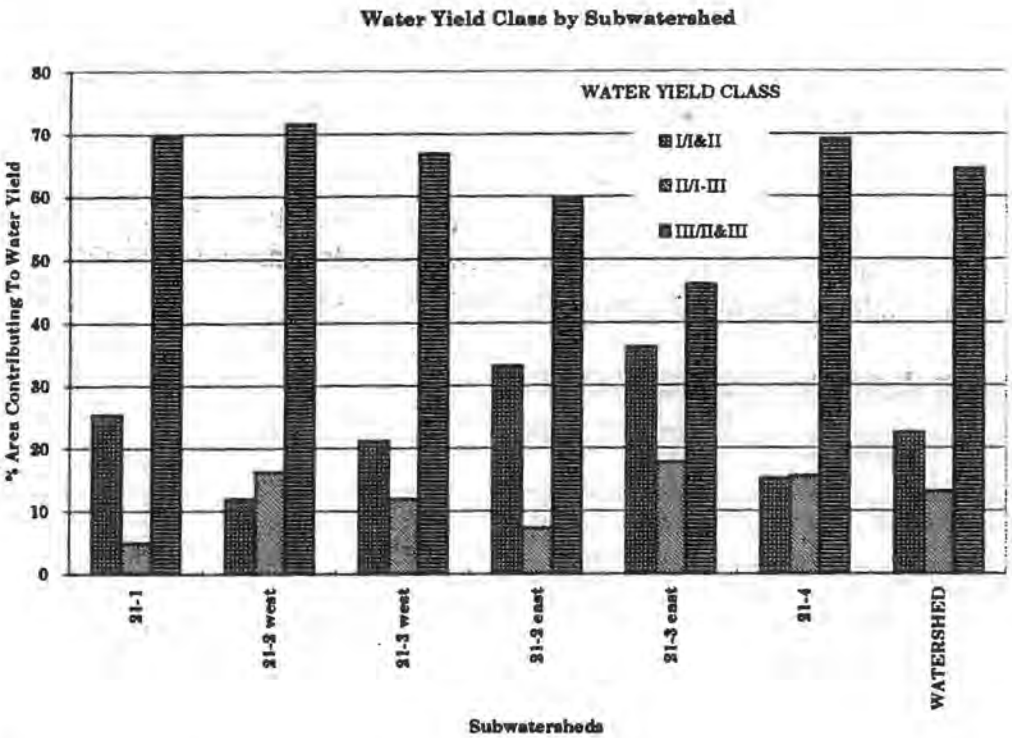
The historical range of hydrologically unrecovered forested land varies from 21% to less than 1% (Table 6). The reduction of hydrologically unrecovered forest to 1% results from modern fire suppression that began in 1910.

Table 6: Percent Hydrologically Unrecovered

	Years		
Seral Stage Habitat Type	**1835-1855**	**1876-1915**	**1947**
Stem Initiation Early Habitat	21%	17%	<1%
Rock outcrops, meadows, unsuited	3%	3%	2%
Total Unrecovered	24%	20%	3%

Landtypes with a Class III water yield dominate the MFWDT. This indicates streams are flashy and respond quickly to storm events and less water is detained in the soils as groundwater for contribution to summer low flow. Figure 8 reveals that streams on the west side of the MFW River show a potentially greater peak flow response to storm events as compared to streams on the east side.

Figure 8: Water Yield Class



The reference condition for **flow regime** is the same as the existing condition. Refer to Chapter 4 for information.

Two notable flood events occurred in the Willamette River Basin prior to this period of record. One flood event occurred in 1861 that exceeded the 1964 flood in magnitude. The second flood event occurred in 1890 that was of slightly lesser magnitude than the 1964 flood event. Floods of a smaller magnitude took place in 1923 and 1945 (Waananen, Harris, and Williams,1971).

Wood Recruitment And Shading

Functions that change with harvest in riparian areas are wood recruitment and shading. A reference condition for these parameters provides a measurement for existing conditions.

The assumption is that stands within the **riparian area older than 55 years** of age begin providing LWM to the riparian area, stream channel and floodplain. The reference condition for this parameter is a range of natural variation from 61% to 86% (Table 7). Another assumption is the reduction between the 1835--1855 and the 1876--1915 time periods primarily resulted from the large floods that occurred in those years. Floods of this magnitude were important recruiting wood from the riparian zone and distributing it throughout the channel.

Table 7: Riparian Area >55 Years

Seral Stage	Reference Timeframes		
	1835 -- 1855	1876 -- 1915	1947
Percent >55 Years	75%	61%	86%

Cold **stream temperatures** characterized the MFW River prior to intensive timber management activities. The temperatures were in the low 40's during the winter time and from the upper 40's to upper 50's during the summer time. Temperature measurements taken during the 1937 U.S. Bureau of Fisheries (USBF) survey reveals a range of water temperatures. Near Simpson Creek, immediately upstream of the MFWDT boundary, the temperature was 50 Fahrenheit near Simpson Creek, to 58 F near Coffeepot Creek (Table 8).

Table 8: 1937 Water Temperatures MFW River

Location	Date	Time	Sky	Air Temp Fahrenheit	Water Temp Fahrenheit
MFW/Simpson	9/3	14:30	P. Cloudy	67	50
MFW/Estep	9/2	16:10	Fair	68.5	56
MFW/Coffeepot	8/28	16:40	Fair	64	58
MFW/Modoc	8/31	17:00	Fair	62	57

The late afternoon and late summer timing of these measurements are past the usual peak summer temperatures that occur from late July through mid-August. These values can be expected to be slightly lower than the maximum summer water temperature for 1937, but provide a good indication of the reference condition. Natural disturbance processes such as fire, debris flows, windthrow, and disease have periodically altered the thermal regime in various parts of the drainage network, primarily through tree mortality. In addition, some riparian harvest along the MFW River may have occurred by 1937. This would influence water temperatures and what we are considering to be the undisturbed condition.

It is likely the temperature of most tributaries was slightly cooler than the mainstem of the MFW River due to the greater amount of canopy closure and the overall higher elevation of the tributaries. The Bureau of Fisheries Survey, measured temperatures at the mouths of three tributaries in the lower, middle, and upper sections of the Watershed (Table 9).

Table 9: 1937 Water Temperatures in Tributaries of MFW River

Location	Date	Time	Sky	Air Temp Fahrenheit	Water Temp Fahrenheit
Simpson Creek	9/12	NA	NA	70	52
Buck Creek	7/10	NA	NA	70	54
Hills Creek	9/11	14:30	Clear	70	57

These values average 54.3 F, one degree cooler than the mainstem at 55.25 F. The data suggests a general trend of increasing temperatures in the downstream direction for both the mainstem and tributaries.

Habitat complexity

Historical floods, fires, and debris torrents were the primary factors affecting channel health of the streams in the MFWDT. The parameters available to represent reference condition for habitat complexity are **stream width and depth, the number of pools per mile, and bottom substrate type**. Table 10 summarizes these parameters.

Reference streams are from stream surveys completed by the U.S. Fish and Wildlife Service in 1937 and 1938 (USFWS,1938). Not all subwatersheds have reference streams for tributaries to the MFW River. In these cases, reference "reaches" within a subwatershed considered to be "unimpacted" by management or natural disturbances will be used for comparison under current conditions.

The reference streams used for the MFWDT are Coal Creek, Buck Creek and the MFW River. Coal Creek headwaters are on the northern slopes of the Calapooya Mountains and flow north to join the south bank of the MFW River.

The estimated flow for Coal Creek was 30 cfs. The water level fluctuated 5 to 6 feet. Very few small cutthroat trout were seen. The character of the Watershed was mountainous and densely wooded. Pools per mile increased upstream with an increase in "pocket pools" and decrease in full spawning pools.

Willow, alder, and maple grew densely along the margins of the stream. There was a scattering of hemlock and fir conifers. The ridges in the lower portion of the MFWDT supported oak, fir, cedar, a few pines, and maples occurring in areas denuded by fire. In the upper portion, yellow pines predominated with occasional sugar and white pines. One hundred and fifty Spring Chinook were noted between Camp Croft and Campers Flat. Two hundred and twenty-seven were seen from this point upstream to Echo Creek Ridge Trail. Fifty-five were documented above Echo Creek (USFWS,1938).

Water level fluctuated between 10 to 12 feet between Modoc Creek and Cold Springs on the MFW. Some silting and some slight domestic pollution from

Westfir and Oakridge occurred at this time. Five Chinook salmon were noted between the confluence with the North Fork and Oakridge in late August. In addition, suckers, dace and squawfish were abundant, with fair numbers of whitefish. The lower river had fair numbers of 2 to 4 inch rainbows. The upper reaches had fair numbers of 1 to 6 inch cutthroat along with 5 inch Dolly Varden (bull trout).

The area consisted of high hills enclosing a narrow valley. The banks steep and generally high, composed of solid rock in many places. This stretch was heavily wooded with fir forest growth. Along the banks were willow, alder, maples and berries. Large pools up to 400 yards long frequently alternated with riffles and rapids. Many fish were seen, including numerous suckers and dace and a few rainbows, cutthroat and whitefish.

Table 10: Reference conditions for MFWDT streams (USFWS, 1938).

Stream	Reach mile	Stream width (ft)	Stream depth (ft)	# Pools/ mile	% Large rubble	% Med. rubble	% Small rubble	% Mud and sand
Coal Crk	1	22.2		15	44	28	18	10
	2	21.9		19	44	25	21	10
	2.6	19.5		20	52	22	17	9
Buck Crk	0.5	18.3		100	50	12	19	19
MFW	Echo Crk Trail/Rigdon GS	10	2.5	17	32	38	27	3
	Campers Flat Bridge (Now called Staley Creek Bridge)	57	4	43	52	26	17	5
	Camp croft	42	20	26	49	28	19	4
	Cold Springs Forest Camp	120	9	34	51	27	16	6
	Modoc Creek Trail Crossing	81	3	29	45	28	22	5
	Confluence Salt Creek	105	1.5	31	48	26	21	5
	Oakrige salmon trap (old location)	180	3	48	43	30	16	11
	Above confluence w/ NF	150	16	34	31	36	23	10
	Shadydell	180	10	12	46	29	21	4

ISSUE (NF) Exclusion of Natural Fire

Modern day fire suppression began in the MFWDT around 1910. Reference conditions are considered between 1835 to 1910. To evaluate the changes in the landscape due to the exclusion of fire, several functions or processes relating to the key questions were evaluated. This issue relates to the vegetation manipulation issue since natural fires were the most significant impact to the vegetation landscape for historical conditions. Some of the parameters measured are the same for both issues. Information will not be repeated under this issue, but is referenced to the vegetation section.

Table 11: Reference Functions/Processes For Exclusion Of Natural Fire

Domain	Question	Function Process	Mechanism/Cause	Parameter Measured
Terrestrial	NF1	Fire Pattern, Behavior & Intensity	Natural Fires	% Seral Stage Size And Frequency Of Fires
	NF2	Habitat Diversity	Natural Fires	% Seral Stage Species Composition Habitat Types
	NF3	TE&S Species And Fire Dependent Species	Natural Fires	Species Composition
Aquatic	NF2	Riparian Structure	Natural Fires	Fire Intensity In Riparian Area Water Quality And Quantity
Social	NF1	Fire Pattern, Behavior & Intensity	Human Use Of Fires	Early Use Of Fire

Terrestrial Domain

The important processes for the Terrestrial Domain are: Fire Pattern, Behavior & Intensity (NF1); Habitat Diversity (NF2); and TE&S Species And Fire Dependent Species (NF3).

Fire Pattern, Behavior & Intensity

The four **seral stages** were predominately created by wildfires in reference conditions. Table 11 shows the vegetative stages from 1835 through 1947 in the MFWDT.

Table 11: Percent Seral Stage

	Ages/Percent		
Seral Stage Habitat Type	**1835 – 1855**	**1876 – 1915**	**1947**
Stem Initiation Early Habitat	21%	17%	<1%
Stem Exclusion Pole Small Timber	<1%	18%	11%
Understory Reinitiation Mature Timber	75% This Includes Mature Old-growth	61% This Includes Mature Old-growth	15%
Mature Old Growth	Included In The Mature	Included In The Mature	71%

Fire underburn occurrence on an 80 to 120 year interval maintained open multi-aged mature, old-growth forest habitats in the drier Douglas-fir sites, especially on gentler slopes. Stand replacement fires created a higher percentage of open seral forest habitats on steeper southern aspects.

In the early 1900's emphasis on fire suppression resulted in a substantial reduction in early seral forest habitats. There was a gradual loss of meadow size and of open forest habitats as ingrowth of understory occurred.

Periodic and reoccurring wild fires were relatively frequent and played a very important part in shaping the MFWDT. Fire has burned nearly the whole area at some point in time.

One probable scenario is a stand replacement type fire burned through an area. This resulted in creation of many snags and a large accumulation of fuels on the forest floor. Several years or decades later, a second fire came through burning more intensely than the first because of the heavy fuel loads. Table 13 shows the size and timeframe for some of the larger historical fires in the MFWDT. The acres are the total of numerous fires that occurred during that period of time. Figure 9 represents the historical fires.

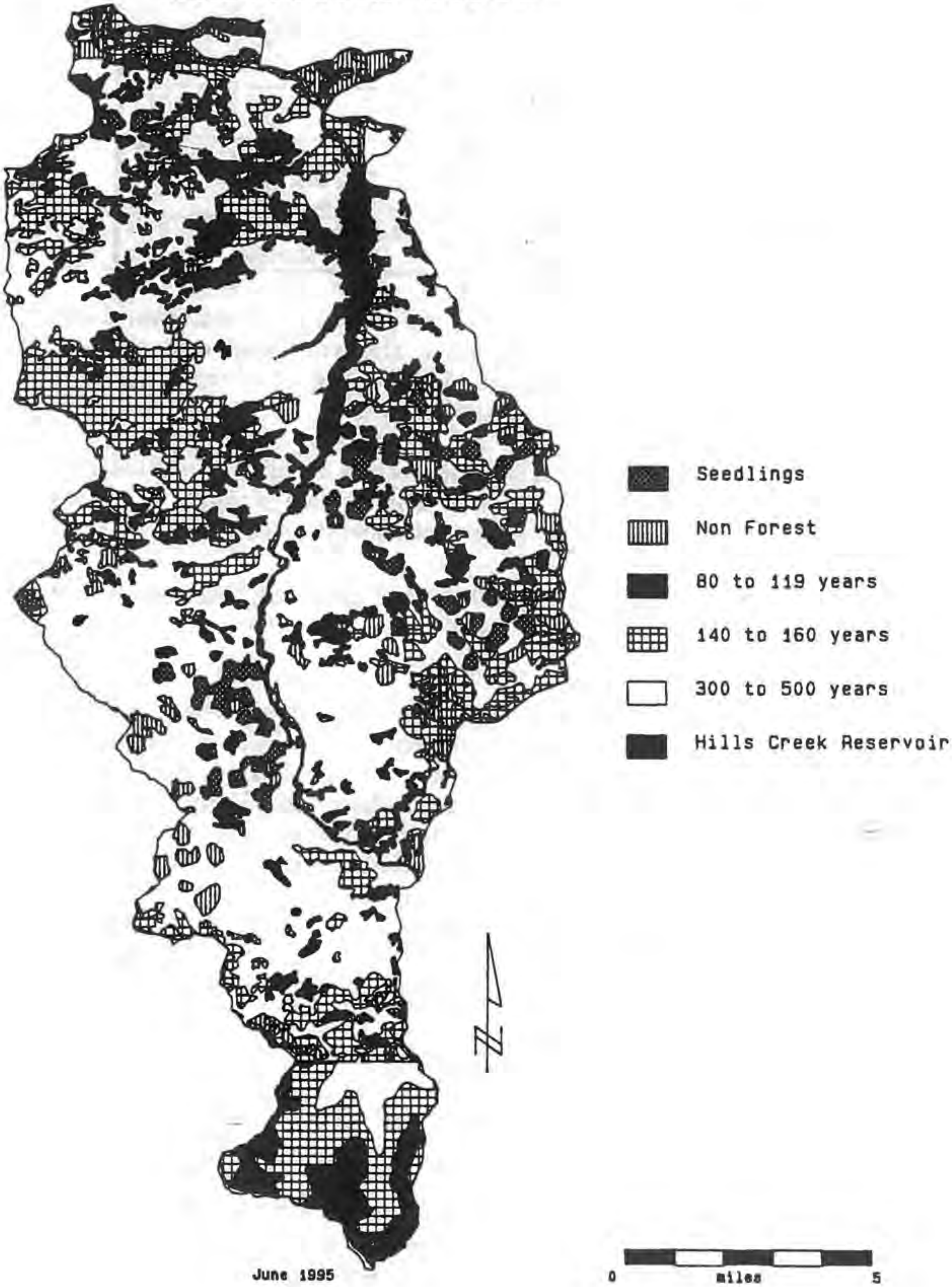
Table 13: Historical Fires for MFWDT

Year of Origin Range	Acres Burned	% of MFWDT
1495 -- 1695	61,726	56%
1835 -- 1855	23,583	23%
1876 -- 1915	13,780	11%

Means found, "that dry site stands are burned at intervals averaging 100 years,(and probably less), by fires that destroy only a portion of the canopy..." (Means,1980). The fact that such periodic, non-catastrophic fires are common on

Figure 9: Middle Fork Willamette Downstream Tributaries

Historical Fires



dry sites in the pre-fire suppression period suggests the possibility of intentional underburning by aboriginal peoples.

Early pioneers claim that the forest floor was so open that stock and horses could be driven or ridden through the timber in many places. By 1917 dense thickets of brush and saplings' growth made its appearance due to lack of fire (Winkler,1984).

Habitat Diversity

Frequency and intensity of fires were the dominant factors affecting habitat diversity. Over the centuries most of the Watershed experienced fire.

Refer to Table 13 for the **percent seral stages.**

Species composition is one way to measure the diversity of habitat. The assumption made is most of the special habitats found in the Watershed today were found in the Watershed before 1910. The total acreage of dry and mesic meadows seen in 1947 were assumed higher in the past.

Fire was a factor in maintaining meadow areas. Meadow size often fluctuated as a result of and the absence of fires. Periodic intense fires would burn the encroaching trees, restoring the meadow's size. Frequency of fires determine the effectiveness of abating the tree encroachment.

More discussion on **habitat types** is found with the vegetation issue. Early seral habitats developed in small patches, complex mosaic patterns, and large acreage blocks. Large areas of early seral habitat created by stand replacement fires, as in the Packard Creek area, would have provided a greater species richness, or number of wildlife species, associated with early seral habitat (Bunnell,1990). Such large areas generally have a greater diversity of habitat sites within them.

Early seral habitats regenerated in two scenarios of habitat structure and composition. One habitat is mostly pure conifers. The second is a mixed hardwood and conifer habitat.

Areas of frequent underburning would have shown a low concentration of large logs and snags. These areas typically had more open understory, with minor lower canopy structure. Such habitats of frequent underburning commonly existed on southern aspects.

Areas where fires were several hundred years apart, would have shown high concentrations of large logs and snags. A corresponding high concentration of wildlife species associated with large logs and snags and multiple canopy structures probably existed.

Brush and hardwood trees upslope from the riparian areas were important components in habitat diversity. These areas provided suitable habitat for many wildlife species.

Brush occurred in several habitat forms. Ceanothus, a fire dependent species, occurred as brush 'fields' after high intensity stand replacement fires. Ceanothus brush habitats dominated the sites for decades by suppressing conifer regeneration. Vine maple and ocean spray brush habitats varied in densities, dependent on sites. More diversity of brush species at a given site added diversity to the habitat structures and wildlife species that utilized them.

Hardwood trees, as big-leaf maple, cottonwood, red alder, white oak, madrone and chinquapin, provided a mix of hardwood and conifer forest habitats across the landscape, commonly on the warmer sites. Hardwood trees tended to persist longer than brush habitats in the second growth conifer.

Flood events affected the hardwood riparian forest of the larger, low gradient river and streams more dramatically than fires. The hardwood riparian areas on steeper gradient streams had a greater variance in effects from fires.

TE&S Species and Fire Dependent Species

Measurements of **plant and wildlife species composition** assists in establishing a reference condition. Two rare plant species dependent on moderate intensity fires for germination are woodland milkvetch and branching montia. The assumption is there were more populations of these plants scattered through the Watershed when fires were allowed to comb the area.

The milkvetch, a Region 6 Sensitive species, was found in 1993 to the north of the MFWDT Watershed, in the Warner Creek fire area. It is assumed that some population(s) of milkvetch on the Umpqua NF were connected to populations within the North Fork of the Middle Fork Willamette Watershed through the MFWDT.

A few populations of Branching montia are found on the eastern edge of the MFWDT in the Shady Beach fire area. Similar habitats exist throughout the Watershed.

Several wildlife species currently listed as Threatened, Endangered or Sensitive, would have inhabited this Watershed up to the 1910's. The assumption is that fire affected habitats of American peregrine falcon, the northern spotted owl, and the northern red-legged frog. The northern bald eagle probably did not inhabit the MFWDT for nesting It was likely an infrequent forager of the Watershed during non-nesting seasons.

For the peregrine falcon, the series of fires around the 1850's and the turn of the century created various habitat types. The diverse array of habitat conditions provided for a variety of bird prey.

For the northern spotted owl, the early fires tended to reduce its habitat acres, and the owl's population in the watershed probably fluctuated to a small extent as a result of the large fires. The great horned owl populations were probably at a higher level following the 1835--1855 and 1876-1915 fire series. The great horned owl probably caused a displacement of some spotted owl pairs.

The red-legged frog tends to favor a forested environment for foraging. A favored breeding habitat is "slump" ponds. These areas are generally on gentler terrain that incurred underburning, retaining a forested environment.

Aquatic Domain

Riparian Structure

The **intensity of fire** is highly variable due to such factors as topography, soil moisture, fuel moisture and loads, vegetation density and weather patterns. One assumption is that frequent lightning caused fires shaped the riparian stand structure. Stand replacement fires would consume riparian vegetation particularly in the upper slopes with intermittent streams. consumed in stand-replacement fires. As vegetation succession progressed, future less intense fires would primarily burn brush and limbs. The resulting structure would consist of surviving mature trees, a sparse understory of younger trees, with grassy ground cover and very little brush.

Mid-Windfall Creek and mid-Big Willow Creek experienced intense stand replacement fires in the mid-1850's. This left a high accumulation of snags, down logs, and early seral riparian forested habitat. A few riparian areas, as various reaches in mid and upper Packard experienced moderately intense fires. This resulted in sparse riparian overstory forest. Most riparian areas experienced underburns with intensity increasing the further the fire was from the creek.

We do not have information available at this time to measure the specific changes fire had on **water quantity and quality**. The assumption is the effects of fire on water quantity and quality of forested watersheds would be similar to current fire impacts. The resulting mosaic vegetation pattern resulting from the different types of fire intensity across a landscape affected hydrologic processes to various degrees.

Stand replacement fires that destroy overstory forest vegetation will generally increase annual water yields. This increase declines with time as regrowth of forest vegetation occurs. These fires may cause accelerated erosion impacts to the water quality of forested mountain watersheds. Erosional effects become increasingly greater as terrain steepness increases.

Where low-intensity fires occurred, much of the organic matter comprising the forest floor may have remained. The effects of these types of fires would generally be an insignificant factor in water quality and quantity.

Social Domain

The assumption is that **human use of fire** did not impact as much of the landscape as wildfires. People did utilize fire to manipulate vegetation. It seems likely that annual firing of the brush and underburning of the forest were intentionally utilized by native peoples throughout the MFWDT. This increased the range and abundance of game and edible and useful plants.

Settlers used fire extensively. Ranchers preferred fire to rejuvenate their fields: A rancher set fire on the lee side of ranch buildings and allowed it to burn across his field; "no effort whatever was made to prevent it from reaching the neighboring timber. "Fires were rarely extinguished before the fall rain or until they burn out for lack of material on which to feed." (Gorman,1899). These fires may have spread into Forest Service lands.

ISSUE (TR) Transportation System

The timeframe for reference conditions for the transportation system is from the mid-1850's until the 1940's.

Table 14: Reference Functions/Processes For Transportation System

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial	TR7	Wildlife & Plant Habitat Quality	Natural Conditions	Plant and Animal TE&S Habitat Special Habitat Disturbance
	TR9	Fire Ignition And Suppression Response Time	Transportation System	Miles of Road
	TR10	Forest Use	Pre-1940's Condition	Miles of Road
	TR6	Riparian Habitat Quality	Roads In Riparian Reserves	Acres of Riparian Habitat Lost
Aquatic	TR1, TR2	Landslides	Natural Disturbances	Frequency Of Occurrence
	TR3	Surface Runoff & Routing	Natural Conditions	Drainage Network
	TR4	Culvert Carrying Capacity	Culvert Design	# Undersized Culverts and Risk Potential
	TR6	Species Distribution Migration Corridor	Natural Conditions	Fish Distribution Culvert Location And Size
Social	TR8	Sedimentation	Trails In Erosive Soils	# Miles Trails In Erosive SRI's

Terrestrial Domain

The important processes for the Terrestrial domain are: Special Habitats (TR7); Wildlife and Plant Habitat Quality (TR7); Fire Suppression Response Time (TR9); Forest Use (TR10); and Riparian Habitat (TR6).

Wildlife and Plant Habitat and Quality

The road system of the 1940's and before **had very little effect to wildlife**, other than as access for hunting and trapping. The OCMWR and the Willamette City residential area resulted in about 155 acres loss of riparian habitat. The consequence to riparian associated wildlife was insignificant.

An emphasis species in the MFWDT is the Roosevelt elk. An assumption is that elk numbers were moderate to low compared to current numbers. Another assumption is the elk predominately used the area on the east side of the MFW River. Especially from the Hills Creek confluence to Deadhorse Creek. Watershed.

The major factors involved in maintaining **sensitive plant habitats or special habitats** is stability of the hydrologic regime and keeping contiguous habitat for dispersal and pollination. The road system was confined to the Oakridge area and along the MFW River. These roads and trails did not adversely affect sensitive plant habitats or special habitats.

Fire Ignition And Suppression Response Time

The reference condition for **miles of open roads** is considered about 22 miles. Most of the MFWDT was unroaded except for the area around the city of Oakridge and the OCMWR. Fire suppression response time would have been slow before construction of the extensive road system.

Forest Use

Over the centuries, Indian groups developed a **well-defined trail system** they used until after Euroamerican settlement in the MFWDT. Wheeled access to the area was first provided by the Free Emigrant Route that later became the OCMWR in the mid-1800's. During the summer of 1853 between 250 and 300 wagons used this route.

Roads within this Watershed were limited to the vicinity of the City of Oakridge, Willamette City, the Hills Creek community of Hilltop at the confluence of Hills Creek and the MFW River, and the OCMWR.

Large scale transportation system development in the MFWDT began in the 1940's. Roads were constructed for timber access of private lands by the Pope and Talbot Company, and by the Forest Service to access U.S. Government land.

Riparian Habitat Quality

A way to measure historical riparian habitat quality is measuring the **loss of riparian habitat**. The approximate length of the MFW River within the Watershed is 30 miles. Using current standards, a minimum 800-ft riparian width (400-ft each side) would provide about 2910 acres of riparian reserve.

The development of Willamette City along the river probably had the largest impact on riparian habitat for a single location. About 48 acres of riparian reserve would have been lost to residential areas. About 107 acres of riparian habitat was lost to roads. About 5% of the MFW River riparian area might have been lost by conversion to road, and residential settings. The assumption is other riparian areas were not affected.

Aquatic Domain

The processes in the Aquatic Domain measured for change were: Landslides (TR1, TR2) and Surface Runoff and Routing (TR3);

Landslides

A function that has changed in the Watershed as a result of road construction is mass failure resulting in landslides from side-cast road construction. A reference condition for landslides is under the Vegetation Manipulation issue (3-8,9).

Surface Runoff and Routing

The major streams that flow directly into the MFW River parallel each other and have a secondary **dendritic drainage pattern**. Stream density for the entire Watershed is 3.1 miles per square mile. Stream densities are 2.7 miles per square mile in the south end of the MFWDT and increase to 3.4 miles per square mile in the north end. Specific information regarding miles of stream by class, acres, square miles of land and stream density is in Chapter 4, Current Conditions and Appendix G, Hydrology Documents.

Culvert Carrying Capacity

The reference condition for road and stream crossings is considered to be zero. Roads that existed used low water fords or log stringer bridges at stream crossings.

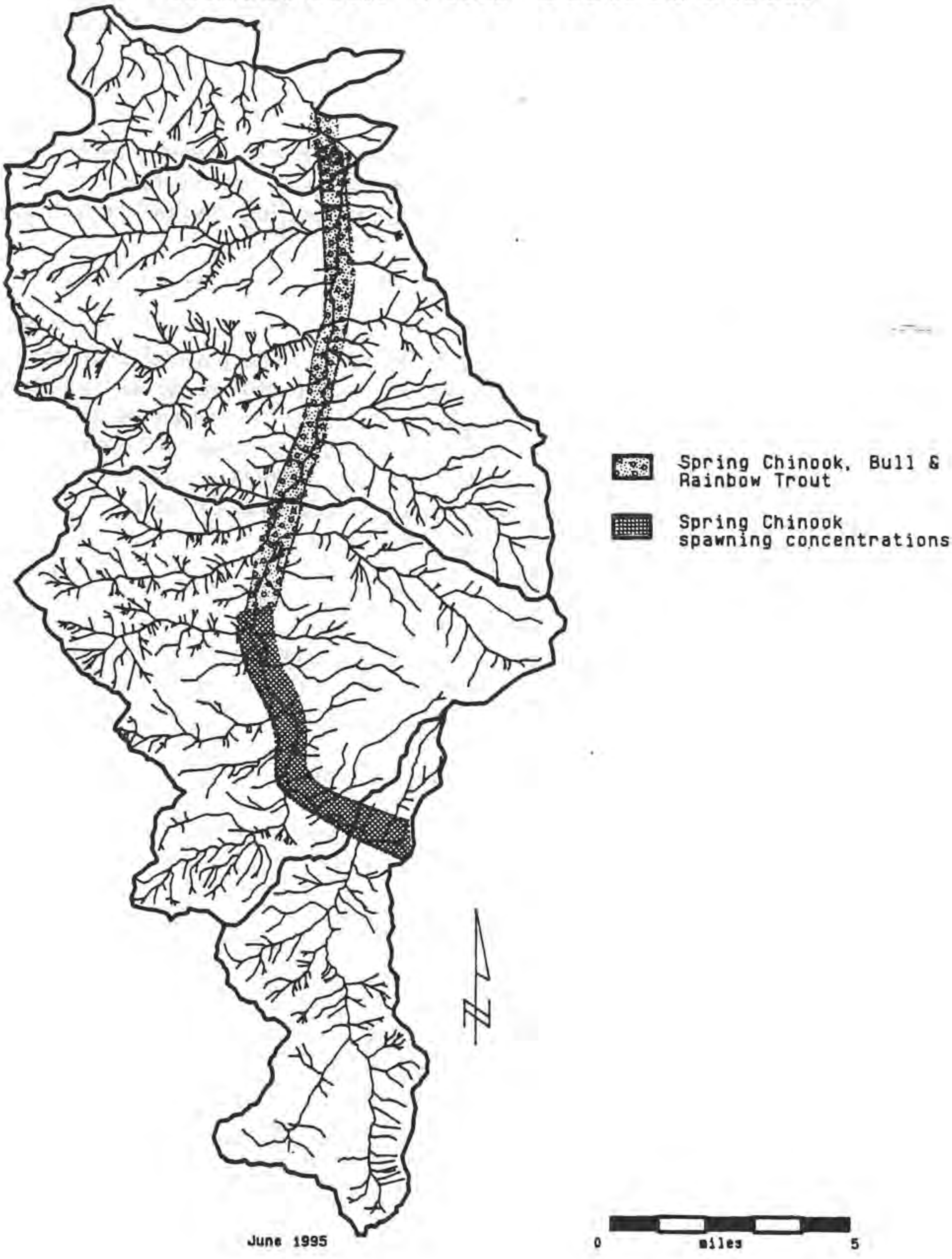
Species Distribution and Migration Corridor

A reference condition for **fish distribution** is from a historical report from the Bureau of Reclamation (1937), the USFWS (1938), Oregon State Water Resources Board (Hutchison, 1966), and from the Upper Willamette River Basin Management Plan (Connolly et. al 1991). See Figure 10.

Spring chinook were the only endemic anadromous fish in the Middle Fork of the Willamette sub-basin. The run in the sub-basin, while relatively small at approximately 2,550 fish, may have been the largest of any above Willamette Falls. In 1947, the run was estimated to account for 21 percent of the spawning population above Willamette Falls. Before construction of the impassable dams of Dexter and Fall Creek, the primary spawning areas for Spring Chinook were the North Fork of the Middle Fork Willamette, Salt Creek, Salmon Creek, Fall Creek, and the Upper Middle Fork Willamette. Chinook salmon were documented spawning as high as Tumblebug Creek.

Figure 10: Middle Fork Willamette Downstream Tributaries

Historical Fish Distribution



Since **culverts** were not a part of the historical landscape a reference condition for blocked passage due to culverts is considered zero.

Social Domain

Sedimentation

From a 1950 district map, this Watershed contained 120 miles of trail. There was approximately one trail per drainage for access to high ridges and mountain peaks, and fire lookouts. The impact of the trails to sedimentation was not significant since most trail treads were usually less than two feet in width and did not present a large bare surface. A visual review of **trail location** and SRI maps indicates most of the trails were not located **in highly erosive soil types**.

Issue (NS) Non-Native Species

The reference time frame for non-native species is from 1835 to the 1940's. The only function discussed is Introduced Species Composition in the Terrestrial Domain. The Hills Creek Dam and Lake Issue address aquatic non-native species.

Table 15: Reference Functions/Processes For Non-Native Species

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial	NS1	Non-Native Species Composition	Natural Conditions	Abundance And Occurrence Of Non-Native Species
Aquatic		See Hills Creek Dam And Lake Issue		
Social		Not Applicable		

Terrestrial Domain

Non-Native Species Composition

A parameter that can be measured for change is the **abundance and occurrence** of non-native plant and wildlife species. Noxious weeds have dramatically increased in abundance since the turn of the century. Scotch broom was introduced as an ornamental shrub and an erosion control agent in the 1920's (Miller,1995). St. John's-wort has been a medicinal herb for many years; it was probably a garden escapee. Thistles traveled west as contaminant in alfalfa and other crop seed bags and came into Portland in the ballast of sea-faring vessels (Forcella and Harvey,1988).

Prior to European settlement in mid-1850's, introduction of non-native wildlife is considered non-existent. By the 1930's and 1940's, certain non-native wildlife species, such as the bullfrog had been introduced into the Pacific Northwest. Their presence or noticeable effects in the MFWDT were doubtful at that time.

ISSUE (EI) Infrastructure

The timeframe used for the existing infrastructure issue is from 1910 until 1963. The process analyzed is Resource Integrity and Function. The Social Domain seemed the appropriate place for the discussion.

Table 16: Reference Processes For Infrastructure

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial		Not Applicable		
Aquatic		Not Applicable		
Social	EI1	Resource Integrity & Function	Lands Committed to Facilities	Miles of Trail Inventory of Facilities

Social Domain

Resource Integrity and Function

Measuring **miles of trails** is one parameter in assessing resource integrity and function. Early Euroamerican settlers widened Indian trails for the herds of livestock. Some of the trails including the Staley Ridge Trail and the trail that later became the Oregon Central Military Wagon Road.

Until the major road construction activities of the 1970's and 1980's, trails were the facilities that provided the access to much of the Watershed. In the early 1960's, much of western portion of the Watershed was unroaded. Many trails were the main transportation facilities. There were at least seventeen major trails, with some still in the current trail system (Table 17).

Except for Dead Horse, Moon Lake, Pine Creek, Star, and Tufti Mountain, the trails accessed the Calapooya Divide. These mileage's are approximate and taken from a 1950 district map. Already, roading was in the process of reducing trail mileage. At one time these historic trails, with many of the trails being built during the CCC era of the 1930's, were the only facilities available to provide access to much of the MFWDT

Another parameter that can be measured for change is the **number of facilities**. Although dispersed camping took place at an early date, the developed campgrounds in this Watershed were largely constructed in the mid to late 1960's. An exception was the Campers Flat area that was a well-established campground used extensively by Native Americans as late as 1910. Packard Creek, and Sand Prairie Campgrounds and CT Beach Boat Ramp and Picnic Area and Bingham Boat Ramp were built in response to the construction of Hills Creek Dam and pooling of Hills Creek Lake in 1961.

Table 17: Major Trails in the MFWDT Prior To 1960

Trail Name	Length (miles)
Larison Rock	4.3
Larison Creek (on ridgetop)	7.4
Minick Way (current Larison Creek)	5.8
Dinner Ridge	7.0
Packard Creek	5.8
Rocky Point Way	4.0
Grass Mountain	5.6
Johnson Meadows	4.2
Indian Creek	5.4
Bristow Trail	4.4
Staley Ridge	10.7
Coal Creek Way	5.8
Moon Lake Way Staley Ridge	3.0
Pine Creek Way	1.7
Star	2.3
Tufti Mountain	5.1
Holland Meadows	6.9
Total	**89.4**

Mining activities have not been a major activity within the Watershed. The MFWDT has always contained the largest number of mining claims on the Rigdon Ranger District due to its proximity to the Bohemia Mining District to the west. There has been prospecting but never any major location activities. According to a 1961 mining claim record, there were 89 claims scattered throughout the Watershed for both placer and hardrock. The search for types of minerals ranged from gold to uranium lodes.

ISSUE (HL) Hills Creek Dam and Lake

Hills Creek Dam and Lake affected landscape processes downstream and upstream of the reservoir and within the original stream syste (See Figure 11). The major affects from preparing to fill and filling the reservoir were: Loss of habitat connectivity for wildlife (HL1); Eradication of undesirable species (HL2); Inundation of river miles and creation of a lake which blocked migration for fluvial species, specifically Spring Chinook (HL2); and Introduction of exotic fish species (HL2).

Now that the lake has been filled, the major issues are: riparian integrity as related to management (HL1); and lake productivity as influenced from turbidity levels varying with wave action and drawdown levels (HL3).

Major issues affecting the downstream habitat are: Loss of habitat complexity as a result of the dam blocking stream transport of LWM (HL4,HL6); and loss of transport capability, flushing flows and floodplain processes as a result of unnatural flow releases (HL4,HL6). Some of the functions and processes are only appropriate for current conditions and will be discussed in Chapter 4.

Table 18: Reference Functions/Processes for Hills Creek Dam and Lake

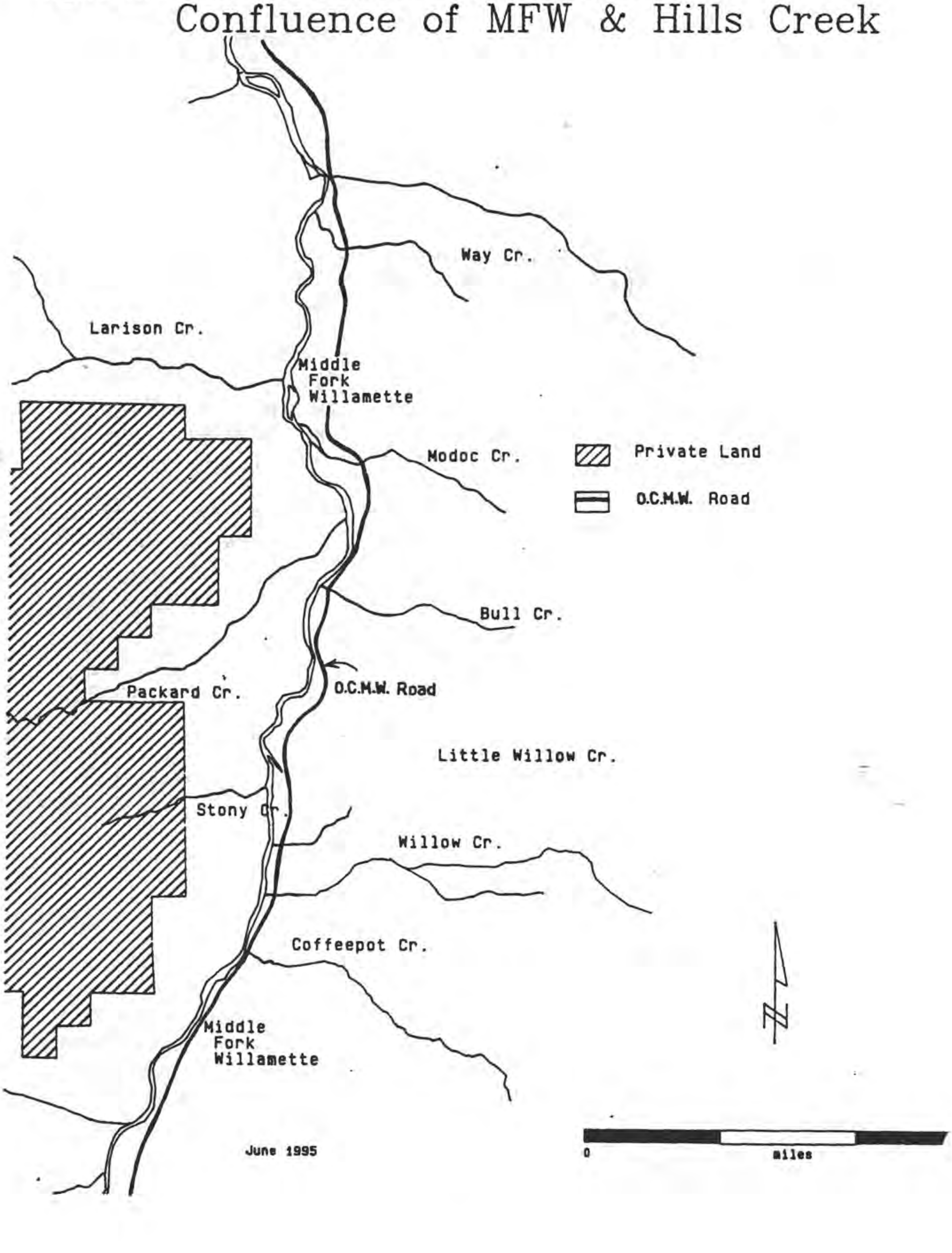
Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial and Aquatic	HL1	Riparian Habitat Quality	Stream System	Habitat Connectivity Riparian Plant Species
Aquatic	HL2	Species Composition	Stream System	Species Presence Spring Chinook, Bull Trout Passage
	HL3	Lake Turbidity	Not Applicable	Not Applicable
	HL4,HL6	Downstream Habitat Complexity Sediment Transport	Not Applicable	Not Applicable
Social	HL8	Facilities	Stream System	Number Of Sites Type Facilities
	HL8	Pattern Of Use	Stream System	Use Numbers

Terrestrial And Aquatic Domain

Riparian Habitat Quality

Twelve miles of river floodplain and riparian habitats served as wintering areas and migration routes for many terrestrial wildlife. It also served as part of the fuller riparian **connective corridor** of the river system and tributary systems as the Larison, Packard, Big Willow, and Bull Creek Drainage's. The riparian **associated species** inhabited the wide floodplain, providing a continual interpopulation genetic interchange. Figure 5 represents the stream system before Hills Creek Dam.

Figure 11: Middle Fork Willamette Downstream Tributaries



Aquatic Domain

Species Composition

Refer to the Transportation Issue (3-22,23) under Species Distribution and Migration Corridor.

Social Domain

Facilities

A measurement of change is the **number and type of facilities** around the area that would become Hills Creek Lake. Larison Creek, Minick Way, Dinner Ridge and Tufti Mountain Trails all had trailheads originating on the Middle Fork Willamette River in the area that is now Hills Creek Lake. During the summer of 1853 more than 1500 people with between 250 and 300 wagons used the OCMWR to cross the Upper Willamette Valley (Menefee and Tiller, 1977). The lake inundated approximately 12 miles of the Oregon Central Military Wagon Road. There were hunting lodges initiated utilization of the area for recreational purposes (Jensen, 1970).

Pattern Of Use

Ethnographic evidence from low elevation sites indicates Native Americans utilized this area. Through the late 1850's and early 1860's gold miners, emigrants, and others passed through this area of the MFWDT. Some logging was done in the 1870's utilizing the Middle Fork River.

Chapter 4

Current Conditions

Middle Fork Willamette River Downstream Tributaries Watershed

This chapter documents the current conditions and Relevant Processes of the Watershed.

Chapter 4

Current Conditions

Middle Fork Willamette River Downstream Tributaries Watershed

This chapter documents the current conditions and Relevant Processes of the Watershed.

ISSUE (VM) Vegetation Manipulation

The parameters used to measure the change in the processes or functions in the MFWDT may not be the same as used in Reference Conditions. Increased harvest of timber began in the 1940's. Harvest replaced wildfire as the major factor shaping the landscape.

Table 19: Current Processes For Vegetation Manipulation

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial	VM1	Habitat Diversity	Vegetation Manipulation Activities	% Seral Stage Species Composition
	VM1	Habitat Connectivity	Vegetation Manipulation Activities	Distribution And Size Of Vegetation Patches
	VM1	Interior Habitat	Vegetation Manipulation Activities	Distribution And Size Of Vegetation Patches
	VM2	Ecological Site Productivity	Management Activities	Large Woody Material (LWM)
	VM5	Riparian Habitat	Management Activities	Riparian Uses
	VM6	Vegetation Manipulation Potential		This is Shown In The Recommendations
Aquatic	VM4	Landslides	Harvest In Unstable Areas	Debris Slides & Mass Movement Location & Occurrence
	VM3	Hydrologic Recovery	Upslope And Riparian Harvest	% Riparian In Seral Stages< 35 Years Water Yield Class Flow Regime
	VM5	Riparian Habitat	Management Activities	% Riparian Seral Stages <35 > 55 Years Channel Stability
	VM5	Wood Recruitment & Shading	Vegetation Manipulation	% Riparian Seral Stage> 55 Years Stream Temperatures
	VM5	Habitat Complexity	Flood Events Stream Cleanout Riparian Harvest	Ave. Stream Width And Depth # Pools Per Mile Substrate Composition
Social	No Question			Social Relevance Is In Characterization

Terrestrial Domain

The important processes in the Terrestrial Domain are: Habitat Diversity, Habitat Connectivity, and Interior Habitat (VM1); Ecological Site Productivity (VM2); Riparian Habitat (VM5); and Vegetation Manipulation Potential (VM6). The Chapter on Recommendations addresses the potential acres available for vegetation manipulation activities.

Habitat Diversity

Western hemlock/Douglas-fir, Mountain hemlock/true fir, and hardwood remain the **dominant forested habitat** types. The addition of Hills Creek Lake adds a large water habitat to the MFWDT. The acreage of each forested habitat exhibits a very different pattern and habitat structure than historical conditions. These differences result from fire suppression and timber management practices. See Figure 12 for the dominant habitat types in the MFWDT. Appendix H has a detailed description of seral stages.

Table 20 presents the current **percent seral stages** in the MFWDT for NFS and private lands. Timber harvesting in the 1950's started the resurgence of early seral habitat, and steadily increased until the present. On National Forest System lands, the early seral habitat is in small harvest patches distributed across the forested landscape. The private lands started with small patch openings (30-50 acres in size), and ended up with large blocks consisting of early seral and pole-size habitats. Past reforestation and TSI practices have simplified managed units. The emphasis was on crop tree production. The impoundment of Hills Creek Lake to about 2240 acres reduced the forest and riparian habitats.

Over 90% of the MFWDT is forested. Private lands are mainly in the stem initiation stage with some acreage in stem exclusion.

Table 20: Current Seral Stages

Seral Stage	Acres	Forest Service Percent	Private Land Percent	Total Percent of MFWDT
Stem Initiation Early Habitat	34,046	21	10	31
Stem Exclusion Pole, Small Timber	14,708	11	2	13
Understory Reinitiation Mature Timber	6,512	6	0	6
Mature, Old-growth Timber	44,003	40	0	40
Unsuited Non-forest**	1,759			
Meadows	1,128			
Water	3,017			
City	930			
Other*	3,897			
Total	110,000			

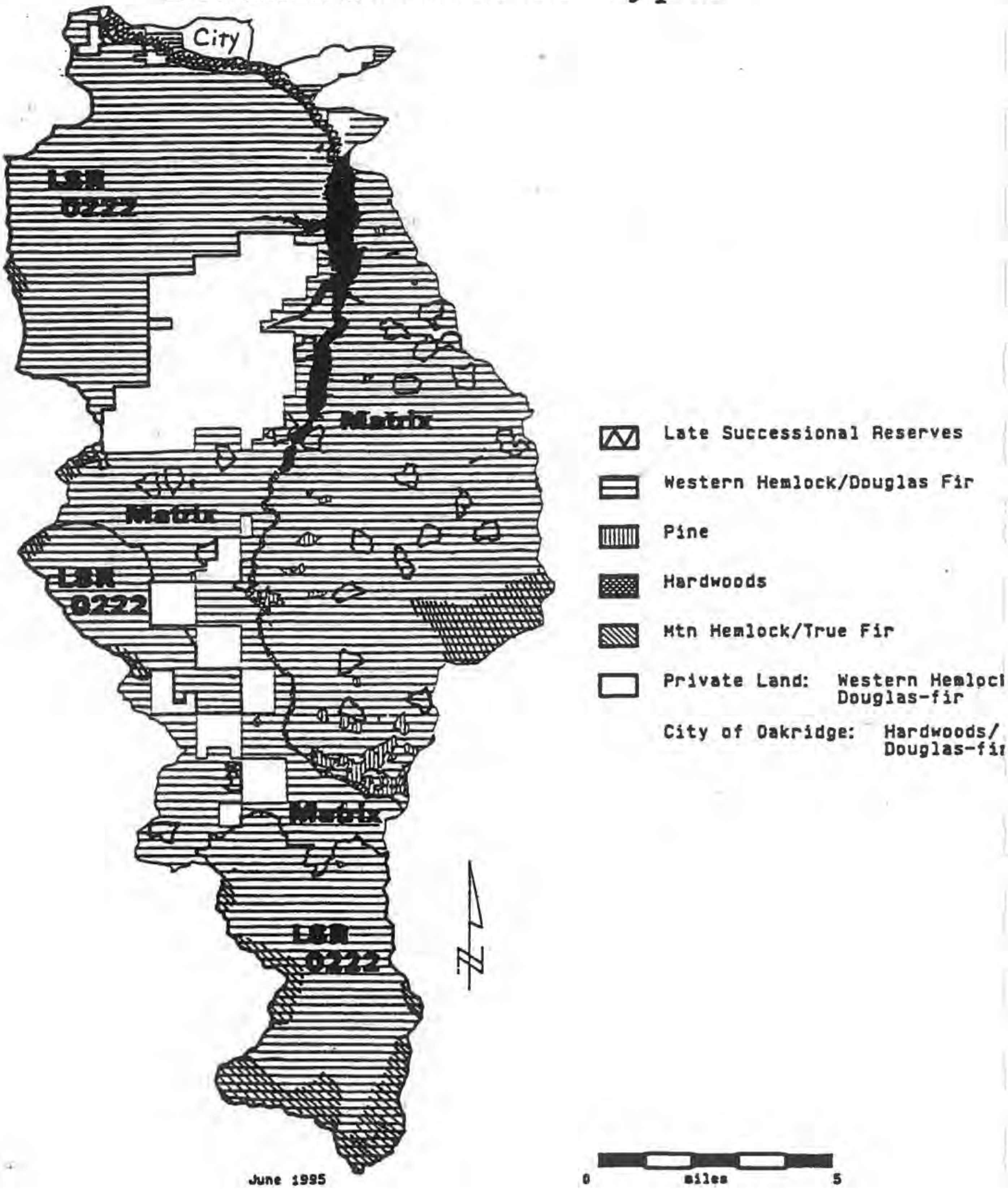
**Change due to private land conversion
*Roads, Administrative and Special Use areas

Management activities and fire have set the stage for potential timber management activities, special forest products and other activities necessary to meet the Forest Plan objectives. Appendix H describes the past blowdown areas, some stand processes, and decade treatments.

Species composition relates directly to habitat types. The following discussion will be on emphasis species and on habitat types.

Figure 12: Middlefork Willamette Downstream Tributaries

Dominant Habitat Types



No plant species listed as Threatened or Endangered by the US Fish and Wildlife Service occur on the Willamette NF.

A number of populations of Thompson's mistmaiden, a Region 6 Sensitive plant, are within the MFWDT.

The Watershed has a number of rare and unique species; some are associated with rocky habitats. Three known populations of Spring phacelia are in the MFWDT. It is at its northern of range on the Willamette National Forest.

Other rare species prefer wetter habitats. A bright pink checkermallow inhabits moist meadow habitats along the crest of the Calapooya Mountains. One population of the little grapefern is in the Watershed. Rigdon is the only District on the Willamette where the one-flowered gentian is found. One of the three populations of yellow willow-herb found on the WNF is in the MFWDT.

Forested habitats contain some rare species. The pine broomrape is found in dry coniferous woods. Plants have never relocated in clearcuts. The giant chain fern is found along stream banks and wet places. This species seems to be at the northern part of its range in the MFWDT.

No known Survey and Manage bryophytes, fungi or lichens occur in the Watershed. Two vascular plants are documented here. One site of the candystick, a vascular species, is documented in the MFWDT from Ecology Plots. Since there has not been systematic surveys, the assumption is there are more populations within the Watershed. This species has not been relocated in clearcuts but some populations have been found in second growth stands.

The second vascular plant, known historically in the MFWDT, is the mountain lady's slipper. This orchid has been reduced in number to approximately 20 populations west of the Cascades. The site in the Watershed was impacted by timber harvest. No plants survived.

Special habitats comprise approximately 1% of the Watershed. The most prevalent special habitats are rock gardens (267 acres), mesic meadows (242 acres), dry meadows (124 acres), wet meadows (91 acres) and rock outcrops (17 acres). These habitats are important for both wildlife and plant habitats. Functions of special habitats and the wildlife species that use them are outlined in the Special Habitat Management Guide (Dimling and McCain,1992).

The Calapooya Mountains forms a physical and a climatic barrier for plant species migrating south, north and west. This area harbors a range of habitat types and species. Even though the peaktops are non-forested special habitats, the remainder of the area is highly fragmented by timber harvest.

Two areas of special botanic richness were designated as Special Interest Areas in the Forest Plan. Moon Point is a 2000 acre parcel, 60% of which is in the MFWDT. Plants of interest include Siskiyou false hellebore and mountain mahogany. The second SIA is Bradley Lake, in the southwest corner of the MFWDT, on the ridgeline of the Calapooya Mountains. Plants of interest include wapato and large-flowered brickellia.

Three portions of LSR 0222 fall within the Watershed Only 41,525 acres or 8% of LSR 0222 is within the MFWDT. The rest of LSR 0222 extends to the north, west and south of the Watershed. The current forest habitat condition of the LSR are in Table 21.

Table 21: Forested Habitat In LSR 0222 Within MFWDT

Portion	Early Seral	Pole & Small Timber in Acres and Percent	Mature and Old-Growth in Acres and Percent	Total Acres
Northern	3,441 (16%)	3,052 (14%)	15,655 (70%)	22,148
Middle	1,595 (27%)	1,235 (21%)	3,149 (52%)	5,980
Southern	2,746 (20%)	1,201 (10%)	9,450 (70%)	13.477
Total	7,782 (19%)	5,488 (13%)	28,254 (68%)	41,525

About 1300 acres of the LSR forms an extension through checker board private lands, toward the river corridor. Of the five spotted owl activity centers, two, exist within this extension. An important function of this extension provides dispersal connectivity in this area for late successional species.

Habitat Connectivity

Distribution and Size of Vegetation Patches is the measurements for habitat connectivity. Connectivity for upslope terrestrial and riparian associated wildlife species is highly fragmented. The large blocks of managed private lands and the Hills Creek Lake form the greatest barriers for most upslope terrestrial and riparian wildlife species that travel on land.

The Calapooya Mountains form a physical and climatic barrier for many plant species.

Interior Habitat:

The **size and distribution** of vegetation stands is also a measurement for interior habitat. With the increase of timber harvesting the large blocks of interior forest habitats are substantially smaller than before 1900 (Figure 13).

Figure 13: Middle Fork Willamette Downstream **Tributaries**

Interior Habitat Current

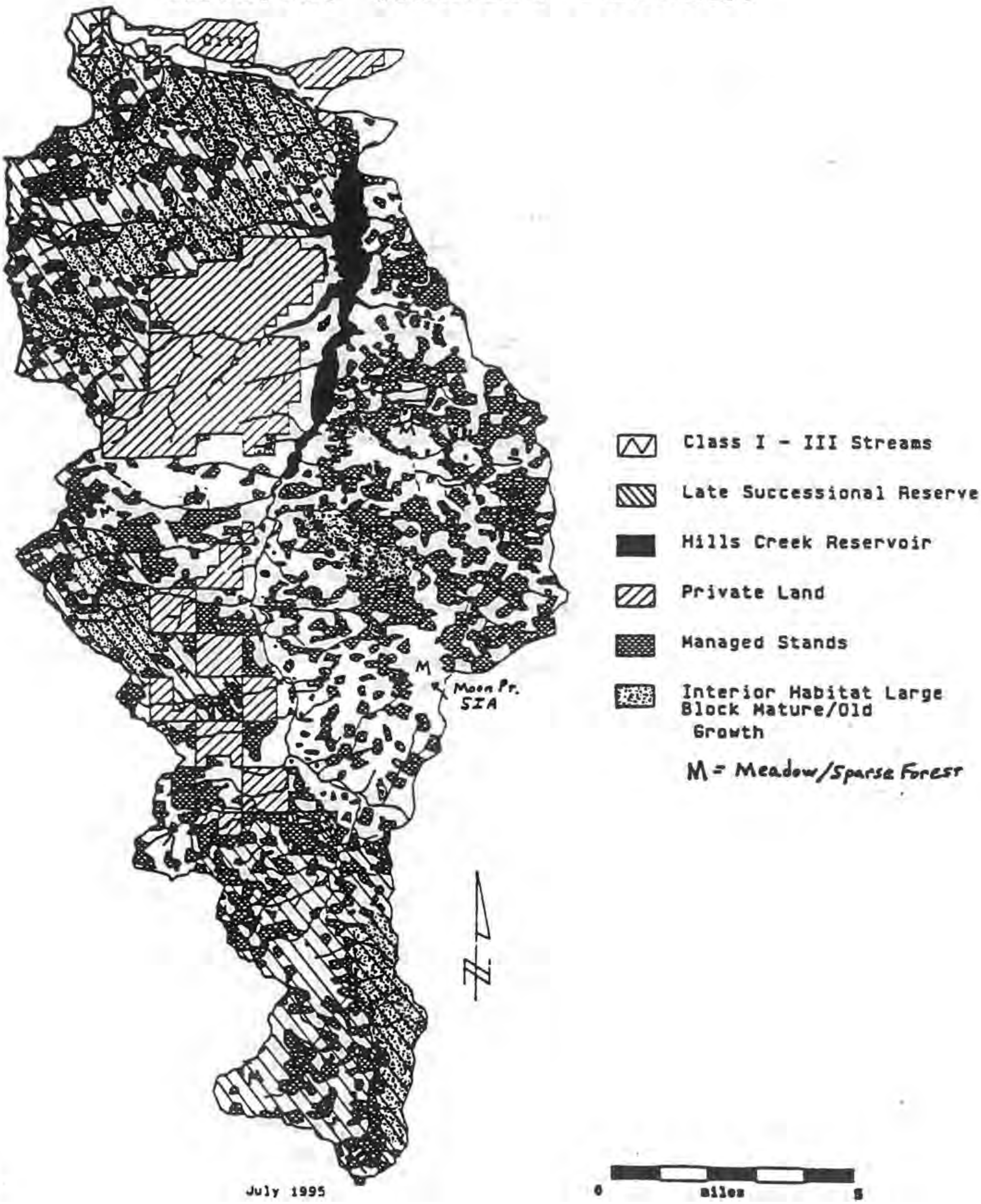


Table 22: Current Large Blocks of Interior Habitat

Area	Approximate Acres
North Slope of Larison Ridge in LSR	3,200
Upper Gray Creek Drainage In LSR	1,600
Mid-Lower Larison Creek Drainage In LSR	3,200
Upper Packard Creek Drainage In LSR	2,560
Upper Bohemia Creek Drainage in LSR	1,280
Lower Buck Creek Drainage In Matrix	1,280
Upper Gold Creek Drainage In Matrix	1,088
Mid-Coal Creek Drainage In LSR	2,560
Mid and Upper Windfall Creek In Matrix	1,280
Total Acres in Large Blocks	18,048

The mid Coal creek interior habitat is a contiguous 2,560 acre block that connects to 1,600 acres of interior habitat on the east slope of Dome Rock Ridge outside of the MFWDT.

The mid and upper reaches of Windfall Creek drainage have an unfragmented 1,280 acre block of forested habitat. It is composed of mature, second-growth and old-growth timber with several hundred acres of small timber habitat. Windfall T.S. is planned to thin and to regenerate harvest of the smaller timber.

Distributed across the rest of the Watershed are blocks of interior habitat ranging in size of about 640 acres to 100 acres.

Ecological Site Productivity

Harvest and treatment history has made a large impact on the amount of **large woody material** available in the MFWDT. Clearcutting in the Douglas-fir forests was the preferred harvest system with over 26,000 acres harvested on NFS lands since the 1940's. Appendix H lists the treatment acres by decade. The major clearcut harvest area from the 1950's to 1990 was in Subwatershed 21-3. Harvesting proceeded from the northern end of the Watershed along Forest Road 21. Over a dozen units were harvested in the Willow Creek area in the late forties. Buck and Groundhog Creek areas had heavy harvest in the 1950's. In general, LWM was left on clearcut units between the 1940's and 1970. About 15,000 acres of NFS lands have been managed this way. Private lands should be in similar conditions.

In the mid-1970's until the late 1980's, harvest practice removed LWM from streams and units. About 14,000 acres of NFS in the MFWDT are in this condition. The assumption is similar conditions would exist for the majority of private forest lands harvested during this time frame.

During the late 1970's until the mid- 1980's, roadside salvaging usually removed merchantable logs and snags for several hundred feet along the roads. These areas retain the potential for LWM recruitment.

Riparian Habitat Quality

See Reference Conditions **Riparian Uses.** The riparian areas that have had harvest have fragmented and broken the connectivity for dispersal and genetic interchange of riparian associated species.

Aquatic Domain

The processes that affect the aquatic domain for vegetative manipulation are: Landslides (VM4); Hydrologic recovery (VM3); Wood recruitment and shading (VM5); and Habitat complexity (VM5).

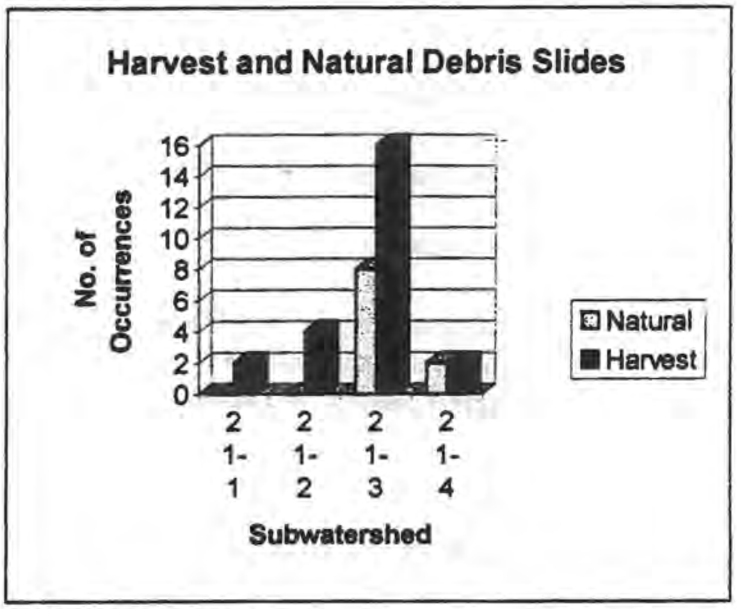
Landslides

Vegetation manipulation, especially clearcut harvesting and associated road construction, have affected the spatial and temporal distribution of **landslide occurrences**, particularly with respect to debris slides. A detailed discussion of road related landslides are included under the Current Transportation System (4-30,31,32).

Clearcut harvesting on steep slopes with shallow, rocky soil reduces root strength and increases groundwater height until such time as the area recovers vegetatively (approximately 5 to 20 years). During this window of time, the probability of shallow, rapid slope failure on steep ground is significantly increased (Gray and Leiser,1982).

Approximately 66% of the Watershed Analysis area is characterized by steep ground with shallow, rocky soil. Between 1940 and 1995, over 26,000 acres were harvested using clearcut methods. Approximately 45% of this harvest occurred between 1980 and present. This implies that 11,720 acres of steep ground with shallow, rocky soil are in some stage of redeveloping pre-harvest root strength and groundwater levels and is therefore at elevated risk of producing a debris slide. Of this, approximately 5,400 acres are on Private land, most being in the Packard Creek drainage.

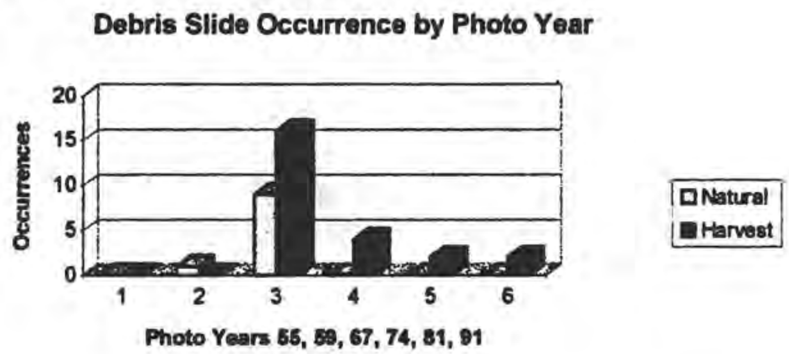
Figure 14: Current Debris Slides



Air photo reconnaissance spanning 1955 to 1991 indicates that 88% (21 of 24) of harvest related debris slides occur in the geomorphic category described above. Bohemia Creek and Buck Creek drainage's have each had 6 occurrences. Windfall Creek and Indian Creek drainage's have each had 2 occurrences. Shortridge, Gray, Bull, Willow, Coffeepot, Coal and Deadwood Creeks have each had 1 occurrence.

Of the 24 harvest related debris slides, 16 appeared in the 1967 photos, presumably in conjunction with the 1964 flood. Four were identified in the 1974 photos and 2 each in the 1981 and 1991 photos.

Figure 15: Debris Slide by Year



Deep seated landslides typically occur in clayey soils. The failure mechanism is less dramatic than with debris slides and therefore more difficult to identify using air photos. Deep seated landslides create a persistent input mechanism of suspended sediments, thus affecting water quality and spawning habitat. Approximately 11% of the MFWDT is characterized by deep, clay soil usually on gentle, hummocky ground. Between 1940 and 1995, approximately 5904 acres of this area have been harvested using clearcut methods (including Private land).

Approximately 38% of this harvest occurred between 1980 and present which implies that 2230 acres of clayey soil are in some stage of redeveloping pre-harvest groundwater levels. Unlike debris slides, the deep seated landslides take much longer to redevelop pre-failure shear strength regardless of whether they are revegetated or not. Therefore, sediment input occurs long after slope failure.

Known deep seated landslides, aggravated or initiated by harvest activity, occur in the headwaters of Bull Creek (Tufti Mountain), Modoc Creek, Tea Creek, Powder/Buck Creek, Windfall Creek, Big Willow Creek, and Coffeepot Creek. Tufti Mountain and Powder/Buck Creek are two of the largest landslides.

Hydrologic Recovery

Hydrologic recovery is measured by **percentage of vegetation less than 35 years.** Thirty-seven percent of the MFWDT Watershed has been harvested since 1960 and is vegetated by trees less than 35 years old. Traditionally hydrologic recovery is based on a transient snow zone with an upper elevation of 4,000 feet. The MFWDT is a transition location between the northern wet and colder forests and the southern warm and dryer forests. The TSZ likely extends to a higher elevation band that is inclusive of the higher ridge tops of around 5,500 feet.

Table 23 presents hydrologic recovery data using stands less than 35 years of age at all elevations. Figures 16,17,18, and 19 represent Subwatershed maps showing all partial and clearcuts less than 35 years in age. Subwatersheds are further described relative to the east and west sides of the Hills Creek Lake and the MFW River. Detailed descriptions that include stream watershed hydrologic recovery that reveals harvest activity are in Appendix G.

Figure 16: Middle Fork Willamette Downstream Tributaries

Subwatershed 21 1
Harvest Stands < 35 Years

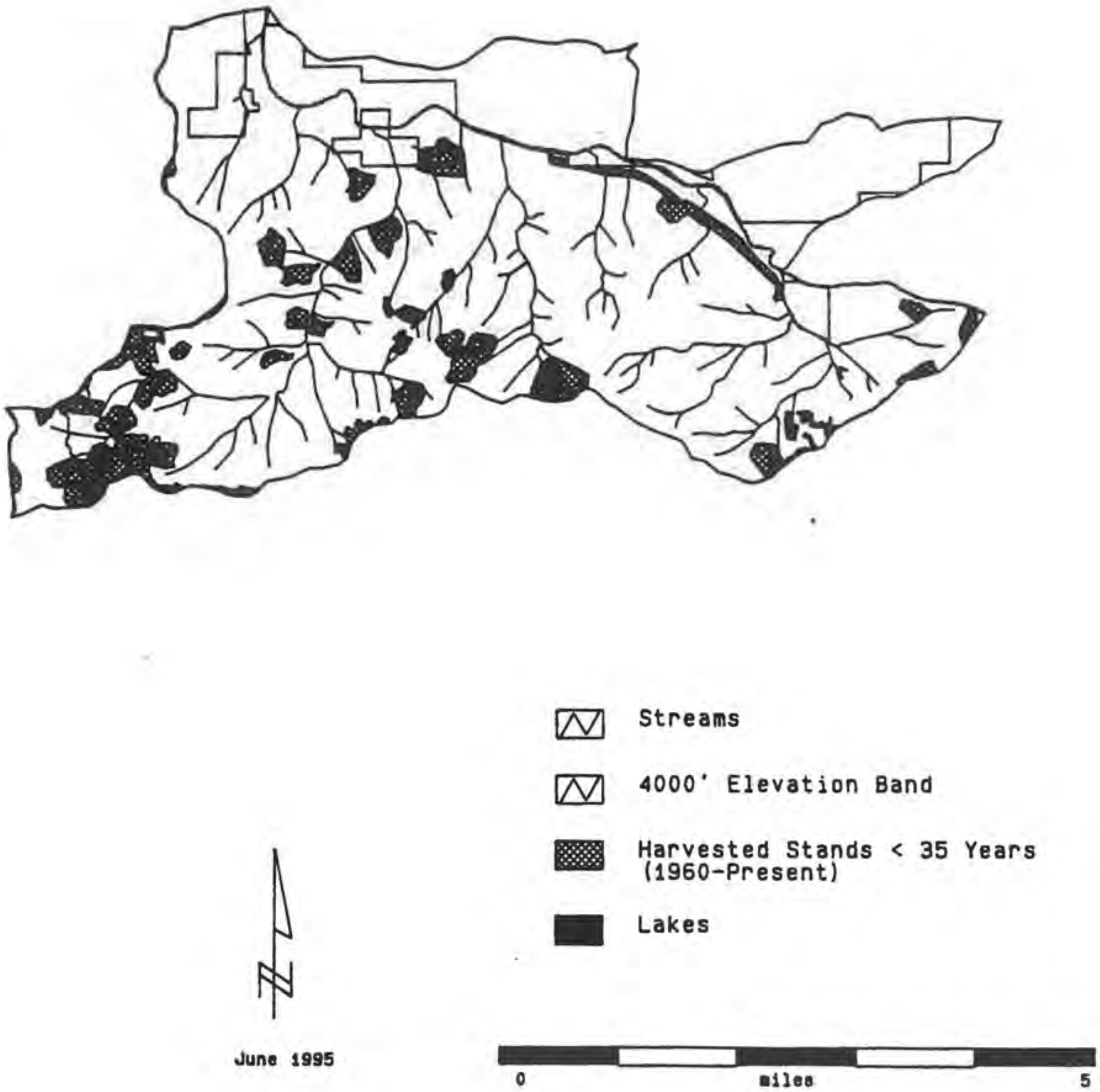


Figure 17: Middle Fork Willamette Downstream Tributaries

Subwatershed 21 2
Harvest Stands < 35 Years

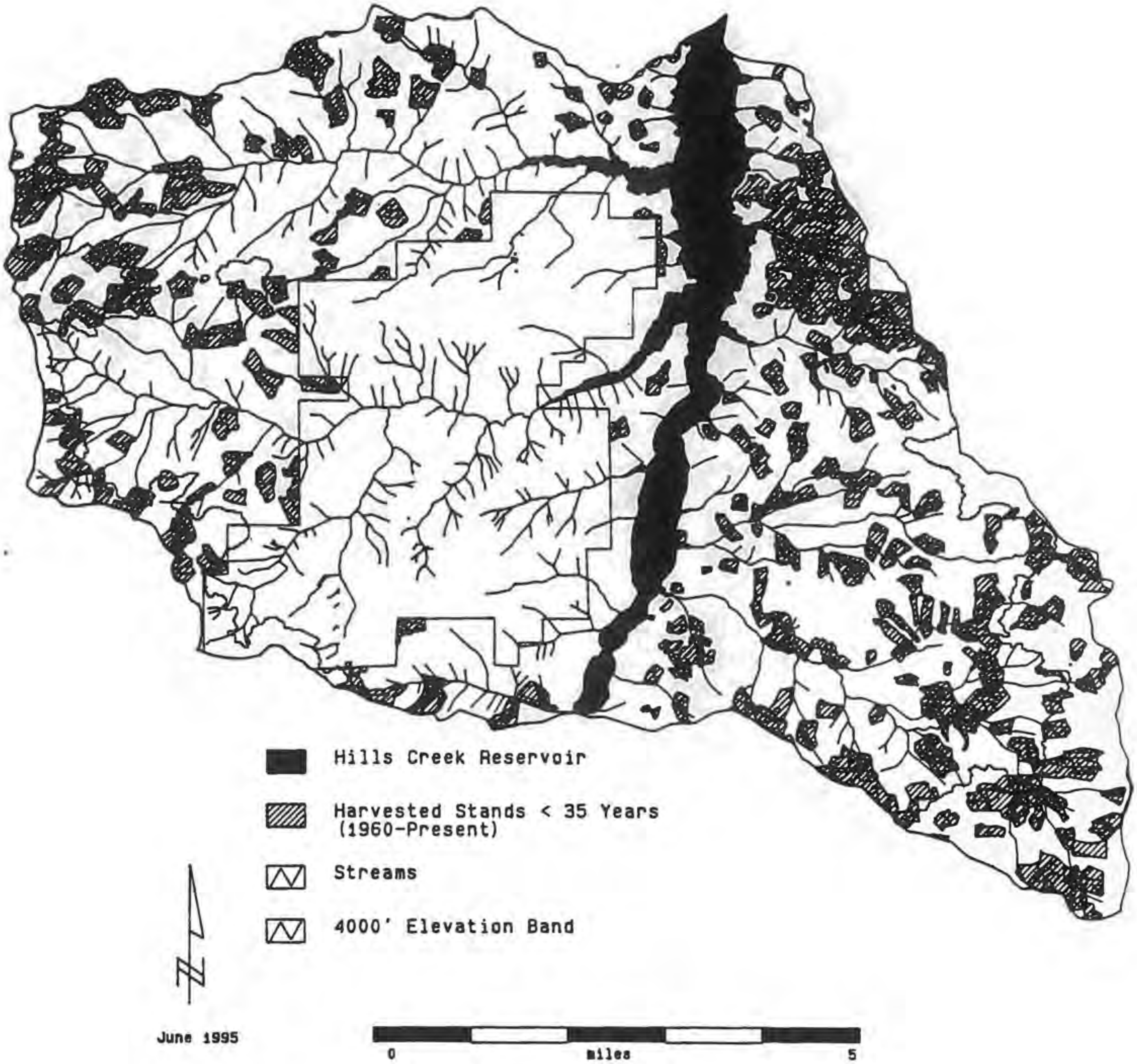


Figure 18: Middle Fork Willamette Downstream Tributaries

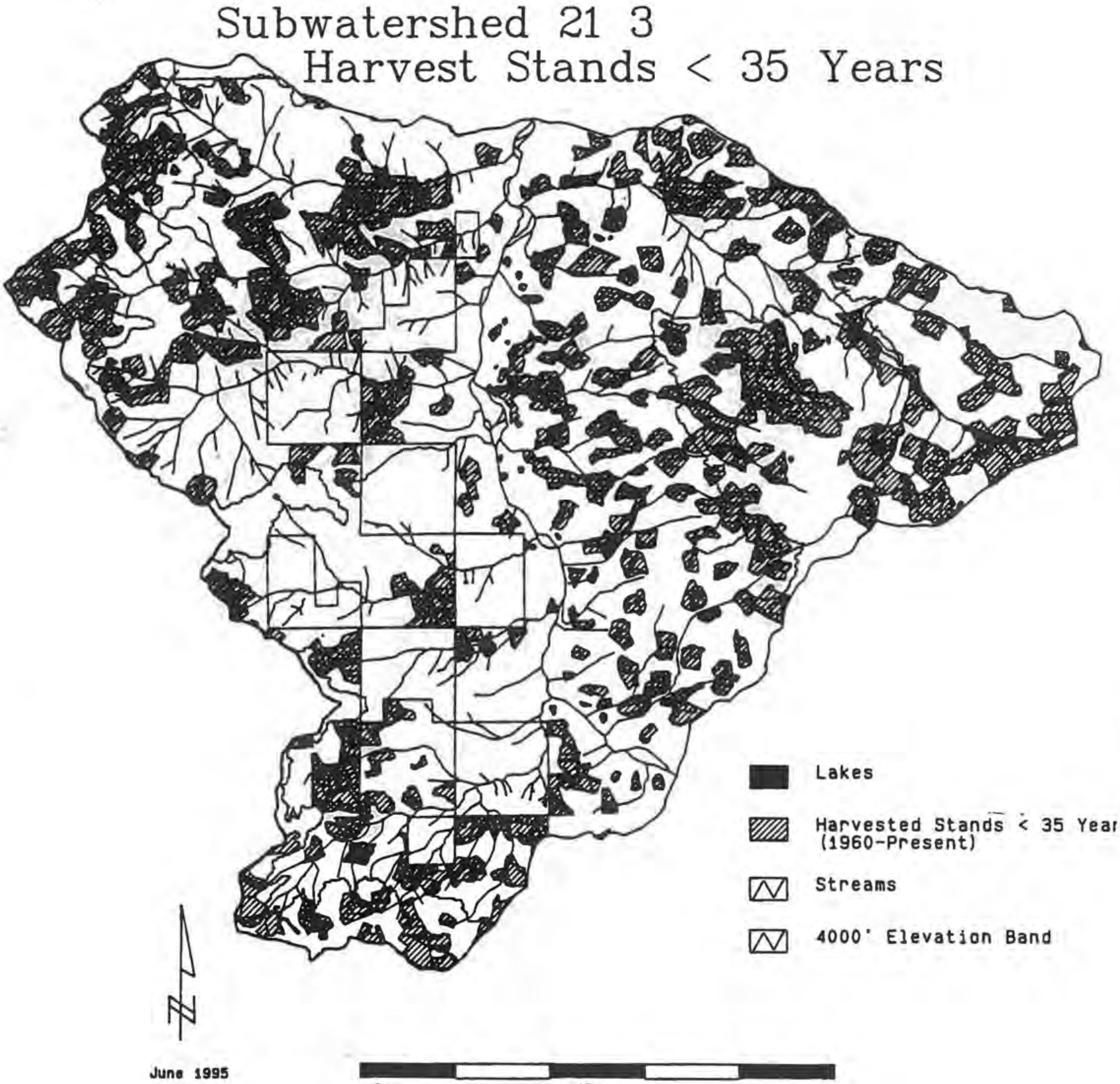


Figure 19: Middle Fork Willamette Downstream Tributaries

Subwatershed 21 4
Harvest Stands < 35 Years

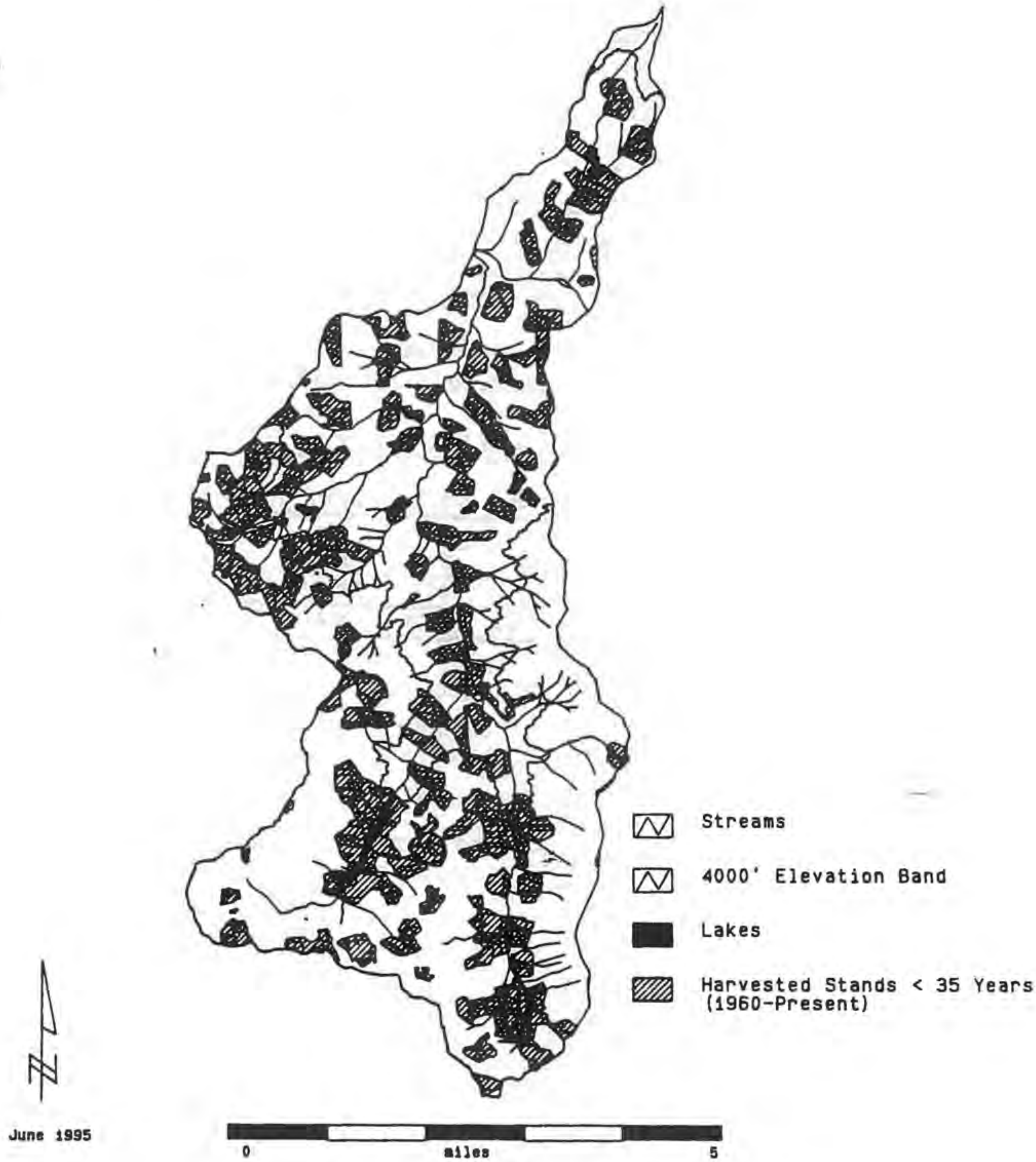


Table 23: Hydrologic Recovery by Subwatershed.

Area	Inside Riparian	Outside Riparian	Private	All Elev. X<35 Yrs	Total Acres	% X<35 Yrs	% Hydrologic Recovery
21-1	**161**	**1,075**	**431**	**1,668**	**10,672**	**16**	**84**
21-2 west	717	2,564	9,240	12,521	25,247	50	50
21-2 east	762	3,839	0	4,601	14,600	32	68
21-2	**1,479**	**6,403**	**9,240**	**17,121**	**39,847**	**43**	**57**
21-3 west	1,435	4,271	4,121	9,827	22,275	44	56
21-3 east	1,012	4,346	0	5,358	16,254	33	67
21-3	**2,447**	**8,616**	**4,121**	**15,184**	**38,529**	**39**	**61**
21-4 north	111	312	0	423	1,584	27	73
21-4 south	728	3,689	0	4,417	14,958	30	70
21-4	**839**	**4,001**	**0**	**4,840**	**16,542**	**29**	**71**
21	**4,925**	**20,095**	**13,792**	**38,813**	**105,590**	**37**	**63**

Note: All private land is assumed to be less than 35 years old.

Table 24 shows the percent of the headwater areas that have been harvested as a result of the previous practice of minimizing harvest within the TSZ.

Table 24: Percentage Of Area and Acres Harvested above 4,000 feet.

Stands X<35 yrs	% 21-1	% 21-2	% 21-3	% 21-4	% Watershed	Total Acres
X>4000'/north	37	43	53	32	42	13,947
X>4000'/south	30	45	37	25	35	9,891
Total X>4000'	36	44	46	29	39	23,837
Total Ac X>4000'	356	5,233	9,587	8,661	23,837	

The following are important facts on each of the Subwatersheds in the MWWDT.

Subwatershed 21-1

- Most hydrologically recovered Subwatershed.
- Moderately high potential for rain on snow events occur.

Subwatershed 21-2 East

- Moderately high potential for rain on snow events to impact the stream channel.
- East side of Reservoir slightly less flashy, more clays for suspended sediment, riparian vegetation better condition less channel/floodplain erosion.
- Nearly half of the area above 4,000 feet within 21-2 has been harvested in the last 35 years.

Subwatershed 21-2 West

- Moderately high potential for rain on snow events to occur and impact the stream channel.
- West-side of Reservoir -- flashier streams, some have little to no riparian vegetation, greater potential for elevated water temperatures and channel/floodplain erosion.
- Nearly half of the area above 4,000 feet within 21-2 has been harvested in the last 35 years.

Subwatershed 21-3 East

- Moderately high potential for rain on snow events to impact the stream channel.
- East side of Reservoir slightly less flashy, more clays for suspended sediment, riparian vegetation better condition less channel/floodplain erosion.
- Nearly half of the area above 4,000 feet within 21-3 has been harvested in the last 35 years.

Subwatershed 21-3 West

- Moderately high potential for rain on snow events to impact the stream channel.
- West side of Reservoir - flashier streams, some areas have little riparian vegetation, greater potential for elevated water temperatures and channel/floodplain erosion.

Subwatershed 21-4

- Most hydrologically unrecovered Subwatershed.
- Moderately high potential for rain on snow events to impact the stream channel.
- Majority of harvest within last 35 years.

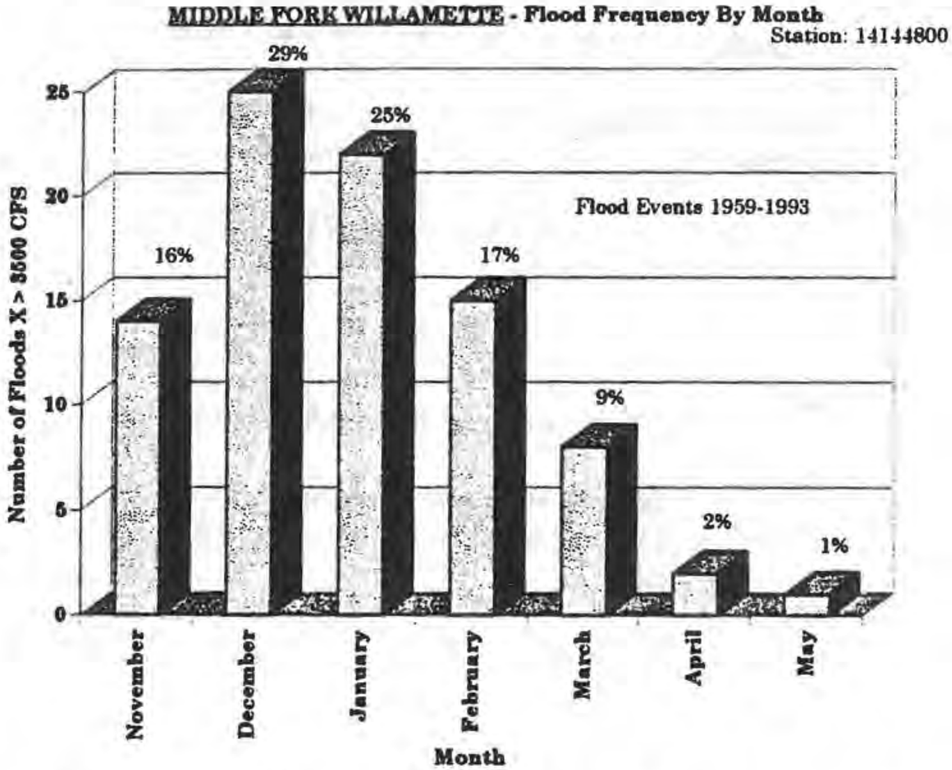
Water yield class remains the same as described in the Reference Condition (3-10,11). The majority of the MFWDT is composed of soils and geology that have a high runoff rate producing streams with a quick response to precipitation and snow melt events.

Measuring the **flow regime** is one way to assess hydrologic recovery. The MFW River has one USGS Gauging Station that has been operational since 1959 recording both stream temperature and stream discharge. The Station is roughly 0.5 miles upstream from Hills Creek Lake near Sand Prairie

Campground. Analysis of water years 1959 through 1993 provided the following insights and information.

Flood frequency by month reveals the percentage of streamflow peaks greater than 3,500 cubic feet per second (cfs) occurring within the watershed for the period of record (Figure 18). The largest of the floods occurred in December 1964. The precipitation initially fell as snow until the temperatures warmed and heavy rains followed. The rains melted snow below 5,000 feet (Waananen, Harris, and Williams, 1971).

Figure 20: Flood Frequency Greater Than 3,500 cfs for the period of record.



Within this Watershed the hydrologic character of the geology and soil combine with the climate to create the following:

- the greatest quantity of total monthly flow, occurs from December to May, peaking in December and January

- The greatest frequency of flood events, larger than 3,500 cfs, occurs in December and January. Although the frequency of flood events is on the decrease from February to May, the total discharge for those same months remains fairly high and constant (Figure 20).

- Higher flows in March and May are likely in response to snowmelt occurring below 4,000 feet, on the south slope and north slopes respectively. This is further demonstrated by the flow data from the USGS flow data period of record.

Detailed information is in Appendix G, Hydrology Documents.

Wood Recruitment And Shading

Management activities within the riparian corridor have altered the riparian vegetation within this Watershed. Harvest acres include the impact of the Shady Beach Fire on the riparian area. **Percent of trees less than 35 years and over 55 years, stream temperature, channel stability,** and the potential for future large woody material recruitment are products of the geology, vegetation and climate. These characteristics are further modified by management activity within the riparian corridor.

Stands within the riparian area older than 55 years of age are assumed to be natural stands and they begin providing down woody and the LWM component to the riparian area, stream channel and floodplain (Table 25). Figures 21,22, 23, and 24 represent harvest units less than 35 years inside riparian buffers. They do not provide a source for future LWM.

Table 25: Percent Riparian Vegetation.

Subwatershed	% Riparian Area X < 35 years	% Riparian Area X > 55 Years
21-1	8	72
21-2	22	50
21-3	33	46
21-4	33	64
Total 21	26	53

Notes: a) 4% of each Subwatershed is roaded (roads have a 40 foot buffer and are mapped in GIS).
b) Riparian buffer calculations are inclusive of Class I-IV streams.
c) Riparian buffer widths are based on the Forest Plan widths.

Vegetation manipulation of the channel bank and floodplain plays a significant role in maintaining the **structural integrity of the channel** and floodplain morphology. Harvest activity results in the loss of root strength that formerly held banks together creating banks vulnerable to erosion processes that accelerate with storm events. The impact of vegetation manipulation on channel stability is relative to the percentage riparian buffer harvested for all stream classes within the last 35 years (Table 25).

Figure 21: **Middle Fork Willamette Downstream Tributaries**

Subwatershed 21 1
Harvest Inside Riparian Buffers

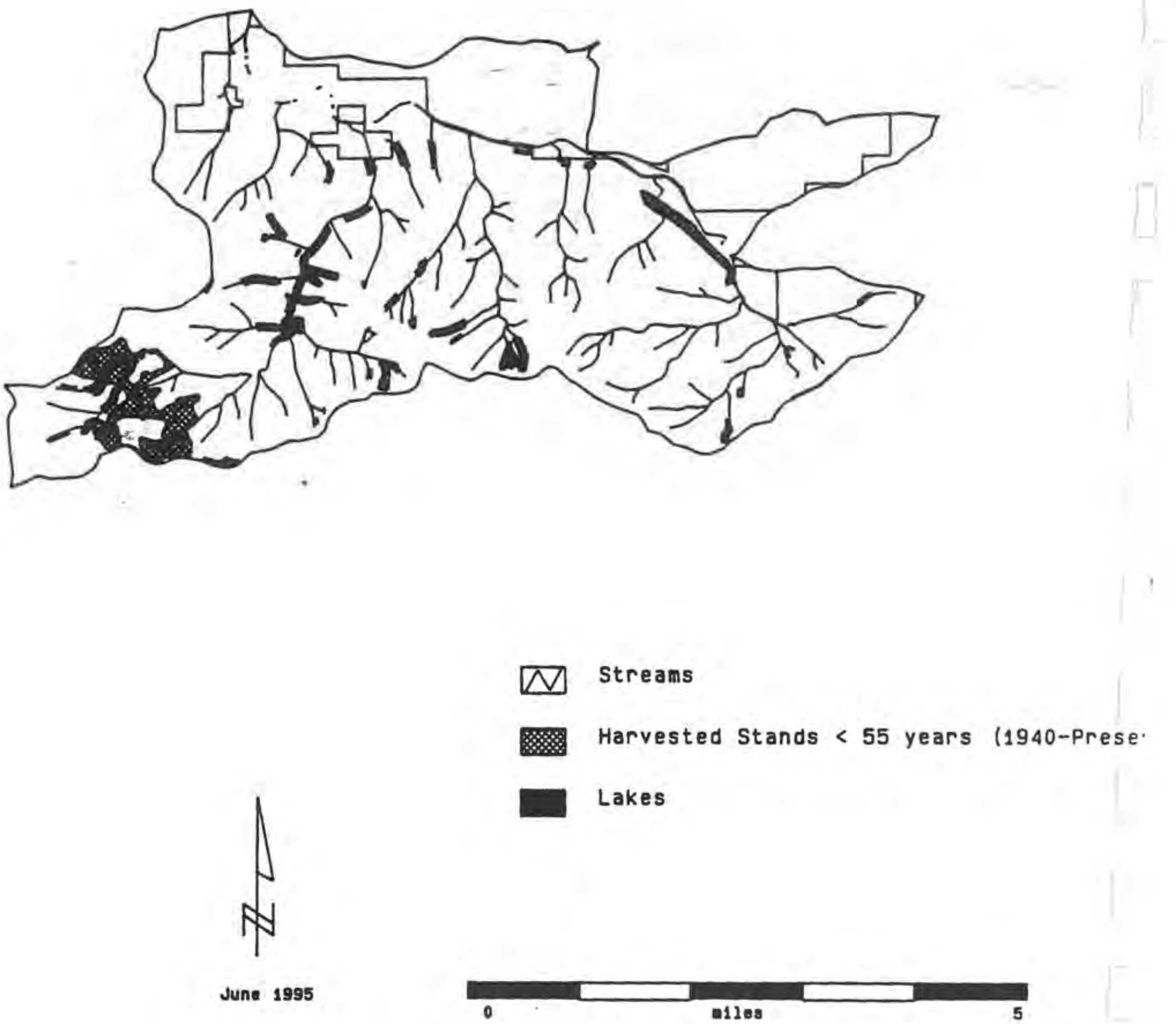


Figure 22: **Middle Fork Willamette Downstream Tributaries**

Subwatershed 21 2
Harvest Inside Riparian Buffers

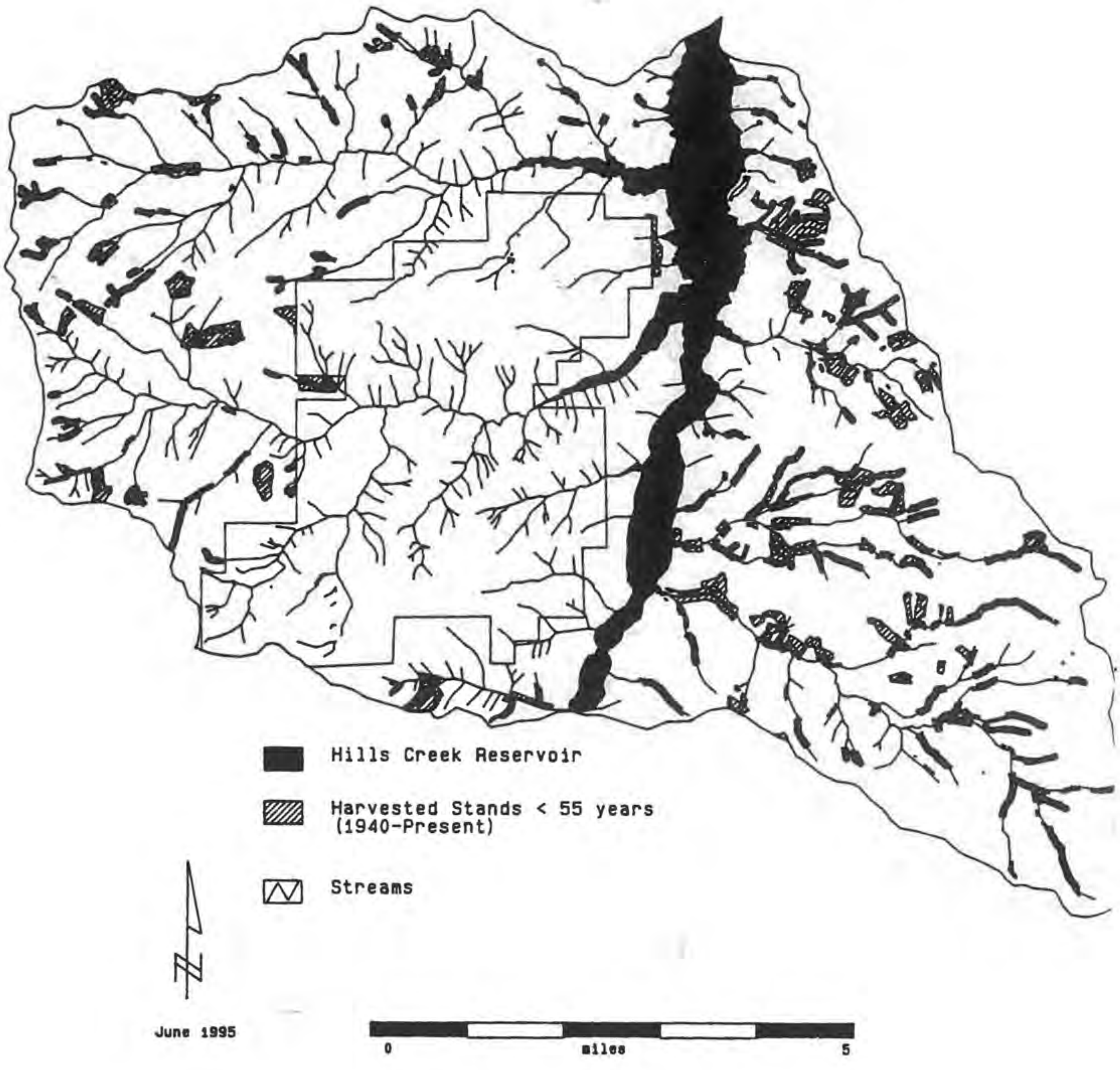


Figure 23: Middle Fork Willamette Downstream Tributaries

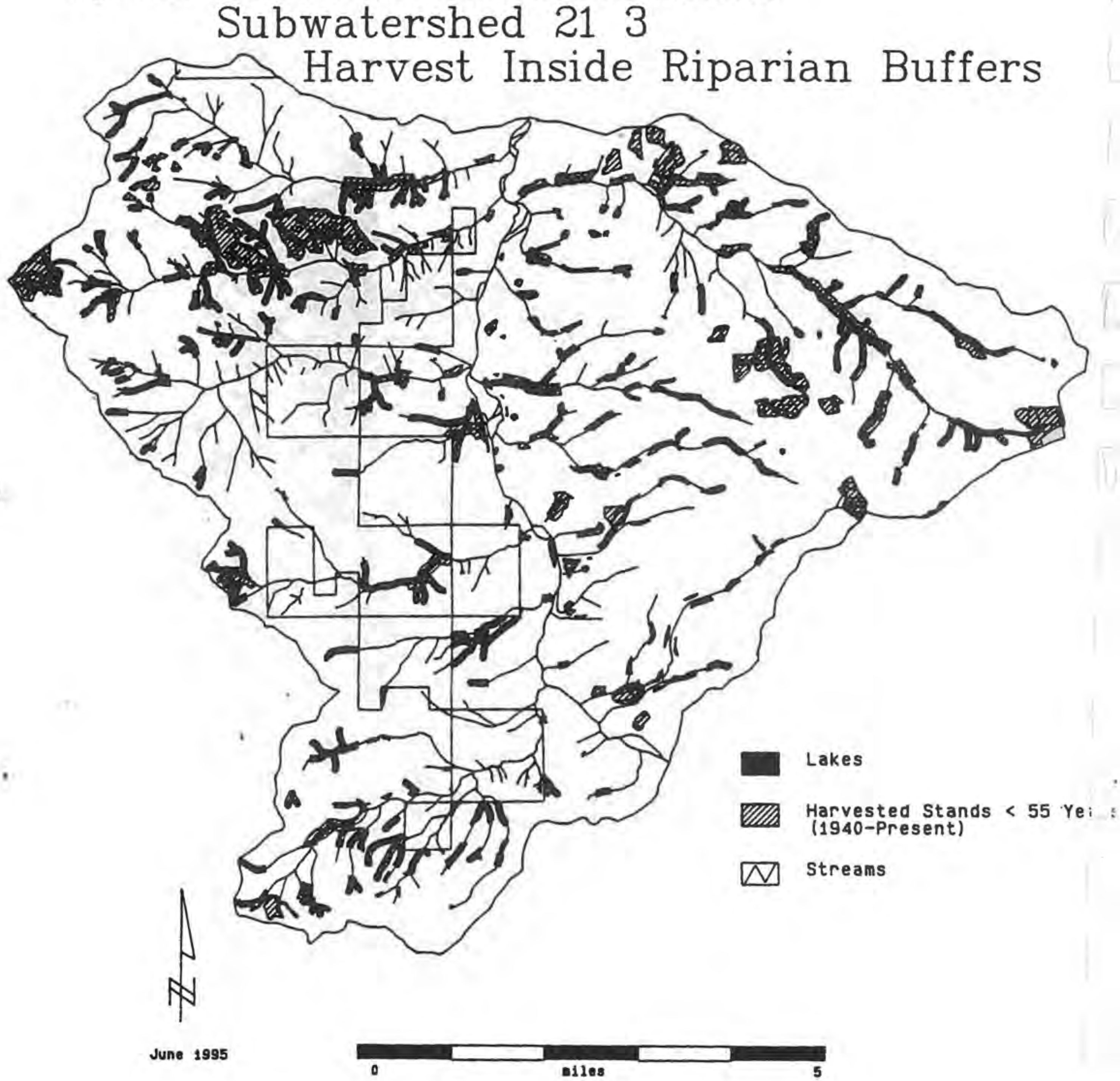


Figure 24: Middle Fork Willamette Downstream Tributaries

Subwatershed 21 4
Harvest Inside Riparian Buffers

Stands within the riparian area younger than 35 years in age, generally do not provide adequate shade for the stream environment especially for wider streams. The impact of vegetation manipulation on **water temperature** is relative to the miles of perennial stream harvested within the last 35 years (Table 26).

Table 26: Percentage Of Perennial Stream Harvested Since 1960

Subwatershed	Stream	% Of Perennial Stream Harvested	Max. Water Temperature Fahrenheit	Date
Total Miles		668.2		
21-1	Gray	8.5		
21-1	Shortridge	0.0		
21-2 west	Larison	14.6		
21-2 west	Packard	56.2	77	1992
21-2 west	Stony	100.0		
21-2 west	Snow	14.5		
21-2 east	Modoc	20.8		
21-2 east	Bull	19.9	68	1994
21-2 east	Little Willow	0.0		
21-2 east	Big Willow	42.0	71	1994
21-2 east	Coffeepot	25.0	65	1994
21-3 west	Windfall	30.0	65	1992
21-3 west	Gold	26.6		
21-3 west	Bohemia	46.6	* 63	1993
21-3 west	Snake	28.6	* 64	1990
21-3 west	Spring Butte	46.9		
21-3 west	Indian	33.0		
21-3 east	Buck	23.9	76	1992
21-3 east	Estep	38.2		
21-3 east	Pine	26.6		
21-3 east	Youngs	16.7	64	1990
21-4 south	Coal	22.8	66	1993
21-4 north	Deadhorse	26.8		

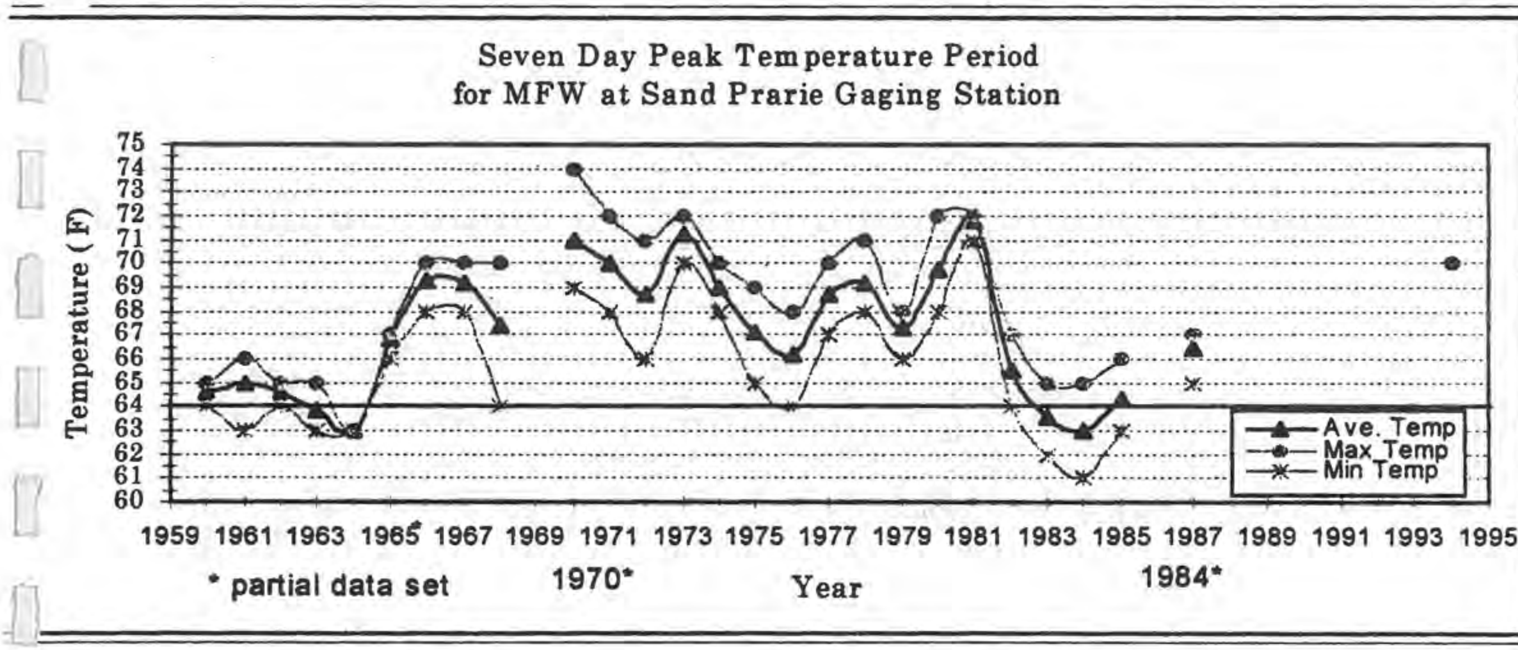
*Indicate grab sample; otherwise water temperatures are from Maximum and Minimum thermometers.

Temperature values in the mainstem MFW River reflect the integration of several factors that affect stream temperatures in the entire drainage network upstream of the sample location.

Temperature data from the USGS gauging station at Sand Prairie is partially affected by temperatures in upstream tributaries outside the boundary of the continuously from 1960 to 1987. This period of record encompasses about half the period of intensive forest management.

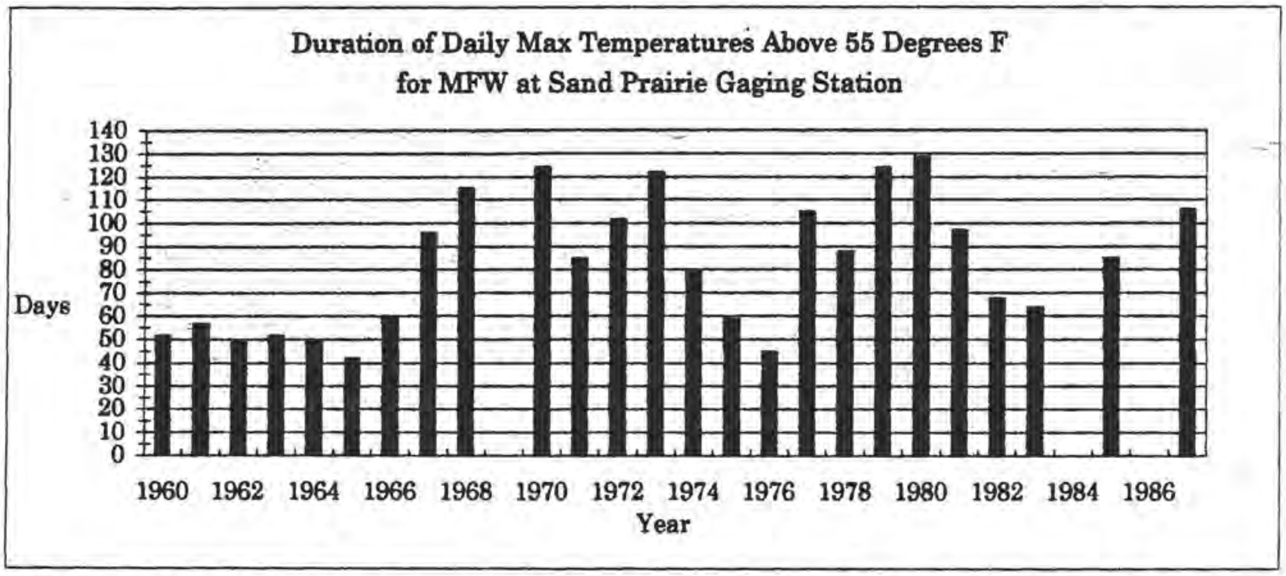
Figure 23 displays the annual variation in the "seven day peak period," a temperature parameter of biological importance for cold water fish (DEQ 1994). The average, maximum, and minimum values for the peak period are shown for each year. The average values range from 63 degrees in 1964 to 72 degrees in 1980. The recommended maximum for the average value during the seven day peak period is 64 degrees. The data show only four years in which the average value has not exceeded this magnitude.

Figure 25: Seven Day Peak Temperature at Sand Prairie Gauging Station



Another view of the temperature regime of the MFW at this location is in Figure 24. For Chinook salmon, 55 degrees is at the upper boundary of the range of satisfactory conditions for adults. It is near the middle of the range for juveniles (DEQ 1994). The number of consecutive days in which maximum temperatures were above 55 degrees ranged from 42 in 1964 to 128 in 1980. Although not tied to a specific water quality requirement, this view of the data reveals a potential biological concern related to the duration of low level temperature stress.

Figure 26: Duration of Daily Maximum Temperatures Above 55 Degrees

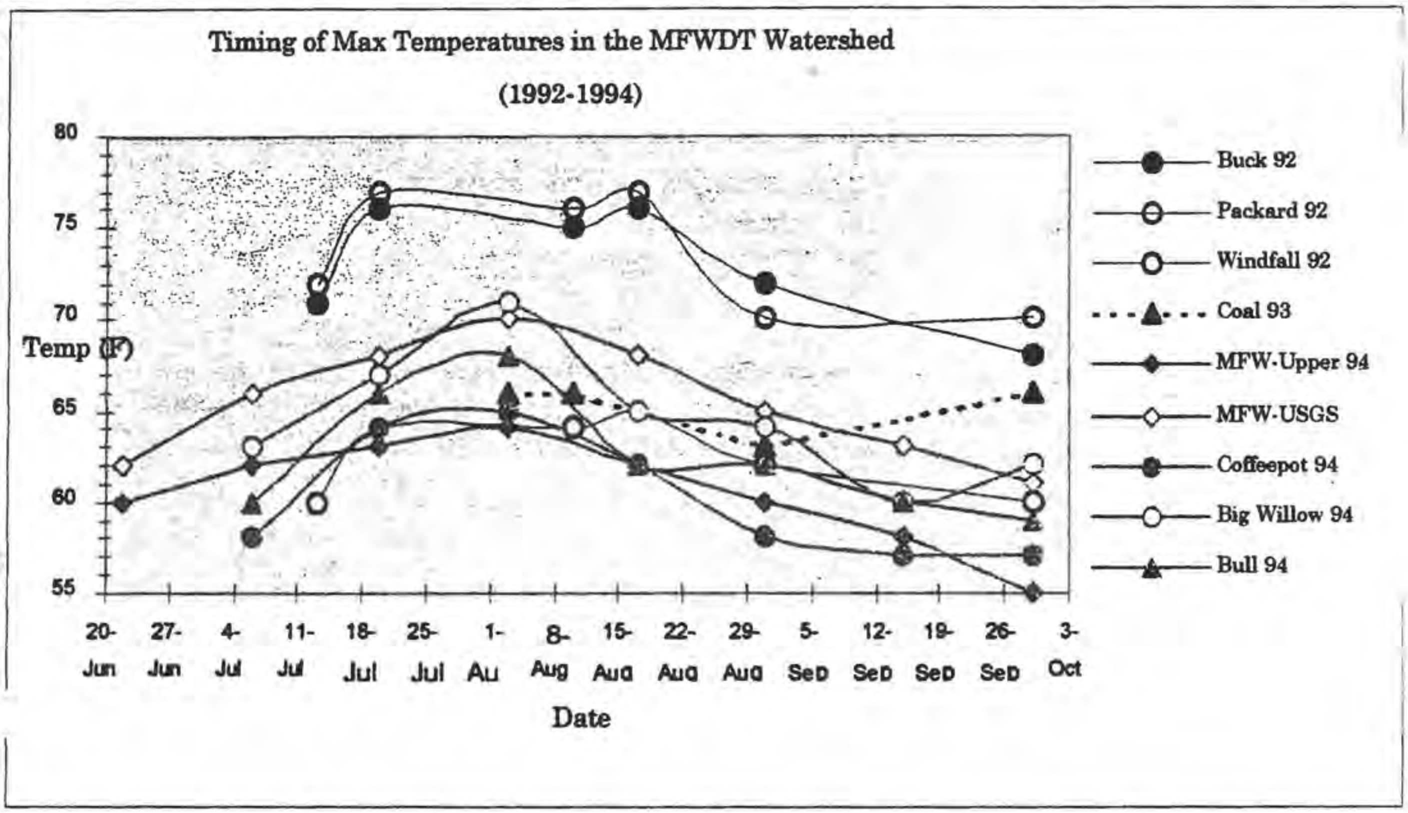


Figures 25 and 26 show some evidence of an overall increase after 1965 in both the magnitude and duration of seasonal high temperatures. The timing of these two measures does not appear to be closely linked.

Data has recently been collected for several tributaries of the MFW River. Two locations in the mainstem MFW were monitored. The data shows seasonal maximum temperatures tend to occur between late July and late August basin-wide. This timing is consistent with the 27 year period of record from the USGS gauging station and reflects the influence of regional climatic patterns. The type of data does not allow computation of the seven day average peak temperature. It is reasonable to expect this standard is often exceeded throughout the Watershed. The combined monitoring results show single maximum temperatures greater than or equal to 64 degrees have occurred in all locations and years for periods of up to eight weeks (Figure 26).

Figure 27: Recent Temperature of MFW River Tributaries

In the context of the entire period of record, the seasonal maximum temperature



recorded at the Sand Prairie site in 1994 is one of the higher values (Figure 27). The data from 1994 represent temperature conditions in a comparatively warm year. The range of values among these sites was less extreme than among the 1992 sites. This difference could be explained by the change in location or the change in year or a combination of these factors.

The widest range of maximum temperatures for a single location in 1994 occurred in Big Willow Creek. Maximum temperatures ranged from 60 to 71 degrees and a warming trend of 2 degrees occurred in the last two weeks of the season. A similar warming trend of 3 degrees occurred in Coal Creek during the last four weeks of the 1993 summer season. This trend did not occur at the other sites monitored in 1994. Between the two sites on the MFW river, the overall pattern of seasonal maximum temperatures is similar reflecting broad scale influences, but the range of values is different, reflecting fine scale influences. Between the two locations, the river is likely receiving inputs of relatively warm water from tributaries. The channel drops 400 feet in elevation and also increases in width so is less shaded.

Habitat Complexity

It is apparent that the processes have been impacted by vegetation manipulation. Riparian harvest has reduced the amount of streamside vegetation available for future wood recruitment into the stream and for stream shading. Stream cleanout associated with timber harvest reduced the amount of large wood left in the stream for habitat complexity. Harvest related debris slides have introduced sediment and distributed wood unevenly throughout most streams. Documentation of monitoring of rehabilitation of these processes by riparian or upland planting and or fertilization has been lacking.

<u>Subwatershed 21-4</u>

Management influence from vegetation manipulation is evident in two ways. The inner riparian seral class is dominated by small pole and small trees of alder and willow and the lower reaches of the streams are lacking LWM.

<u>Subwatershed 21-3 West</u>

Red alder is established along the <u>harvested</u> streamside units. Since 1959, a total of 9 harvest related_debris slides and 30 road related and natural events have occurred. Most of those landslides reached the creek. The deposition of the slide material, coupled with the removal of streamside vegetation, that eliminated future wood sources, has all but eliminated pool habitat in these streams.

The <u>unharvested</u> reaches of this stream are lined primarily Old-growth Douglas-fir habitat. LWM is copiously present and the channel is generally completely <u>shaded</u>. Bank armoring is good to excellent in bedrock habitats with <u>natural</u> bank cutting and erosion increasing in stretches with unconsolidated substrates and steep channel banks.

<u>Subwatershed 21-2 East</u>

The inner riparian seral stage was 69 and 19 percent sapling pole and small trees, respectively. The bed substrate is predominately large and small boulders, with 24 pools per mile and a residual pool depth of 2.1 ft. There is a lack of LWM in the stream..

<u>Subwatershed 21-1 West</u>

The steeper ground has experienced less debris slide activity since 1959 than Little Pine Subwatershed - West. The channel, along harvested units, is primarily bedrock with little or no woody material. Pools tend to be limited and spawning gravel non-existent.

In the class II alluviated mountain valley streams, the soils tend to be shallow, rocky and non-cohesive in a flat valley bottom of soil, gravel, and rock debris.. Streambanks are generally unstable. The stream widths are around 4 feet at the mouth, with boulder and rubble substrates. Gravel is negligible.

System and spur road construction in clayey soils has produced numerous sources of persistent suspended sediment.

Subwatershed 21-1 East

These streams exhibit the unstable geology of the area by being naturally unstable, slightly drier than other areas (as evidence of fire history), and particularly susceptible to perturbations.

Bull Creek has sustained a high harvest rate. Timbered slopes are actively delivering woody material to the valley bottom. In the upper reaches the stream undercuts its banks severely in places increasing the potential erosion on land upslope of the stream.

Almost the entire length of the streambed of **Little Willow Creek** is entrenched with undercut or unstable banks. The stream bottom is gravel and cobble. The stream contains a large amount of wood that is old and decaying. The present discharge is insufficient to move the large logs (Anderson and Stone,1994)

Way Creek is a Class IV headwall tributary. It has an abundance of woody material in the stream channel and some brush (Howland and Gangle, 1989, unpublished data). It is essentially in pristine condition with only a small clearcut at the time of the survey. Bank stability was fair with 50 percent bare bank loose soil and very little rock content. The stream bottom material ranged from small rock (3 to 6 inch diameter) to clay. Overall canopy was moderate to open.

Big Willow is divided into four geomorphic types. The upper reach is typical valley wall/headwall tributary with a moderate channel gradient and deep channel entrenchment through sand and gravel substrate. The stream had a high wood recruitment rate, although the majority of the wood was of the brush size category. With approximately 95 percent of the area unaffected by past timber harvest, the inner riparian seral class was predominantly large Douglas-firs and scattered Western Red Cedars. Active wood recruitment was observed for most of the reach (Anderson and Stone, 1994).

Downstream from the headwalls the habitat complex consisted mostly of rubble, boulder Cascade-stairstep pools with bedrock. This reach has high wood recruitment, with active recruitment from large trees throughout most of the reach. The major habitat was cascading and regular riffles.

The stream survey broke this homogeneous valley type into two reaches to capture the channel changes due to increased riparian harvest. Within the harvested area, the habitat complex consisted mostly of rubble, boulder Cascade-stairstep pools. The reach had portions of the stream flushed to bedrock. The riparian seral class was no longer dominated by large trees and the recruitment of wood dropped.

The percent harvest within the riparian area increases downstream. By the mouth of Big Willow Creek, the substrate is predominately bedrock, with fine rubble in deep plunge and trench pools. Wood recruitment is further reduced. The inner riparian area is 50 feet wide on average, and dominated by red alder and Bigleaf maple.

The upper Class III headwall tributaries of **Coffeepot** consist of large 7 to 10 foot waterfalls. Many of the small trees along the upper banks have bent trunks, with old growth trees tilted as much as 35 degrees toward the stream in the direction of the mass movement. As the stream passes through a nearby clearcut area, the abundance of slash materials and downed timber overlaying the stream increases dramatically. There are no fish in this area, although there is a variety of small "yellow and green" frogs (USDA, 1989).

Subwatershed 21-1

The existing condition of the streams in the Oakridge Subwatershed, except for Gray Creek, is be referenced to other streams of similar geomorphology and stream size in the Watershed. This Subwatershed is composed of tuffs, breccia, colluvium, and residuum landtype complexes, which are highly erosive and susceptible to mass wasting.

The landform of **Gray Creek** is very similar to Big Willow Creek. however, the mouths of Gray Creek end in the flood plain of the MFW River. The gradient drops considerably and the meander pattern begins to widen.

The instability of this area is portrayed in a landslide near the culvert across from Gray Creek on Road 5852-333. The culvert at the time of survey did not provide for fish passage. The streambed had numerous debris jams and rock diversions. While some of the jams appeared stable and working as sediment traps, others maintained little to no holding capacity.

Middle Fork of the Willamette River

The processes affecting the MFW River are cumulative and incorporate those stated above. The lack of wood and small seral size of trees along the Middle Fork reflects stream cleanout, riparian harvest and mass wasting that has occurred throughout the drainage. The residual pool depth has decreased with an increase in sediment production.

Issue (NF) Exclusion of Natural Fire

In 1910 the Forest Service established a fire suppression policy. Steady advances in fire control including the use of telephones quickened the response time of organized fire fighting crews. The Great Depression emergency programs contributed to improvements and fire control, including construction of roads that increased access to fires in the area. Construction of lookouts and stringing telephone wire reduced detection and reporting time.

The establishment of organized ground and air fire fighting crews, prevention programs, sophisticated and computerized communication and dispatch capabilities helped minimize acreage burned by wildfire in the Watershed.

Table 27: Current Processes For Exclusion Of Natural Fire

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial	NF1	Fire Pattern, Behavior & Intensity	Fire Suppression	% Seral Stages Size & Frequency Of Fires Fuel Loadings
	NF2	Habitat Diversity	Stand Treatments	% Seral Stages Species Composition Habitat Types
	NF3	TE&S Species And Fire Dependent Species	Fire Suppression	Species Composition
Aquatic	NF2	Riparian Structure	Natural Fires	Fires Intensity In Riparian Reserves Water Quality and Quantity
Social	NF1	Habitat Diversity	Native American And Early Settlers Fire	Human Use of Fire

Terrestrial Domain

The important processes for the Terrestrial Domain are :Fire Pattern, Behavior & Intensity (NF1); Habitat Diversity (NF2); and TE&S Species and Fire Dependent Species (NF3).

Fire Pattern, Behavior And Intensity

Refer to Table 20 for **percent seral stage** (4-3).

A parameter of change is measurement of the **size and frequency of fires.** The MFWDT is <u>one of the highest fire areas</u> on the Willamette National Forest. Fire suppression since the turn of the century has resulted in a disruption of the natural fire cycle, causing a <u>decreasing frequency but increasing intensity</u> of fires (Agee, 1993). Change in fire frequency and management practices changed vegetation and fuel models. This has changed the fire intensity. Currently, the likelihood of stand replacement fire is not very high. Replacement fires in the modern era are significantly less frequent and smaller than they were between the years 1680 through 1918. Fire suppression activities have also repressed low and medium intensity fires. Natural underburns have been virtually eliminated.

Between 1949 to the present there have been 271 lightning, 112 human caused fire for a total of 383 fires in the MFWDT. Three-hundred and seventy-six of these were less than 15 acres. The largest was the Shady Beach Fire. This human caused fire burned approximately 3,300 acres in this Watershed. Table 28 lists fires at least 15 acres. Before 1949, records were poor and scattered so there may be more fires than indicated in the table.

Table 28: Fires 15 Acres or Larger in MFWDT since 1949

Fire Name	Year	Acres	Cause
Shady Beach Fire	1988	3,300	Human
Packard Fire	1987	255	Human
Salix Fire	1985	15	Human
Bohemia Fire	1980	518	Human
Deadwood Creek Fire	1966	50	Human
Buck Creek Fire	1952	40	Human
Johnson Meadows Fire	1919	420	Lightening

Ninety-five percent of the human caused fires are along Hills Creek Lake and Road 21. The lightning caused fires are evenly distributed throughout the Watershed. The MFWDT has averaged 8.5 fires per year since 1949. Figure 28 represents fires since 1949.

Past wildfire occurrence has been relatively frequent in the Watershed area and has played a large part in driving plant succession, creating stand structure and determining the amount of fuels. To get a picture of the MFWDT **fuel loadings** and site conditions, information was obtained from Ecosystem Plots. Table 29 and 30 represents the Fuel Models and Fuel Loading Class found in the Watershed. Figure 29 depicts the Ecoplot Areas used for the analysis.

Table 29: Fuel Models and Loading

Fuel Model	Size of Material	Tons per acre	Total tons per acre
FM8	0"-- 3"	< or = 5	
FM8	all		< 20
FM10	0"-- 3"	> 5	
FM10	all		> or = 20

Figure 28: Middlefork Willamette Downstream Tributaries

Fires Since 1949

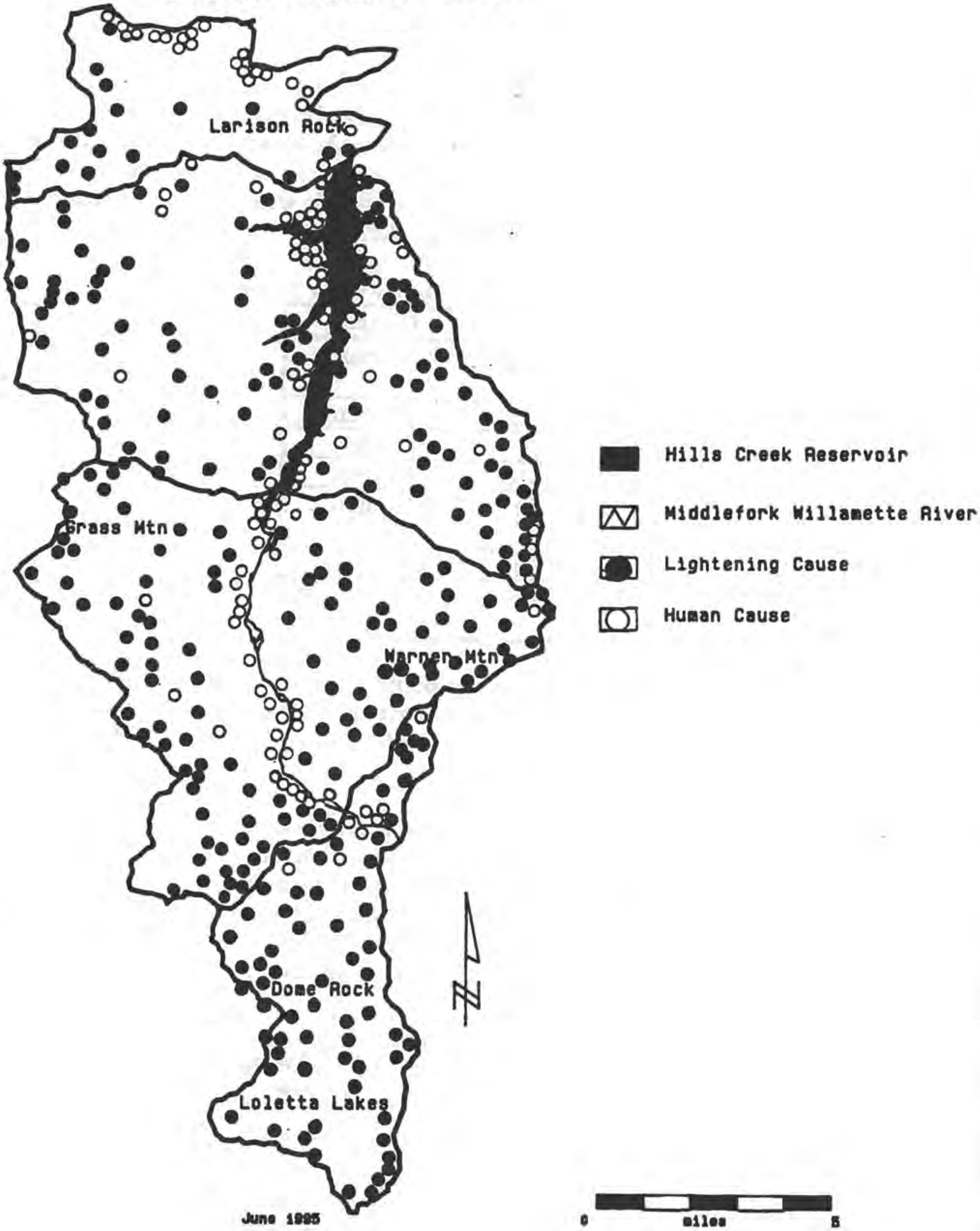


Figure 29: Middlefork Willamette Downstream Tributaries

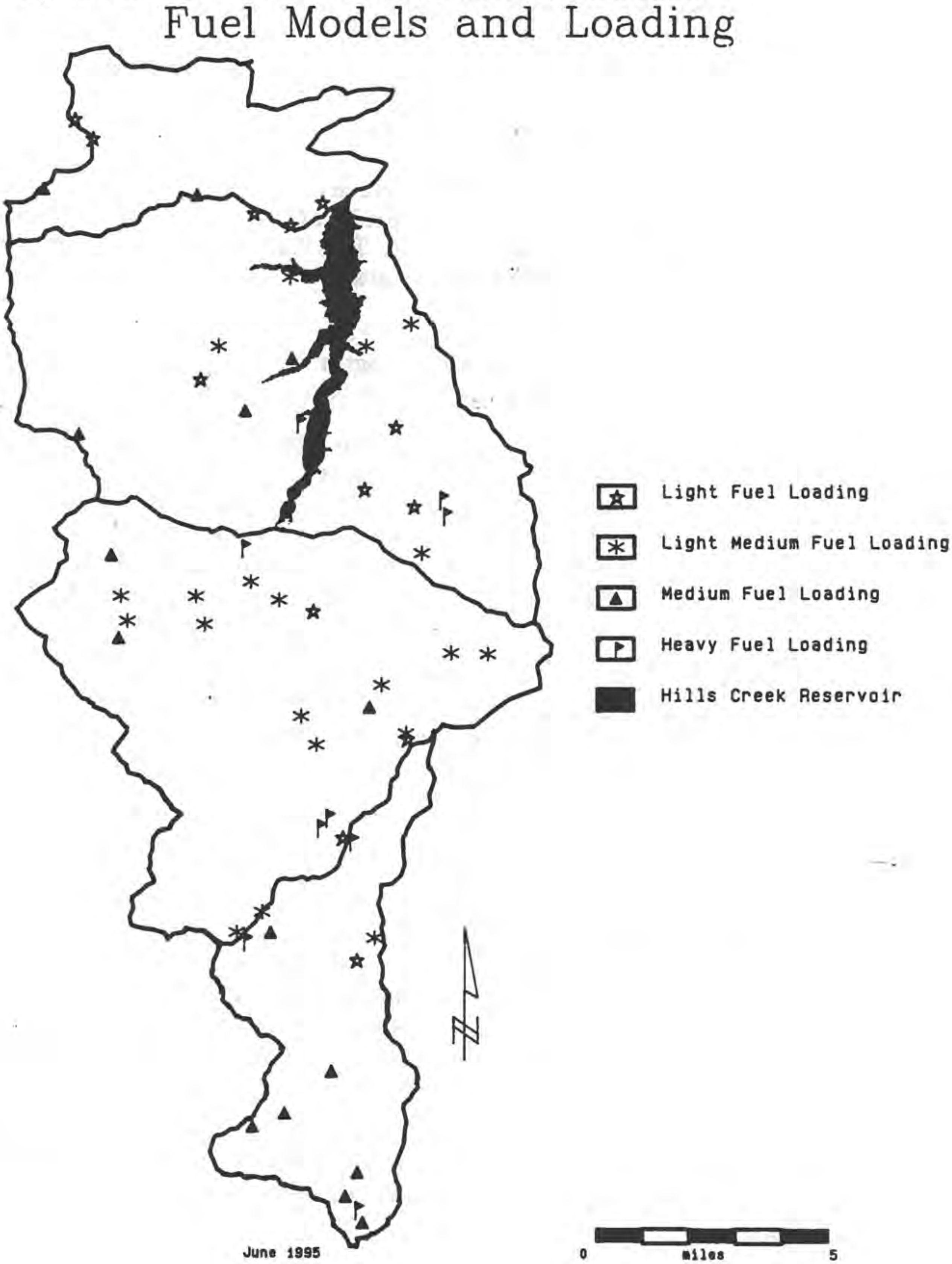


Table 30: Fuel Loading class

Fuel Model	Fuel Loading Class				Total Acres
	1	2	3	4	
FM8	23%	35%	0%	0%	62,403
FM10	0%	0%	26%	16%	42,384

Some characteristics of fire behavior for FM10 are: Heavy Fuel Loading, Crowning out, spotting, and torching of individual trees. These characteristics are more frequent and intense than in FM8. This leads to potential fire control difficulties. FM10 is found in 42% of the Watershed.

Some characteristics of fire behavior for FM8 are: Light Fuel Loading; Slow burning ground fires with low flame lengths; occasional flare ups of jackpot or heavy fuel concentrations. FM8 is found in 55% of the MFWDT.

Today's high hazard conditions are in those areas that have a lot of lateral fuels and brush components in the understory. Some type of harvest activity has occurred in 34,869 acres of the MFWDT. Nearly forty-five percent or 15,559 acres, have not had any prescribed fire treatment. These untreated stands add to the existing increase in fuel loadings. The increase depends upon whether the harvest treatment removed unmerchantable logs and whether the units were handpiled but not burned. See Figure 30 for a representation of stands.

Tree ring counts, fire scars, historical vegetation maps and aerial photos were used to construct a rough fire incidence for the Watershed. From these observations it was possible to determine that very high intensity stand replacement fires to low intensity underburns played a large role in shaping south and westerly aspects. All the fires listed in Table 32, except for Johnson Meadows and Salix, are examples of high intensity stand replacement fires burning on south and westerly slopes.

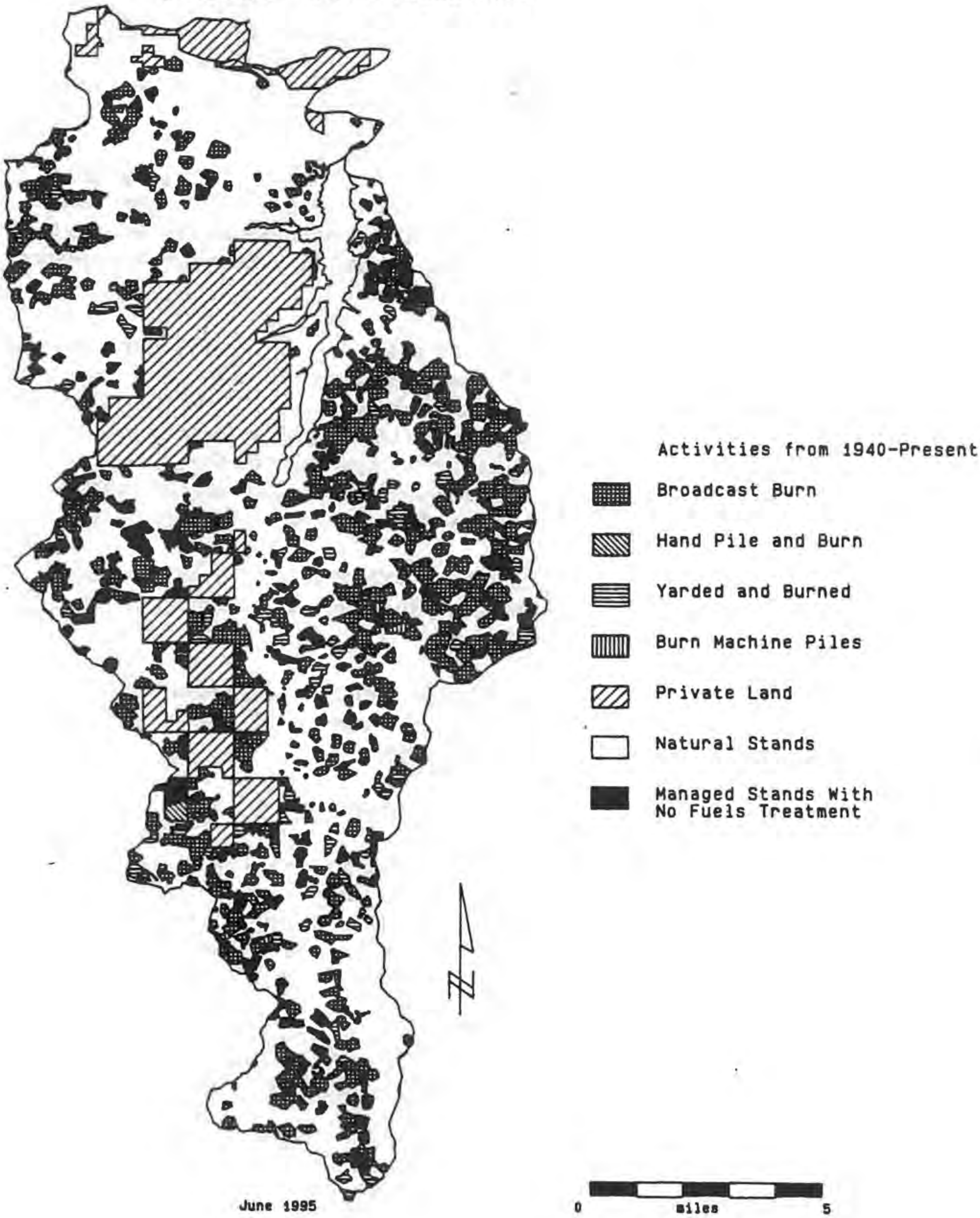
Brush fields and grasses often grow in the high intensity fire areas. This results in a slower regeneration of the forest.

On north slopes, flats and in the deeper canyons, fires have been less intense, and may have alternated between low intensity underburning and infrequent stand replacement fires. This is predominately evident in the Salix and Johnson Meadow fires.

On ridge tops and upper side slopes, fires played a role in the maintenance of meadows and restricted tree survival to rocky micro sites, where fuel to carry fire was lacking (Agee,1990). This relates to the Salix, Johnson Meadow, and Bohemia fires.

Figure 30: Middle Fork Willamette Downstream Tributaries

Fuels Treatment



Habitat Diversity

In the early 1900's, emphasis on fire suppression precluded large acreage of early seral forest habitats from occurring by stand replacement fires. Suppression reduced natural fires to small acreage and early seral forest habitats quickly grew into the next developmental stages. Refer to Table 20 for **percent seral stage**.

Species composition is a function of habitat diversity. Special habitats, especially non-forested habitats as meadows, have decreased in size. Some natural meadows have become fully forested by encroaching conifers, as the 9d Special Habitat designated in lower Coal Creek that was an oak and meadow complex (T.24 S.,R.3 E., Sec. 14, SE).

Forested **habitat types**, characterized by low levels of logs and snags and open understory began to change. Incremental increases in down logs, snags, and young understory trees filled in the open forest floor. These changes in habitat characteristics would positively influence the suitability for some wildlife species, as the spotted owl, the pileated woodpecker, and the pine marten. The loss of open forest habitats would decrease habitat suitability for other species, such as the northern goshawk and the flamuated owl in ponderosa pine areas.

In addition, the overstory mature-old-growth ponderosa and sugar pine show stress and increased insect infestation, due to moisture competition by the new understory.

Fire exclusion has permitted the gradual reduction in the abundance and structure of hardwood trees in the mixed hardwood and conifer forest habitats, due to continued suppression by succession.

TE&S Species and Fire Dependent Species

Measurements in plant and wildlife **species composition** assist in establishing the current condition. The Woodland milkvetch, a Region 6 Sensitive species, and the branching montia, a rare species, have certainly decreased in abundance due to fire suppression. Their seeds only germinate on contact with moderate intensity fires.

The reduction in early seral habitats by fire suppression, probably had the greatest effect on the peregrine falcon foraging habitats. With the fire suppression emphasis starting in the early 1900's, three habitat conditions began to disappear or shrink in size.

From the 1900's to the 1940's, early seral and pole-size forest habitats substantially reduced in size as they grew into small timber and mature forest habitats. The second habitat condition that changed for the falcon's foraging habitat was the slow ingrowth of understory trees in open forest habitats. Two prey species associated with open forest conditions, the American robin and the cedar wax wing, likely experienced a decline in population in foraging areas. The third change was a slow loss of meadow acres due to the encroachment of conifers.

Fire suppression was favorable to the northern spotted owl. As the areas of fire-created early seral habitats grew into small timber and mature forest habitats, these areas became suitable for foraging by the spotted owls and less favorable for the great horned owls. The ingrowth of understory trees and accumulation of logs in the open forest habitats were slow and probably only made a minor difference to the spotted owl's suitability of habitat by the 1940's

The period of fire suppression between 1900 and the 1940's only maintained the Red-legged frog's forest habitat.

Aquatic Domain

Riparian Structure

Fire suppression reduced the occurrence of all levels of **fire intensity** in the riparian zones. This change altered the vegetation pattern in many areas. Riparian zones have a naturally high site productivity and may have high stocking density. These characteristics combined with decades of fire suppression efforts have increased riparian fuel loads. The current structure of many riparian stands contain a high percentage of brush and limb fuel components.

Class IV streams would most likely have experienced occasional high intensity fires. **Water yield** may be somewhat reduced from riparian zones along these class IV streams as a result of fire suppression. **Water quality** in these streams may be somewhat better across the Watershed for the same reason. These speculations apply to portions of riparian zones not impacted by timber harvest.

Social Domain

Habitat Diversity

The Cascade Range Forest Reserve was established in 1893. By 1905, forest rangers were hired to patrol the area. One of their duties was fire fighting. It is assumed that by this time **intentional human caused** fires for manipulation of habitat was prevented.

Issue (TR) Transportation System

Transportation system development within the Watershed Analysis area began in the 1940's, with peak construction during the 1960's and 1970's. Approximately 85% of the current road system were complete by the early 1980's (Figure 31).

Many roads have exceeded their designed service life and are in varying stages of deterioration. Existing stream crossing structures, posing a substantial risk to riparian conditions, are to be improved to accommodate at least a 100-year flood event. Roads fragment habitat and affect connectivity of habitats for both plants and animals. Roads also provide a transport vector for non-native plants..

Table 31: Current Processes For Transportation System

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial	TR7	Wildlife & Plant Habitat Quality	Road Construction And Existence	Plant And Animal TE&S Habitat Special Habitat Distribution Road Density
	TR9,TR10	Forest Use	Transportation System	Open Miles Of Road Fire Ignition and Suppression Time
	TR7	Wildlife & Botanical Disturbance	Roads In Riparian Reserves	# Miles In Riparian Reserves
	TR6	Riparian Habitat Quality	Roads in Riparian Reserves	Acres Riparian Reserve Lost
Aquatic	TR1,TR2, TR5	Landslides	Road Construction And Design Insufficient Funding	Frequency Of Occurrence Unmaintained Roads
	TR3	Surface Runoff & Routing	Road Density	Drainage Network
	TR4	Culvert Carrying Capacity	Culvert Design	Undersized Culverts And Risk Potential
	TR6	Species Distribution Migration Corridor	Culvert Location And Size	Fish Passage Culvert Location and Size
Social	TR8	Sedimentation	Trails In Erosive Soils	# Miles Trails In Erosive SRI's

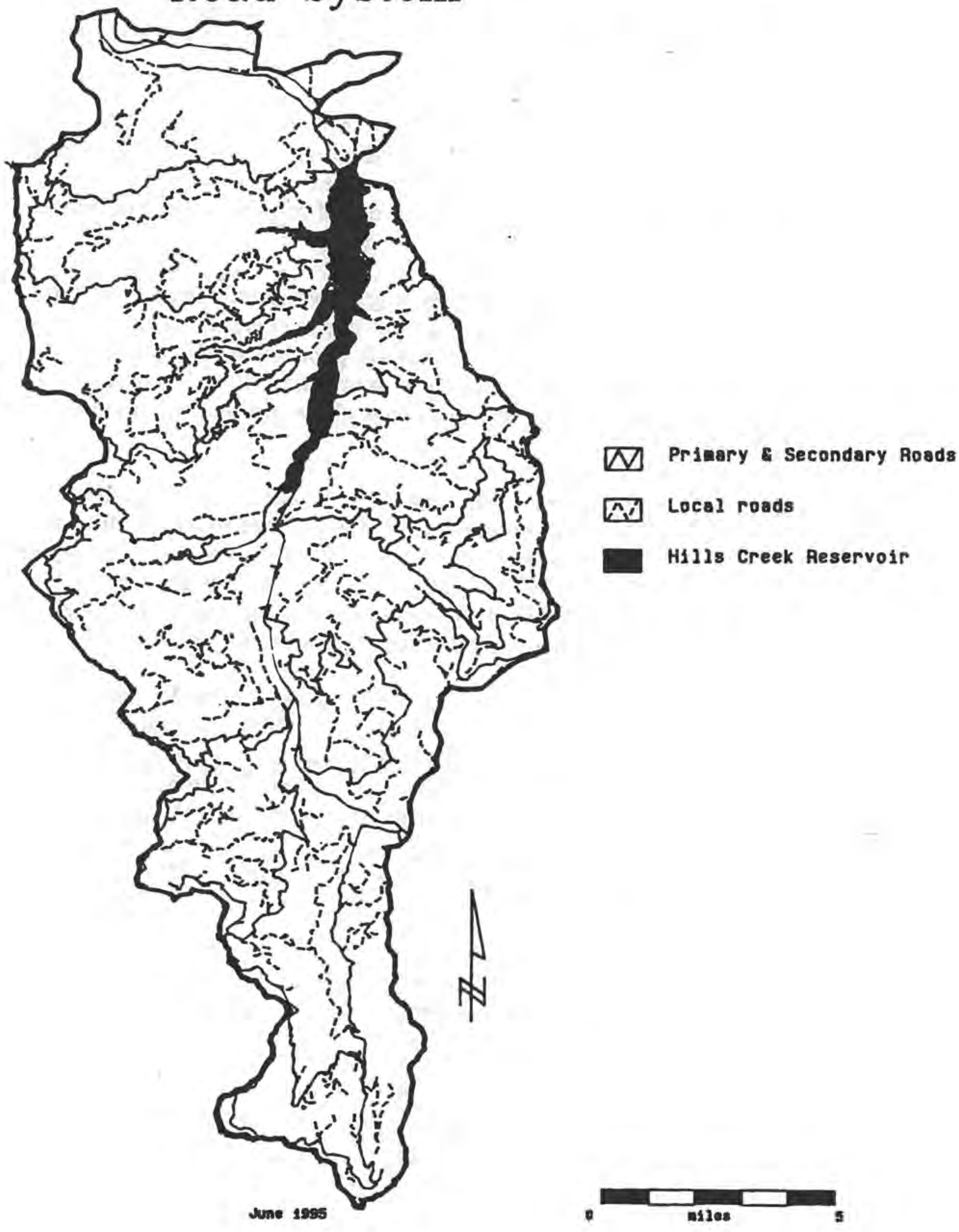
Terrestrial Domain

Wildlife and Plant Habitat Quality

One population of the Sensitive plant, Thompson's mistmaiden, is found above Road 2123 where the road was blasted into a rock outcrop. The area seems to have maintained its hydrological integrity because the plants were located after the road was built. A rare plant that has probably been affected by roads and the construction of quarries is spring phacelia. One known population occurs less than 1/4 miles from a quarry just east of Bearbones Mountain.

Figure 31: Middle Fork Willamette Downstream Tributaries

Road System



There is one open road within disturbance distance of a bald eagle nest site. There are several spotted owl nest areas close to open roads. Effects of road to Threatened and Endangered wildlife species are predominately access and disturbance by humans, which can affect reproductive success during the nesting seasons.

Two bald eagle nest sites and one peregrine falcon nest site exist within this Watershed. Roads exist within disturbance distances of each site. The roads of concern within vicinity of one eagle nest and of the peregrine falcon nest sites are closed during the nesting season. One road of concern of the second eagle nest is presently open.

In the 1950's Roosevelt elk, an emphasis species, were still considered scarce in the Watershed. With regulated hunting, low predator populations, and an increasing supply of sustaining forage, the elk populations rebounded from the lows at the turn of the century. Currently, more than three hundred head are in the MFWDT. The largest numbers exist east of the MFW River and in the Coal Creek drainage.

The Watershed has 13 elk emphasis areas (Figure 32). Four of them have more open miles of road than is recommended. Coffeepothead has 3.39 miles per square mile (mi./sq.mi.) open road; Dry Pine has 3.80 mi./sq.mi.; Larison has 3.17 mi./sq.mi.; and Snake Fir has 3.94 mi./sq.mi.. There is a total of 71 miles of open roads needing closed to meet the recommended maximum densities. See Appendix J, Wildlife Documents for the location of the different areas.

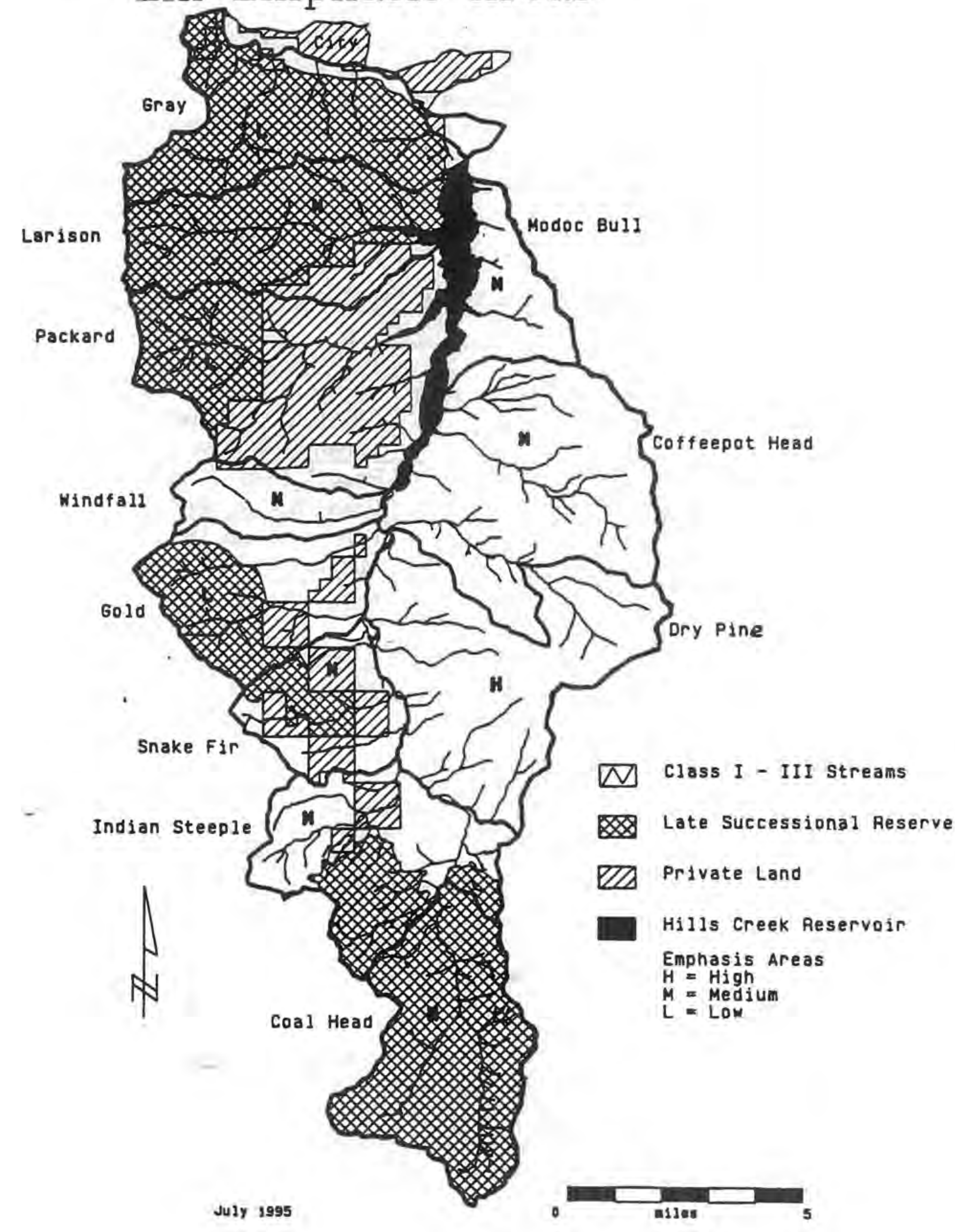
There is a verbal agreement between ODFW and the Rigdon Ranger District to manage designated 'high elk use areas' within the Moderate and the Low emphasis areas. Management of these high use areas use the same elk habitat principles that apply to the High Elk Emphasis Area. Table 32 shows the percentage of the Moderate emphasis areas that have 'high elk use area'.

Table 32: Percent of High Use in Moderate Emphasis Areas

Moderate Elk Use Area Name	Percent of Area in High Use
Modoc Bull	40
Larison	40
Windfall	30
Coffeepot Head	70
Snake Fir	30
Indian Steeple	80
Coal Head	40

Figure 32: Middle Fork Willamette Downstream Tributaries

Elk Emphasis Areas



The percentages of 'high elk use areas' within the Low emphasis areas have not been calculated.

Changes in **special habitat distribution** is a factor in habitat quality. Since the increased harvest of timber in the 1940's, roads have been constructed throughout the MFWDT. Ridgelines are often logical locations for current logging systems. Roads have had a great effect on plant populations in the Calapooya Mountains where Road 5850 runs through a series of meadows as well as rocky ridgetops. Table 33 lists some of the major special habitats affected by roads. More information is under the Vegetation Manipulation Issue.

Table 33: Special Habitats Affected By Road Location

Special Habitat	Impact
Holland Meadows	Road Through Meadow
Unnamed rock outcrop, Packard Creek T.22S.,R.2E.,Sec.13	Road 2106445 And Landing Affecting A Sensitive Plant, Thompson's Mistmaiden
Johnson Meadow	Road Through Meadow
Bristow Meadow	Road Through Meadow
Joe's Prairie Meadow	Road Through And Along Meadow
Groundhog Meadow	Road Through Forested Edge
Little Groundhog Meadow	
Unnamed meadow in Deadwood Creek	Road 5851 Across Top Slope
Stone Mountain	Road And Rock Quarry

Forest Use

The existing transportation system provides access for a variety of commercial, administrative and recreation uses in the MFWDT.

There are about 540 **miles of system road** in the Watershed. Only minor amounts of new construction occur yearly. Of the total roads, 43 miles (8%) are paved and 465 miles (92%) are aggregate surfaced roads. Seventy-five percent of the roads were constructed prior to 1980 when sidecast construction methods were used.

The road system was constructed and has been maintained primarily with timber sale revenues. Reduced timber sale activity in recent years has lead to an accompanying reduction in road maintenance deposits. Appropriated funding for road maintenance is also declining. There is not enough funding to maintain the entire road system to currently prescribed road maintenance standards.

Fire ignition and suppression response time may be impacted with the recommendations from the ATM plan.

Riparian Habitat

About 806 acres of **riparian reserves have been lost** in the MFWDT due to road construction intersecting Class I, II, and III streams. The loss of 806 acres represents about 4% of the riparian reserves associated with Class I,II,III streams.

Aquatic Domain

The processes affecting the aquatic domain from road conditions and density are: Increase in the number and location of landslides through mass failure of the existing road system (TR1,TR2,TR5); Increase in the drainage network through increased surface runoff and routing as a result of increased roads (TR3); and A decrease in fish passage and possible distribution as a result of a block in migration at impassable culverts (TR6).

Landslides

Road construction in conjunction with timber harvest has affected the spatial and temporal distribution of **landslide occurrences** within the MFWDT. Road related debris slides, localized cut and fill failures, and road locations through soils that generates persistent suspended sediment have affected the distribution of large woody material and the quality of aquatic habitat.

Road construction practices prior to 1980 included sidecast fills and less stringent aggregate surfacing quality standards. It was during this era when most of the road system was constructed on steep ground. The result of this was an increase in the number of debris slides soon after construction, particularly in draws. There is also a delayed reaction of approximately 20 years after construction when the wood buried in the sidecast fills decays. Much of the road system within the Watershed is currently undergoing this delayed failure reaction.

Approximately 66% of the Watershed Analysis area is steep ground with shallow, erosive soil. Between 1940 and 1995, roughly 285 miles of road were constructed through this terrain with the vast majority being built prior to 1980.

Figure 33: Road Related And Natural Debris Slides

Air photo reconnaissance spanning 1955 to 1991 indicates that 93% (28 out of 30) of road related debris slides occur in the geomorphic category described above. Windfall, Bohemia and Snake Creeks each had 5 or more varying size occurrences. Bohemia Creek appeared the most impacted. Several large debris slides initiated at the top of the drainage soon after the construction of Rd. 5850. Other creeks directly affected are Larison, Packard, Zup, Coffeepot, Gold, Spring Butte, Buck, Coal and Deadwood.

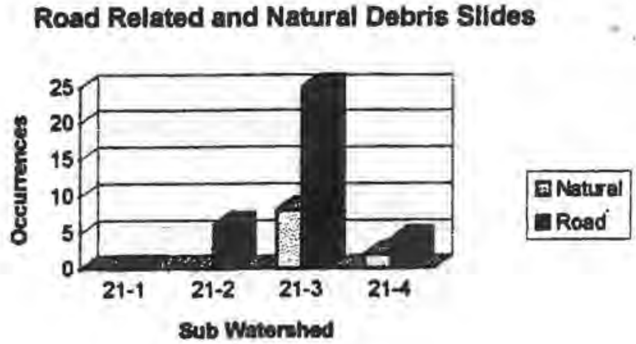
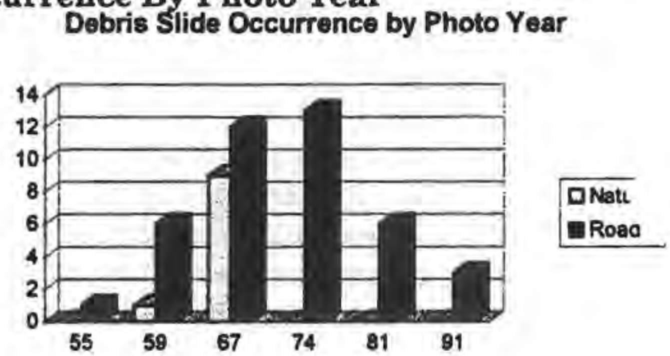


Figure 34: Debris Slide Occurrence By Photo Year



Of the 35 road related debris slides, 12 appear in the 1967 photos. Presumably, these slides are from the combined effect of recent construction and the 1964 flood. The fact that 13 new initiations appear in the 1974 photos and 6 in the 1981 photos is interpreted to imply that debris slide occurrence may be as much a product of the construction techniques as it is of large storm events. The trend indicates the number of occurrences is declining.

Outside edge cracking and displacement of sidecast fills are common occurrences on the road system located on steep ground. Road maintenance activities in these areas have focused on controlling road surface runoff and cleaning ditches. Removing the potential for surface runoff to saturate the outside edge of sidecast fills has been effective in reducing the potential for debris slide initiation. The problems still exist and, with time, the fills are likely to fail. Expectation is the frequency of occurrence of road related debris slides will decline to some level below that which was exhibited in the 1960's and 1970's. Expectation is that these slope failures will continue to occur unless there is some assurance of continuing maintenance of the drainage system or the problem areas are stabilized.

Road construction through soils with high clay content has altered the spatial and temporal distribution of chronic sediment sources by providing point sources (cut and fill failures) and by expansion of the drainage network (ditches).

Approximately 11% of the analysis area are clayey soils, usually on gentle slopes. The vast majority of these soils are in Subwatersheds 21-2 and 21-3. About 65 miles of road, not including spur roads, have been constructed in these soils. Slope failure mechanisms inherent to this setting are usually localized cut and fill rotational landslides. These slope failures tend to be persistent sediment sources.

An accurate count of the total number of occurrences of these types of slope failures is not possible due to dispersed and lost records of treatments. One can assume that the distribution pattern through historical times has mimicked the road construction history, since slope failures in this setting tend to occur soon after construction. The most recently constructed roads in clayey soils occurred with the harvest of Shady Beach Fire and spurs associated with the harvest of the private land in Packard Creek drainage.

Current **road maintenance activities** focus on ditch and culvert inlet cleaning and grading road surfaces. At current funding levels, approximately 25% of the road system can be effectively kept at its current Maintenance Level. This funding level is expected to decline.

In the absence of definitive treatment of existing road related slope movements by stabilization or removal, continued maintenance of the road drainage system is essential to minimizing the chances of slope failure.

Surface Runoff & Routing

Construction of roads has increased the **drainage network**. The predominant soils in the MFWDT transport water rapidly to the stream channel producing flashy flow responses to storm events and snow melt. Roading interrupts the subsurface and surface flow of water to the stream system, and channelizes the water in the ditches. These "pseudo" class IV streams effectively shorten the time it takes for water to reach the stream channel, accentuating the flashy streamflow tendency. The road network effectively doubles the drainage density, thus decreasing the time it takes for the stream to respond to a storm event (Table 34). This causes greater peaks in flood flow, increased duration of peak flow, and consequently a greater potential for floodplain and channel alteration.

Table 34: Road and stream density.

Subwatershed	Square Miles	Road Density	Stream Density	Road & Stream Density
21-1	16.7	3.3	3.4	6.7
21-2	62.3	3.6	3.2	6.8
21-3	60.2	3.5	3.2	6.7
21-4	25.8	3.0	2.7	5.7
Watershed Total	165	3.4	3.1	6.5

Culvert Carrying Capacity

Approximately 560 culverts are located where roads intersect Class I through IV streams. Three to four times that amount exists when ditch relief culverts are considered. Many of the culverts, originally designed to allow fish passage, have lost that ability. This loss is due to outlet scour or different velocity and distance design requirements than currently used. Most pipes were designed to carry a 50-year storm event, if designed at all.

Inventory and analysis of 44 culverts within the MFWDT indicate 43% will overtop the fill during a 100-year flood event. A summary chart of culvert condition surveys is in Appendix F. It is unknown which **undersized culverts** pose a **substantial risk** for fill breach or significant diversion of water to adjacent relief culverts.

Species Distribution & Migration Corridor

The **present distributions** of cutthroat trout, Spring chinook and bull trout and other fish species is in Table 35. Cutthroat trout are present in all Class II streams and may be present in some Class III. Historical Spring chinook spawning and migration occurred throughout the MFW River up to Tumblebug Creek (upstream of this Watershed). Concentrated spawning occurred between Little Pine Creek and Deadhorse Creek. Bull trout use the MFW River to migrate to spawning grounds higher in the Watershed.

In 1966, wild cutthroat and rainbow trout occurred throughout the drainage. Cutthroat trout numbers were moderate to high in most streams. Rainbow populations were low to moderate and confined to low-elevation areas. Hatchery rainbows were stocked in all larger streams and in Hills Creek Lake. White fish were common and a few Dolly Varden (bull trout) occurred in larger streams (Hutchison,1966).

Nongame fish common in the Middle Fork drainage in 1966 were large-scale suckers, squawfish, redside shiners, and chiselmouth. The distribution of the warm water fish extended upstream a short distance into the Middle Fork Willamette River.

Table 35: Present Distribution Of Fish Species In The MFW River.

Species	General Distribution
Lamprey, *Entosphenus tridentatuss*	Hills Creek Lake; Middle Fork Of The Willamette; Spawn In Upstream Tributaries
Mountain Whitefish, *Prosopium williamsoni*	Many Cooler Streams; A Few In Hills Creek Lake
Brook trout, *Salvelinus fontinalis*	Common In High Lakes And Extending Into Outlet Streams
Bull charr, *Salvelinus confluentus*	Rare In Middle And North Forks Of Willamette; Fair Number In 1966
Rainbow trout, *Oncorhynchus mykiss*	Native In Several Areas And Planted In Many Others.
Cutthroat trout, coastal, *Onchorrhynchus clarkii*	Common In High Elevation Streams And Lower Portions Of The Drainage; Few Lakes (15 cm (6 In.) In 1966)
Chinook salmon	Planted Above Hills Creek Lake In 1993; Fair Number In MFW To Tumblebug Creek In 1966
Largescale suckers, *Catostomus macrocheilus*	Common In Streams And Reservoirs Of Low To Moderate Elevation; Documented As High As Staley Creek Bridge
Mountain sucker, *Catostomus platyrhynchus*	Abundant In Middle Fork Willamette River
Chiselmouth	In Dexter and Lookout Point Reservoirs
Dace, *Rhinichthys* spp.	Common in most lakes; streams and reservoirs
Redside shiner, *Richardsonius balteatus*	Extending above Hills Creek Lake
Northern Squawfish	Abundant in Middle Fork Willamette River
Black bullhead	Fern ridge reservoir and Long Tom River
Brown bullhead	Cottage Grove & Dorena Reservoir; lowland lakes and streams
Yellow bullhead	Planted in private lakes and ponds; Hills Creek Lake
Sculpins, *Cottus* spp.	Abundant in Middle Fork Willamette River

Road drainage structures represent a variety of potential obstacles to fish **passage and migration**. The most common problems are excessive water velocities or vertical barriers to fish passage. Other problems can include:

- The velocity of water over a given length of structure in relation to fish capabilities.
- Depth of water in the structure at high, moderate, or low flows.
- Icing or debris problems
- Design flows in relation to annual hydrographic and seasonal time of fish passage
- Size and species of fish passing through the structure.

The majority of past research and reports regarding fish passage at road drainage structures has been oriented to adult anadromous fish. However, juvenile anadromous fish species also exhibit a variety of upstream migrations. Particularly susceptible to blockages are juvenile anadromous fish that remain in fresh water for substantial periods of time before migrating downstream. Some of these species are steelhead trout, sockeye, chinook and coho salmon, Upstream migrations of juvenile resident fish have also been documented (Bernard and Israelsen, 1982). Typically these have been fall migrations of juveniles from mainstem streams into tributaries.

Adult resident fish, such as cutthroat trout, also exhibit a variety of instream movements. These include adfluvial spawning migrations, as well as movements for unknown reasons. Figure 35 displays the approximate spawning migrations of some of the fish species in the Middle Fork of the Willamette based on Baker and Votapka (1990).

Figure 35: Migration Periods For Some Fish Species In The MFW

```
                     MIGRATION (-----)  SPAWNING PERIOD (***)  JUV OUTMIG (xxx)
Northern squawfish                         ********
Mountain sucker                          ************
Chinook salmon                           xxxxxxxxx        ____________________**********
Mottled sculpin           *********************
Longnose sucker                          ***************
Rainbow trout                xxxxx***********
Cutthroat trout         xxxxx***********
Mountain Whitefish                                       ***************
Bull trout                                                   ________**********___
                        Feb  Mar  Apr  May  Jun  Jul  Aug  Sep   Oct  Nov  Dec  Jan
```

Limiting passage criteria to just Spring chinook and bull trout, passage is still needed throughout the entire year for some life stage. The most critical time and life stage that is limiting for the species of concern needs to be determined.

Assessment of the Middle Fork Sales culvert information, suggest that all the culverts exceed velocities for salmon and resident fish (Appendix F). Six exceed the depth criteria for salmon and only six not exceeding the standard for resident fish. Similar exceedance is in the Boulderdash Sale (Appendix F).

Social Domain

Sedimentation

There are 16.6 miles of trail located within riparian reserves and 14.9 miles of trail located outside the riparian buffers in this Watershed. The **trail system** traverses ten landtypes considered to be **highly erosive surface soils** and subsoils. Eighteen miles of the trail system are in these landtypes. Trail condition surveys do not indicate significant erosion problems associated with trail tread. Localized muddiness in wet areas limits trail use. Condition surveys indicate that waterbars or puncheons are satisfactory for prevention of trail tread degradation. The major portion of the trail system is quite stable as noted from past years of maintenance.

There are another five trails totaling 15.5 miles proposed for construction. A portion of the mileage will be in riparian reserves as well as hill slopes and ridge tops. These proposed trails are listed in Appendix D of the Willamette National Forest Land and Resource Management Plan and in Appendix E of this document.

ISSUE (NS) Introduction and Spread of Non-native Species

Introduction and spread of non-native species may effect the viability of Threatened, Endangered or Sensitive species.

Table 36: Current Processes For Non-Native Species

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial	NS1	Non-Native Species Composition	Roads Harvested Stands Predation & Competition	Abundance And Occurrence Of Non-Native Species Bullfrog And Barred Owl Distribution
Aquatic			See Hills Creek Dam and Lake Issue	
Social			Not Applicable	

Terrestrial Domain

Non-Native Species Composition

To determine plant and wildlife non-native species composition, the **abundance and occurrence of non-native species** was measured.

The highest priority species for treatment are new invaders, those **noxious weeds** that are in early stages of invasion and have not naturalized to the point that resource damage is occurring. A number of new invaders are found in the MFWDT, including spotted knapweed, diffuse knapweed, meadow knapweed and giant knotweed. Most populations of new invaders are restricted to roadsides (Table 40), although one population of spotted knapweed is found in Packard Creek Campground. New invaders are of biological concern in this Watershed because of their potential to move from the road system into special habitats like meadows. Their ability to out compete natives has been widely documented. Giant knotweed could move up the Middle Fork into tributaries as it has in the Coast Range (Grenier,1994).

Spotted and diffuse knapweed are moving from the east side of the Cascades to the western part of the state; it is speculated that the method of movement is seeds caught in mud and transported on vehicle tires and undercarriages. The knotweed is a garden weed; populations near the Hills Creek Lake are from yard debris dumped adjacent to the water's edge.

Table 37: New Invader Noxious Weeds in the MFWDT

Common Name	Location
Spotted knapweed	Packard CG, Road 21/2135 Road 2102, Road 2120 Road 21
Diffuse knapweed	Road 21/2135
Meadow knapweed	Road 21/2127
Giant knotweed	Road 2106/105, 107 Road 2127/180, 188

Other weeds found on the Forest are termed established infestations. These weeds have spread to the point that eradication is impossible and resource damage is unacceptable. Established weeds in this watershed include Canada thistle, bull thistle, tansy ragwort, Scotch broom and common St. John's-wort.

The thistle species, tansy and Scotch broom may be found in any disturbed site, but are most commonly associated with clear-cut logging units, landings, and logging roads. These species are generally outcompeted, due to lack of sunlight, in moderately young (20 year) forest plantations. St. John's-wort can be found in these sites, but is also common in meadow habitats which often harbor natural soil disturbers such as groundhogs and mountain beavers. One extreme example in the MFWDT is Little Groundhog Meadow. The site was severely grazed by sheep prior to 1951, resulting in soil erosion and severe gullying. True to its name, the area harbors a plentiful population of groundhogs that are a natural mechanism of disturbance. St. John's-wort, once established, has outcompeted the native species, causing a severe reduction in the biological diversity of the site.

Because of the sheer acreage of these infestations, control methods are limited to mainly biological control. This type of control involves the use of insects which naturally feed on the plant or its seeds, eventually causing an equilibrium in population numbers (Appendix K, Botanical Document).

Records of biological control releases indicate that insects have been active in the MFWDT Watershed since 1981. The species targeted are tansy, St. Johns-wort and Scotch broom.

Bullfrogs and barred owls are the main non-native wildlife species of concern. The expansion in range of both has negative effects to native species, as predation on native turtles and amphibians populations by the bullfrog and displacement and genetic dilution of the spotted owls by the barred owls. Bullfrogs are found in ponds below Hills Creek Dam. There has been recent reports of bullfrogs in the Lake. There are 8 known locations of barred owls within the MFWDT. Four are in Subwatershed 211; one in Subwatershed 21 2 ; three in Subwatershed 21 4.

Issue (EI) Infrastructure

A number of administrative, community oriented, and industrial infrastructure facilities occur within the Watershed. These facilities may or may not affect resource values and processes. The Social Domain is the area of discussion because most of the facilities in the MFWDT are recreational.

Table 38: Current Processes for Infrastructure

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial		Not Applicable		
Aquatic		Not Applicable		
Social	EI1	Resource Integrity And Function	Lands Committed To Facilities	Inventory Of Facilities Mining Activities

Social Domain

Resource Integrity And Function

A major **commitment of lands** for the City of Oakridge Liquid Waste Disposal Area (sewage treatment plant and irrigation area) involves 16 acres southwest of the city. This area contains the sewage treatment plant for the City of Oakridge and an irrigation area where the treated liquid waste (sludge) is spread by irrigation sprinklers. The sludge does not contain significant amounts of heavy metals and is not hazardous. Calculations indicate a site life of 40 - 50 years.

The city of Oakridge reconstructed the sewage treatment plant in 1991 to comply with State of Oregon DEQ regulations. The new configuration is designed to accommodate peak wastewater flows of 5.01 cubic feet per second(cfs). The design flow is approximately twice the most recent value of 2.26 cfs calculated from the 1987--1989 data. The effluent which is discharged into the Middle Fork Willamette River is monitored year-round on a weekly basis. Due both to the high quality and assimilative capacity of the river and to the improvements of the treatment plant, the discharge of effluent does not significantly reduce water quality in the Middle Fork Willamette River. The treatment plant and irrigation area are planned to be exchanged by the Forest Service to the city.

Other land uses that date back at least thirty years include memorandums of understanding and special use authorizations for Bonneville Power Administration powerlines, Lane Electric Cooperative powerlines, U.S. West Communications telephone lines, and 2 Corps of Engineers Hydromet Stations. The Hydromet, gauging stations are below Hills Creek Dam next to Forest Road 21 and above Sand Prairie Campground on the Middle Fork Willamette River.

Clearing of timber for Hills Creek Dam began in May, 1959. The dam was placed in service for flood control in November, 1961. The project was completed in June, 1963. This project displaced structures located in the valley floor upstream from the dam site. There are several water rights involved with the MFW River downstream from the dam. There are domestic uses involving the City of Oakridge for irrigation to Greenwaters Park; a well on Pope & Talbot, Inc. lands adjacent to the river for the Summit View Water District which includes the Dink's Market area; and the Hemlock Water District near the Oakridge Middle School; and the City of Lowell.

There are two short term recreation special uses, a black powder 1840's rendezvous that has used the Hills Creek Lake lower pool area in upper Larison Cove for the past 13 years, and a sports car hill climb competition on Forest Road 2102.

Warner Mountain Lookout has been operating as a recreation rental cabin from November 1 through May 10 since 1991. The 1994 - 1995 season has been the most busy to date. The lookout was rented out 35 percent of the available time. Almost every weekend was reserved.

The currently maintained trail system includes: Larison Rock, Larison Creek Middle Fork, Staley Ridge/Dome Rock, Moon Point and Youngs Rock trails. See Figure 36 for locations. The Greenwaters Foot Bridge, to be constructed over the MFW River in August, 1995, will provide shorter and more immediate access the area south of the river than the current road system. This bridge has the potential to become a segment of the Eugene to Crest Trail System.

Although Dispersed camping took place at an early date, the developed campgrounds in this Watershed were mostly constructed in the mid to late 1960's.

There are four campgrounds and two day use areas, of which two include boat ramps to access Hills Creek Lake (Table 39 and Figure 37).

These sites are generally open year-round except Sand Prairie and portions of Packard Creek Campgrounds. All have reduced services during the winter months. From mid-April through September, the campgrounds are operated with full services.

These services include water testing on a monthly basis for those sites that supply potable water. In addition, the lake water at the swimming area is tested during the summer for ensure a safe swimming area. Normally the swimming area test results are 500 - 750 coliform counts per 100 ml of water. State Health Division limits are a maximum of 1000 coliform counts per 100 ml of water. The

Figure 36: Middlefork Willamette Downstream Tributaries

Recreation Trails

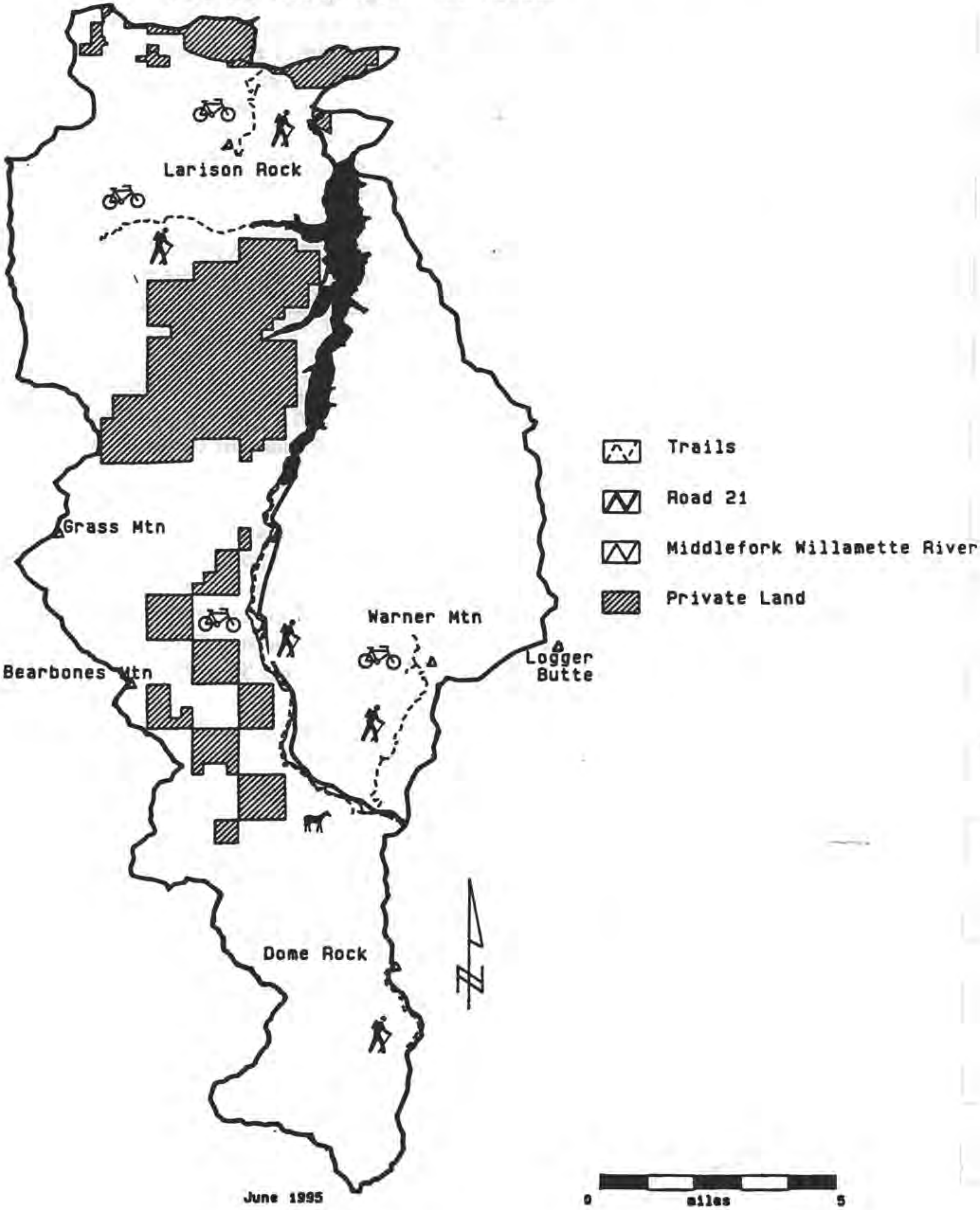
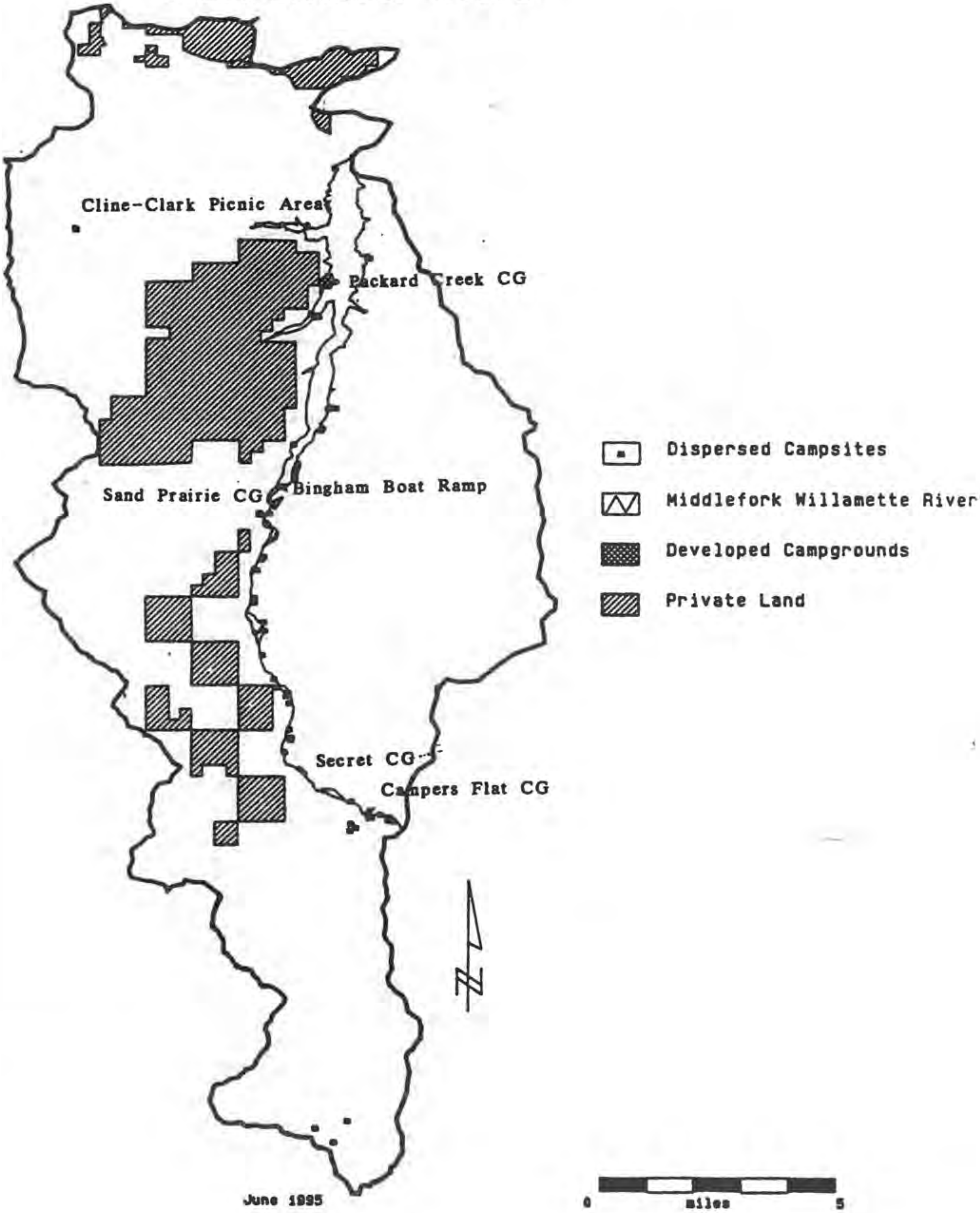


Figure 37: Middle Fork Willamette Downstream Tributaries

Recreation Sites



testing has helped stopped rumors concerning contaminated waters in the swimming area.

Table 39: Developed Sites in MFWDT

Developed Sites	Number of Sites	PAOT's*
Cline-Clark Picnic Area	3	15
Packard Creek Campground, Boat Ramp and Swimming Area	33	697
Bingham Boat Ramp		60
Sand Prairie Campground	21	250
Secret Campground	6	30
Campers Flat Campground	5	25

* Persons At One Time

Packard Creek, Sand Prairie, and Campers Flat Campgrounds have or have had potable water systems. Packard Creek has a deep well that provides chlorinated potable water. Campers Flat has a well with a hand pump. Sand Prairie had a water system that was a surface source, the Middle Fork Willamette River, but the system deteriorated and could no longer meet the new potable water requirements of the Oregon Department of Health. Potable water has not been provided for three years. The water system will be reconstructed during 1996 using the river as the water source. Several wells have been drilled, including a test well in 1994. Tests have shown that ground water in the Sand Prairie area is not useable because of excess chlorides levels.

Another form of recreational camping is the use of dispersed campsites which are located throughout the Watershed, but are largely concentrated along the perimeter of Hills Creek Lake and Middle Fork Willamette River. Other dispersed campsites are generally hunter camps used in the fall hunting seasons. There are approximately 55 maintained dispersed campsites in the MFWDT. 51 of them are located on Hills Creek Lake and the Middle Fork Willamette River and require regular visits and debris removal.

All of the recreational developed sites and most of the dispersed campsites are located in riparian reserve areas along Hills Creek Lake and Middle Fork Willamette River. Some of the negative affects are bank erosion and loss of vegetation by recreational uses. Most dispersed campsites are the result of past timber harvest activities that access river and stream bottoms with spur roads and landings. This random placement of sites has caused dispersed sites to be located within the riparian areas on river banks, thus causing conflicts with other recreation uses such as hikers.

Improvement of the fisheries and waterfowl habitat in the upper pool (above the Upper Crossing bridge) has apparently been successful by the increase in the number of fishing boats now using this area. The bridge is a popular fishing spot.

A survey of the August, 1994 Bureau of Land Management **mining claim** records show there are only three active claims in this watershed. These are located near Rocky Point, the south slope of Grass Mountain, and one about one-half mile northeast of Bristow Prairie. A Plan of Operations and Decision Memo has been approved for exploratory work on the Grass Mountain and Bristow Prairie claims. Core drilling and hand trenching is scheduled for the claim on Grass Mountain during the 1995 season.

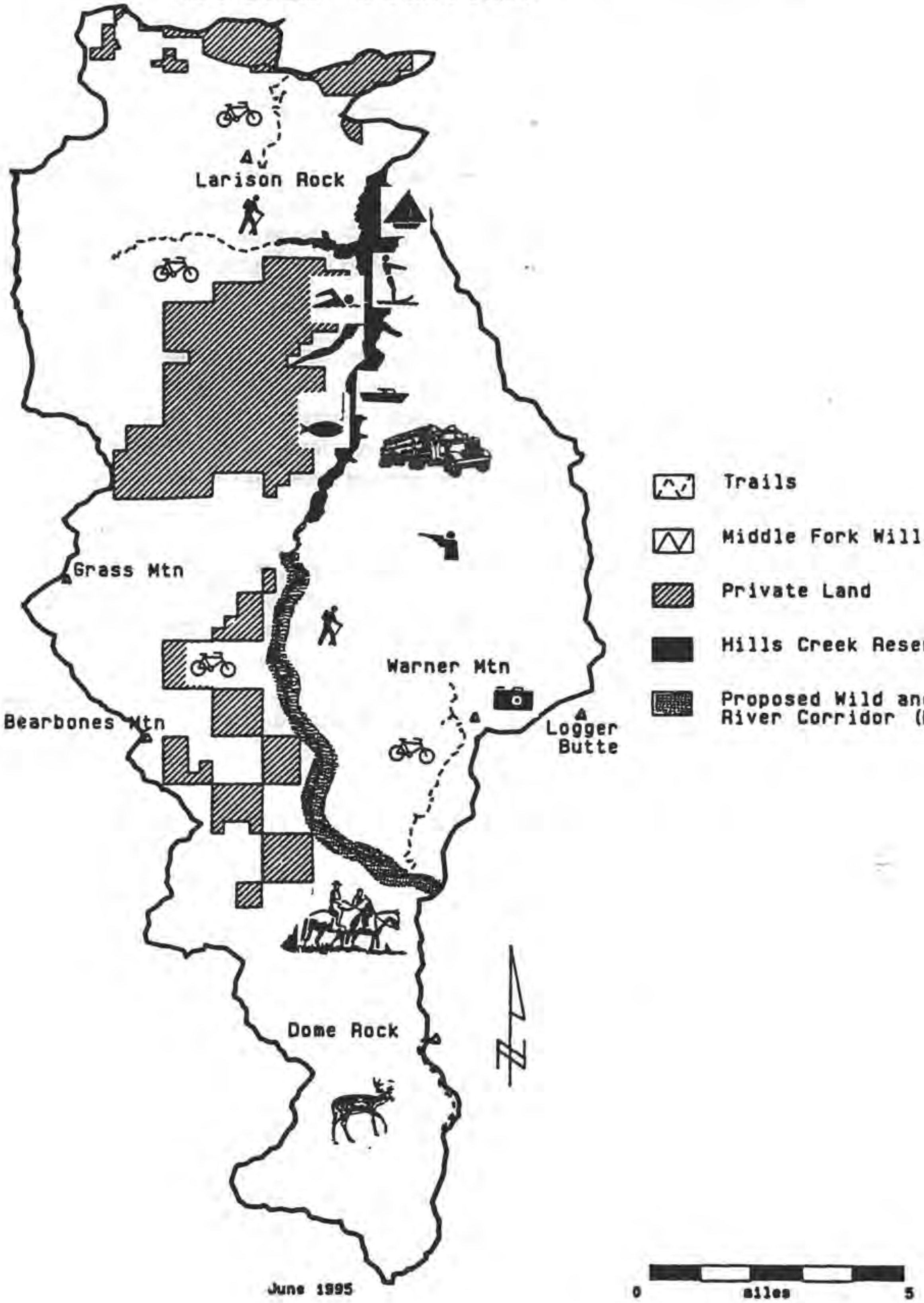
Mining has not been a significant activity within this Watershed or even on the district. Prospecting and staking claims is common and ongoing, but little development takes place. Occasionally there is some interest in the use of small suction dredging on the Middle Fork and tributaries such as Coal Creek. This activity is more recreational rather than mining interest due to the lack of gold deposits.

Collection of common variety minerals such as flagstone amounts to approximately one-half dozen minerals permits per year. Each permit averages one cubic yard of material. There is an occasional request for minor amounts (five gallon buckets) of pumice to mix with garden soils.

See Figure 38 for a representation of various visitor uses.

Figure 38: Middle Fork Willamette Downstream Tributaries

Social Context



ISSUE (HL) Hills Creek Dam and Lake

Several processes associated with filling Hills Creek Lake have changed in the Watershed. They are: changing the riparian habitat quality from a floodplain riparian complex to an upland riparian complex disconnecting elk migration and feeding areas (HL1); and changing aquatic species composition with the introduction of exotic fish and blocked migration passage for Spring chinook and bull trout (HL2).

In addition, several new processes have been established with a new lake system. These include: A fluctuating drawdown zone increasing soil exposure and lake turbidity (HL3); a change in the downstream stream habitat as a result of wood and sediment storage in the lake and a possible change in downstream temperatures as a result of water releases from the dam (HL4,HL6); and increased use and facilities (HL8).

These processes and changes are summarized in Table 40. Figure 39 represents the current Hills Creek Lake system.

Table 40: Current Processes for Hills Creek Dam and Lake

Domain	Question	Function Process	Mechanism Cause	Parameter Measured
Terrestrial and Aquatic	HL1	Riparian Habitat Quality Migration	Inundated Stream System Road Waste and Disposal	Elk, Spring Chinook, Bull Trout Riparian Species
Aquatic	HL2	Species Composition	Eradication W/Rotenone Filling Of Lake	Reduction In Bull Trout Numbers Introduction Of Exotic Fish
	HL3	Lake Turbidity	Lake Drawdown Zone	Shoreline Exposure And Erosion
	HL4, HL6	Downstream Habitat Complexity	Bedload, LWM Transport Blocked In Lake	LWM And Spawning Gravel
Social	HL8	Existing Facilities	Recreation Use	# Sites, Condition # Type Facilities
	HL8	Recreation Use	Use Numbers	Dollars Collected At Various Lake Levels Affects Of Corps Of Engineers Operations On Other Reservoirs

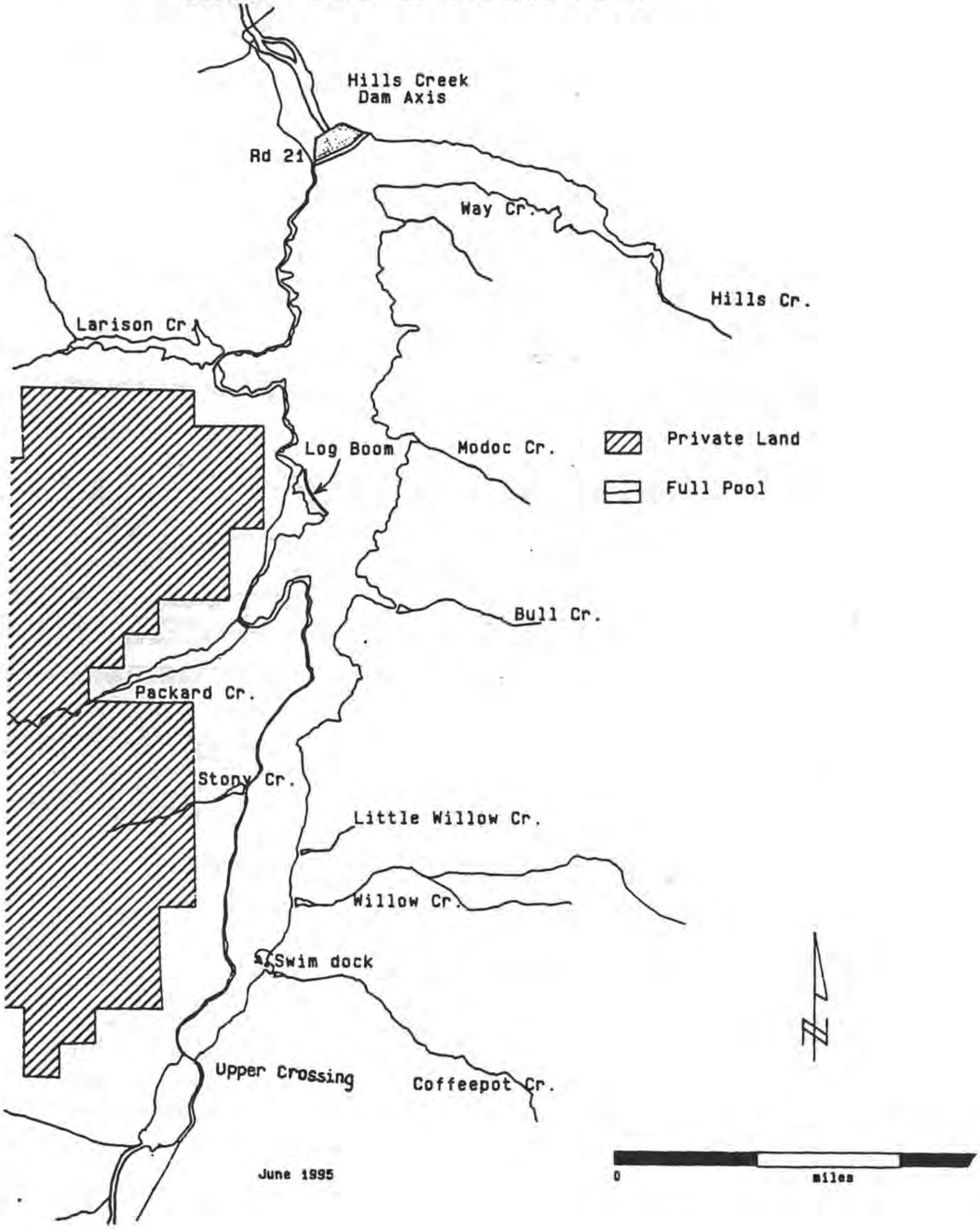
TERRESTRIAL AND AQUATIC DOMAIN

Riparian Habitat Quality

The filling of Hills Creek Lake inundated 12 miles of lower alluvial stream channel and associated riparian floodplain and habitat and created a new upland riparian zone. **Spring chinook** historically used the MFW River for spawning and rearing. To mitigate for the loss of stream habitat, a hatchery was established in Oakridge. Recently, Spring chinook have been re-introduced into the system above Hills Lake with out-year plans to truck juveniles around the dams.

Figure 39: Middle Fork Willamette Downstream Tributaries

Hills Creek Reservoir



The Lake eliminated critical winter range along the MFW River and blocked migration of **elk**. Connectivity for many plant and animal **riparian associated species** was lost with the inundation of the MFW River. The upland riparian zone is characterized by upslope forest environment as opposed to riparian habitat.

Terrestrial species that rely heavily on Hills Creek Lake are two known nest sites of Bald eagle, several pair of osprey, and at least one known population of western pond turtle. The second Bald eagle nest site was confirmed on the Hills Creek arm in the spring of 1995 and a management plan needs developed. The western pond turtle's traditional location are in coves along Hills Creek Lake.

Potential users of the lake are peregrine falcons. They could use the lake area for foraging. A management plan is being developed for potential peregrine falcon habitat areas.

Along with the filling of the lake, roads were built along the lake. These roads were constructed through highly erosive soils and continue to fail each winter. Historically, **road waste** was placed in the riparian zone of the lake to create dispersed camp sites. A rock quarry was developed on the MFW River arm for dam and road construction.

Aquatic Domain

Species Composition

Before the lake was filled, the tributaries to the MFW and the mainstem were treated with rotenone to remove "undesirable" fish species. Although numbers of species eradicated in this project are unknown, the project was assumed to be successful. A **remnant population of bull trout** has been located in the MFW River, however, whether this is a viable population is unknown.

Since the creation of Hills Creek Lake, **exotic fishes have been introduced**. They include large and small mouth bass, yellow bullhead, black crappie, and bluegill have been added to the system by state agencies or fishermen. The fish species presently stocked by the Oregon Department of Fish and Game include: rainbow trout and Spring chinook. Table 41 lists species found in Hills Creek Lake.

Table 41: Fish Species In Hills Creek Lake

Fish Species	Presently Stocked
Northern Squawfish Bull trout	No
Spring chinook Rainbow trout	Yes
***Large/smallmouth bass**	No
Yellow bullhead Bluegill	No
Black crappie	No
Long & Shortnose dace	No
Sculpin sp.	No
Redside shiners Mountain suckers	No
Coarse-scaled suckers	No

* Species introduced since the filling of the reservoir

The effect of the introduction of the warm water fish species on the native populations is unknown. Over the past several years the Corps of Engineers and Forest Service have worked cooperatively to enhance the warm water fishery.

Lake Turbidity

Hills Creek Lake fluctuates an average of 30 feet a year, leaving miles of **erosive shoreline exposed** to wind produced waves and rain, increasing lake turbidity. Youngberg concluded that the main sources of turbidity, created from suspended inorganic colloids, originates from the drainage basin and the shoreline (Younberg, et. al. 1971), the former being the greater contributor. Principal source areas included slumps, landslides, and road failures. Organic matter, such as planktonic algae, was also present in the water and affected the summer water surface appearance, but did not contribute significantly to overall reservoir turbidity.

At the 30 foot drawdown level, approximately 685 acres of bare soils are exposed from mid-September until April 1 each year. Wind-produced waves and winter rains have caused considerable erosion from this area and the lack of vegetation is both visually dominant and minimally productive habitat. The Forest Service and the Corps of Engineers have worked cooperatively to stabilize eroding banks since the early 1980's.

The effectiveness of the restoration in shoreline stabilization has not been well documented at this point and is difficult to quantify. A standardized monitoring protocol is recommended.

Downstream Habitat Complexity

The MFW River downstream of Hills Creek Lake was surveyed once since filling (Ely, 1980). Only biological information was collected Almost 10 miles of river were sampled from the North Fork Willamette to Black Canyon Campground. The sampling yielded 8 cutthroat trout, 9 wild rainbow, 3 hatchery rainbow and 25 juvenile chinook. Chinook juveniles were observed throughout the section because of surplus hatchery fish being released at Black Canyon campground. Approximate densities of other fish observed are: 3700 suckers, 2800 whitefish, 650 squawfish, 500 cottids and 500 dace.

Based on a visual survey by Ely, it is apparent that the habitat complexity has simplified below the dam. The stretch is lacking in **LWM and spawning gravel**. Much of the historical riparian area is now residential and lacks the large wood component in the stand structure for future recruitment. Cooler water temperatures released from the dam may also limit biological productivity.

Social Domain

Of particular concern are the existing facilities, recreation use, and the effects of lake level on recreational use (HL8).

Existing Facilities

The **number and condition of sites and the type of facilities** along Hills Creek Lake were measured to assess recreation use. There are four developed sites on the Hills Creek Lake (Packard Creek Campground, Cline-Clark Picnic Area, Bingham Boat Ramp, and CT Beach Picnic Area/Boat Ramp. There are approximately 30 dispersed sites on the reservoir and the majority of these sites are used all summer. Packard Creek Campground boat ramp is the only ramp available year-round and is used throughout the year, especially by people fishing.

Recreational opportunities offered by Hills Creek Lake include year-round fishing. During the warm summer months, swimming and water skiing become the major water sports. Because the Packard Creek Campground area is sheltered from the afternoon winds, it is very attractive to the water skiing crowd. Camping in both developed and dispersed sites is heavy and the demand for more camping facilities need to be supplied. The local economy is boosted by recreationists making Hills Creek Lake a destination point.

Recreation Use

Recreational use within the MFWDT has steadily increased over the years. Estimated recreational use which largely takes place in the vicinity of Hills Creek Lake has been a combination of estimates and counts from camping fee envelopes and survey forms.

The Lake is used year round for fishing with moderate fishing pressure during the winter months from both boat and bank fishing. Crappie and large mouth bass fishing is an attraction after the lake fills.

Fishing activities decline during the warm summer months and other sports such as water skiing occur during the months of July and August. During the normal years when the pool fills, the swimming area and beach at Packard Creek Campground become enormously popular with crowds of up to several hundred persons per day on weekends. Dispersed sites located adjacent to the lake are almost continuously occupied during the summer.

Table 42: Recreation Visitor Days

YEAR	RVD'S*
1985	85.0
1986	84.7
1987	82.4
1988	90.0
1989	90.1
1992	91.1
1993	126.6
1994	122.3

*RVD's are measured in thousands

Recreational use has increased by almost 40 percent over the last two years. The increased use, especially on Hills Creek Lake, indicates another campground is really necessary to met the demand for water recreational activities. This is provided that full pool levels are maintained until the Labor Day weekend. Much of the recreational use is influenced by pool levels and weather conditions, but a general increase in use has been observed by administrative persons.

It has been observed that years when Hills Creek Reservoir does not fill to full pool, recreational use such as swimming and other water sports such as water-skiing become almost nonexistent. Packard Creek Campground is basically empty. Fee receipt records for the years of 1992 and 1994 show camping dropped as much as 50 percent. This not only is a reduction in recreation use but also a significant reduction in camping fee collections in the fee campgrounds.

Until 1983, the Corps of Engineers draw down schedule for Hills Creek Lake began lowering the pool level as early as the first week or two of August. This resulted in substantial reduction in recreational use, especially at Packard Creek, during August and Labor Day.

In 1983, the Corps of Engineers agreed to leave the lake level at no more than six feet from full pool until the end of Labor Day weekend. More recently, the lake level is held at nearly full pool until Labor Day. The first year of leaving the lake level near full pool resulted in Packard Creek Campground being almost full of campers. This resulted in an increase of approximately $ 2,500 in camping receipts. Now the campground remains fully occupied during August and early September

The local economy is boosted by recreationists making Hills Creek Lake a destination point. Long term recreating produces a benefit for Oakridge businesses in terms of services, supplies, and food.

Excerpts from a 1982 feasibility study of tourism and recreation in the Oakridge and Westfir areas indicated that the most popular recreation uses were camping and lake use. The study concluded tourism and recreation provided a significant amount of business to about 40 firms in Oakridge. It found that residents from outside of Lane County provided 25 percent of the local business during the summer and 10 percent during the winter. According to proprietors in Oakridge, fishing is the most asked about attraction or facility in the Oakridge/Westfir area, followed by hunting and camping.

Beginning in 1998, the Corps of Engineers plans to let the first of two contracts to start construction of water temperature control towers at Cougar and Blue River Lakes. These towers will allow water to be released downstream that will more closely resemble water temperatures that naturally existed prior to construction of the dams. The effects on Hills Creek Lake would be an earlier release of water to the MFW River to meet minimum flow requirements. During low flow conditions a decrease in Hills Creek Lake water surface elevation is expected to occur near the end of July. This would mean that C.T. Beach and Bingham Boat Ramps would not be available for use.

Chapter 5

Interpretations and Trends

Middle Fork Willamette Downstream Tributaries Watershed

This chapter compares the current and reference conditions and explains the causes of the significant differences, similarities, or trends of the processes and functions.

This chapter compares the significant differences, similarities and trends of the ecosystem functions and processes. It also identifies the capability of the Watershed to achieve management objectives.

There are many processes affecting the MFWDT. Until now, the discussion has focused on the processes relating to the specific issues of the Watershed. These processes are complex and can not be artificially separated by specific issues. To provide the broadscale look at the MFWDT and its processes the discussion now focuses on the identified functions and processes.

Habitat Diversity

Habitat diversity in both forested and non-forested stands **has declined** with vegetation manipulation replacing fire as the dominant disturbance factor. Fires of varying intensities and diverse temporal and spatial extent resulted in a complex mosaic of forest composition and stand age structure. This complexity of forest composition and structure created a diversity of habitats for biological organisms. Fire-tolerant and disturbance-tolerant species were selected for.

The **patchy distribution** of clearcut harvest units provides a **highly fragmented** forest environment. A great number of young single-aged stands with reduced habitat complexity compose this fragmented environment. This increase in young stands results in a higher percentage of sites where early pioneer species may survive. **Species composition has shifted** from a diverse species mixture **towards favoring crop trees in managed stands.** During the past decade the emphasis has been on reforesting with a mixture of species.

Effects of the patchy seral stage distribution pattern are **increases in edge-related species** in the mature, old-growth habitats. The patchy distribution of harvest units, generally 40 acres or less, **disrupts the foraging home range** of wildlife species associated with any of the seral habitat stages.

Diversity has decreased in many managed plantations, due to past managed practices that favored crop trees, during precommercial thinning, and commercial thinning. Reduction in stand diversity **reduced wildlife and botanical species richness.**

Table 43 represents the change of the current seral stages from the reference timeframes.

Table 43: Changes in Seral Conditions

Seral Stage	Current Acres	1835 – 1855 Acres	1876 – 1915 Acres	1947 Acres
Stem Initiation	34,046	23,000	18,447	370
Stem Exclusion	14,708	1,000	19,550	11,568
Understory Reinitiation and Mature, Old-Growth	50,515	82,328	67,581	93,993

The **effect vegetation manipulation** has on species featured in Table C-3 of the ROD is **unknown**. The majority of these species are associated with either old-growth and/or riparian habitats. The **amounts of these habitats have decreased** in acreage and structural complexity with the greatest decrease over the past 30 years. With the current S&G's some wildlife and plant species are expected to be maintained in Matrix lands. Some other species are expected to be reduced in numbers in the Matrix but provided for in the LSR's.

Vegetation management directly effected one subpopulation of the Sensitive Thompson's mistmaiden in the Dinner Ridge area. This population is below a landing created for a unit in Orcal Timber Sale.

The **only known population of mountain lady's slipper in the MFWDT was eradicated** when a clearcut removed the overstory and associated mycorrhizal fungus composition of the site. This made it impossible for the species to survive (see files on Salix Timber Sale, 1980).

Prescribed fire might work well in stimulating the uncommon fire-dependent species, woodland milkvetch and branching montia, populations. These species were discovered respectively in the Warner Creek and Shady Beach fire areas that burned in the fall. It is **unknown whether spring fires will stimulate these species to germinate** or whether an early spring burn will affect growth and reproduction of other species. **Continued fire suppression results in conversion of species** to plants less resistant to fire.

Fire suppression benefits some TE&S species and does not benefit others. Fire suppression does not benefit peregrine falcons, due to the **gradual loss of open forest habitats and meadows** that provide a diversity of prey species.

Fire suppression benefits spotted owls. Gradual increase in LWM and understory of natural stands promote the prey habitat and characteristics of spotted owl habitat. Conversely, fire suppression gradually increases the fire hazard in the LSR. There is an **upward trend for the remaining spotted owl habitat in the LSR**, as the increase in large woody material enhances prey habitat, and younger habitats are permitted to grow toward suitable foraging habitat. There is also an **increase in fire hazard** in owl habitat of the LSR 0222 and the smaller 100-acre LSRS within the matrix that could negatively affect the owls.

Increase in LWM is a benefit for forest amphibians, such as the red-legged frog. LWM is used as cover from predators and provides moist refugia during dry summer months. Possibly a **slight upward trend for red-legged frog** populations **in the LSR**, as fire suppression increases large woody material. There may be a **slight downward trend in Matrix** with programmed harvest.

Elk herds have increased substantially from the reference conditions. The increase is from the institution of regulated hunting and the management of their habitats. The **current management objectives for elk emphasis areas will be difficult to meet for the High and possibly the Moderate emphasis areas while still meeting objectives for multiple species and site productivity.** Reasons for this difficulty are: the tradition of using KV funds that are tied to a specific timber sale area that's only a small part of a larger elk emphasis area; infrequent timber sale entries; de-emphasis on broadcast burning, seeding non-native forage species; and potential conflicts in meeting road density objectives.

During the next 10 years there will be a **decrease in Habitat Effectiveness Index (HEI) for forage** in the MFWDT. This results from increased acreage of **lower forage quality**, on assumption that less broadcast fuel burning, seeding of non-natives and fertilization might occur.

During the next 10 years there will be a **downward trend in the geometric mean** of the four habitat effectiveness indexes for the Dry Pine High Elk Emphasis Area. This is due **mainly to increasing acreage of hiding cover in relation to optimum thermal cover** and to **reduced forage quality**.

During the next 10 years there will be a **downward trend in the geometric mean** of the four habitat effectiveness indexes for the Coffeepot Head Moderate Elk Emphasis Area due mainly to **reduced forage quality**.

During the next 10 years there will be a **downward trend in forage acreage and size and spacing** index for Gray, Larison, Coal Head, and Packard emphasis areas, due to the designation of the LSR.

Forest habitats will have gradual shifts. Fire exclusion has permitted the **gradual reduction in open forest habitats**. There will be a **continued loss** of **large acreage blocks of similar aged forest habitats** as a result of future harvest in the Matrix. With the projected program of timber harvest, there will be a **loss in acreage of mature and old-growth ponderosa pine/Douglas-fir** habitats.

A reduction in abundance and structure of the hardwood components in mid-seral mixed hardwood-conifer forest habitats, namely managed plantations, is due to past emphasis on treatments favoring "crop tree" production.

Timber harvest, fire suppression, and grazing have affected special habitats. Timber harvest has indirectly affected these habitats by roads cutting across wet areas, meadows and ridgelines. Grazing has affected all of the meadows along the Calapooya Mountains as well as the Moon Lake, Joe's Prairie, and Warner Mountain area. Some natural meadows have become fully forested. There will be a **continued loss in dry, non-forested habitats** with conifer encroachment resulting from **fire suppression**.

There will be an **increase in high intensity fire hazard** of remaining mature, old growth forest habitats, with the increasing levels of ground and ladder fuels.

LSR 0222 will show **decreased fragmentation** during the next three decades as the early seral habitats grow into pole-size and small timber habitats. There will be an **increase** toward **large acreage blocks** of **late seral forest habitats**. There will also be an **increase in fire hazard**, due to fire suppression and accumulation of fuels in natural stands.

A **reduction in early and mid-seral forest structure**, due to past emphasis on density stocking and even spacing of crop trees.

Habitat Connectivity

Connectivity was wide spread in the reference condition. Currently, **Hills Creek Lake and the large private holding in the Packard Creek area are major obstacles** to connectivity. The Lake impedes the river corridor. Hills Creek Lake and the private lands holding impede east-west landscape connectivity. The drainages impacted are Packard Creek and Larison Creek on the west and Hills Creek, Modoc Creek, Bull Creek, and Willow-Coffeepot Creek on the east.

Past harvest units **highly fragment** the **remaining connectivity**. There is a **state of slow recovery** to the extent provided by the Forest Plan.

At the Watershed level, **riparian connectivity will slowly improve** with growth of regenerated harvest units.

Matrix inter-riparian ridgeline connections between adjoining drainages will **continue a downward trend** until older managed stands can contribute to connectivity.

Matrix upslope terrestrial connectivity will continue downward with programmed harvest. Reliance will be on existing non-harvested, forested habitats, such as the Green Tree Retention clumps, forested lands unsuited for timber management, and the 100-acre LSRS.

LSR inter-riparian connections across ridges **will have an upward trend** with ingrowth of regenerating harvest units.

LSR upslope terrestrial connectivity will have a **slow upward trend** with growth of regenerating harvested units.

Upslope terrestrial and ridgeline terrestrial connectivity between LSR 0222 and LSR 0221 **will decrease in the Matrix** for connections between riparian areas. This will occur for the next several decades until older managed stands contribute towards connectivity. **Riparian area** connectivity between the two LSR's will **slowly increase.**

Interior Habitat

Timber harvest and associated road building over the past 30 years left a **highly fragmented** Watershed. Large unfragmented blocks, similar to historical stands in character, survive in the Late Successional Reserve. The center of the MFWDT is **highly fragmented, especially east of the MFW River**. Fragmentation is an issue because of the "edge effect". This means the microclimate is different on the edge of a stand than the interior. (Research suggests it takes 500 feet to reach interior conditions.)

Species needing interior forested habitat include the old-growth associated C-3 species in the ROD. We **know certain C-3 species need closed canopies and can not survive in young stands.**

Riparian areas in forested habitats were harvested from the 1950's to the 1980's. **Some rare plants** like the giant chain fern **could have been affected** by this practice. **Some riparian-dependent C-3 species**, especially the moss and liverworts associated with maple, **probably experienced decreases** in population size.

Dispersed timber harvest units **substantially reduced** the **acreage of interior mature, old-growth habitat** from reference conditions. Increased edge effects lower the true acres of remaining interior habitat blocks.

For the next five to six decades, until managed stands in the LSR mature, there will be a continuing **loss of interior mature and old growth forest habitats in Matrix lands.**

Ecological Site Productivity

Most of the **current managed units** have **reduced ecological site productivity** as a result of past removal of LWM and snags. Ecological site productivity **is functional in natural stands surrounding the older managed units** and is distributed across the landscape.

Riparian habitats harvested between the early 1970's and the late 1980's are **assumed to be deficit in LWM and snags**, rendering those areas unsuitable for species such as the red-backed vole and northern flying squirrels.

There will be a **slight increase in ecological site productivity in the LSR**, as the older harvested units mature and are influenced by the surrounding mature forest.

Probable static trend in Matrix lands. Continued harvest will be offset with the S&G for LWM and Wildlife and Green Tree Retention.

Riparian Habitat

Past harvest activity within the current riparian buffer allocations for class I through IV streams indicate the MFWDT has **47% of the total riparian area less than 55 years of age**. This is **especially significant when harvest occurred on both sides of the stream.** Areas with both sides of the stream harvested can be assumed to have **no LWM in the creek or available** from the terrestrial riparian area for future LWM recruitment. Streams flowing through private land can be expected to have little or no LWM in or available to the stream. Streams with extensive harvest within the riparian area include Packard, Stony, Snow, Big Willow, Buck, Coffeepot, Windfall, Bohemia, Spring Butte, Indian, Coal and Estep Creeks.

There will be **slow recovery over the next 55 to 200 years** as young stands reach a size to provide stream channel complexity and relative stability. **Thinning** within these managed stands **would accelerate the growth** of remaining individual trees. Strategic **placement of LWM in the stream** and floodplain would improve short term aquatic habitat and complexity, and stream and floodplain function.

Past harvest activity within the current riparian buffer allocations for class I through III streams indicate the MFWDT has **29% of the stream length less than 35 years of age**. This does not include small face streams along the MFW River and Hills Creek Lake. These young stands **will continue to steadily recover**.

Vegetation Manipulation Potential

In Matrix lands, the desired future condition is to increase diversity and ecological function while providing quality timber and other commodity production. On allocations that provide for timber production and associated riparian lands the following table shows the stand ages. These acres were developed from a GIS "What's Available" extraction. The process starts with the total matrix acres and eliminates the buffered acres for special habitats, lakes, roads, the LSRS's, the no harvest land allocations, and unsuited soils. This provides an estimate of acres available for harvest in Matrix lands.

Table 44: Potential Acres Available in Matrix

Matrix	0--5 years	6-15 years	16-25 years	26-50 years	51-80 years	81-200 years	200+ Years	Total Acres
Non-Riparian Acres	2,735	4,519	3,204	5,549	2,720	1,211	12,578	32,516
Riparian Acres*	452	1,092	918	1,327	427	104	766	5,086

*Vegetation manipulation activities are for the sole purpose of benefiting riparian resources.

13,789 acres in the 81-200+ acres may be reduced 2000 acres by further identification of special habitats and their associated buffers. They may be further reduced by 532 acres from Slinky, Stonepot, Boulderdash and Weeping Timber Sales and the 15% green tree retention. This **leaves 9569 acres for PSQ** on matrix lands. The PSQ acres are primarily in Subwatersheds 21-2 and 21-3 (Appendix H, Vegetation Documents).

Table 45: Non-riparian matrix acres:

Subwatershed	Acres of 80+ years
21-4	769
21-3	8,506
21-2	4,126
21-1	388

In the LSR and LSRS, the desired future condition is the development and protection of late-successional and old-growth characteristics. Development of these characteristics should focus on stands under 80 years of age. Treatments should be assessed for any stands that are prone to insect, wind, or fire disturbances to prevent large scale disturbances.

The desired future condition of the Riparian Reserves is to sustain a physically complex and stable riparian and wetland vegetation along with restoring large conifers and providing connectivity.

Individual Subwatershed acres are in Appendix H. The summary below shows acreage where potential vegetation manipulation projects for habitat improvement can be done and commodity removal may be a result of the treatment.

Table 46: LSR Acres

LSR	0-5 Years	6-15 Years	16-25 Years	26-50 Years	51-80 Years
Non-Riparian Acres	1,090	2,635	1,619	2,354	536
Riparian Acres	175	631	509	555	49
Total	1,265	3,266	2,218	2,909	585

Over 24% of the LSR for the scenic allocations and previously general forest allocations are under 80 years of age. **About 4531 acres** are in age class 0 - 15 years and **may be suitable for release and precommerical thinning**. A portion of these may have already been treated. **About 5622 acres** are in the age class 16-80 and **may be suitable for post and pole or commercial thinning**. Some small acreage in special habitats may have vegetation treatment opportunities. See Appendix H for LSR Current conditions by Subwatershed.

Fire Pattern, Behavior and Intensity

Fire suppression activities remain the same. There will be **less fuel management treatments** of harvested stands because of reduced programmed harvest.

Increased fuel accumulation will increase the likelihood of extreme fires. Carefully **controlled prescribed fires may** be an effective way to **reduce fuels** in harvest units and natural stands **and to perpetuate desired plant communities** in the area. Compared to wildfires, prescribed burns are generally much smaller and less intense. This reduces the impacts on other resources.

Wildlife and Plant Habitat Quality

Roads have a great effect on plant populations along the Calapooya Mountains. Road 5850 runs through a series of meadows (Holland, Johnson, Gertrude Lake, Bristow, Bradley and Loletta Lake basins) as well as rocky ridgetops. At the eastern edge of the MFWDT, the meadows around Groundhog and Little Groundhog Mountains and Joe's Prairie have also been dissected and had drainage patterns disrupted. **Roads are also vectors along which noxious weeds travel.**

Road fills are normally drier and promote dry-site plant species. Often, these alterations in soil and moisture regime **promote off-site species to invade** into the habitats.

Under current standards and guides, **new road construction would not affect** additional special habitat, unless an assessment determined that any specific special habitat was insignificant for maintaining biodiversity.

Fire Suppression Response Time

The **present transportation system provides good access**. An ATM process needs to consider administrative access for fire suppression response time and safety.

Wildlife and Botanical Disturbance

Four elk emphasis areas are **above the maximum open road density**. About 71 miles of open roads within these four areas need closed to achieve the elk emphasis Habitat Effectiveness objectives. Additionally, **several** of the other Moderate Elk Emphasis Areas, with **High Elk Use Areas**, **need roads closed** to meet the verbal agreement with ODFW.

Open roads have a **negative effect on habitat quality** for big game. The effects are increased human access, both in numbers and frequency: and the resulting consequences of disturbance and hunting of elk and deer. The disturbance result relates to energy expenditures. Increased disturbances also affect calving sites for elk. Direct effects to survival of elk calves are very low.

The **elk population has grown substantially over the past decades despite the coinciding increase in road mileage**. During the mid-1980's, ODFW studied elk's reproductive success. The study included Rigdon Ranger District. Results showed **reproductive success of the elk was within**

normal range at about 72%. Currently, the **rate of population growth has slowed and appears to have flattened.**

The Larison Moderate Emphasis Area is almost completely within the LSR and private land. Coal Head Moderate Emphasis Area falls completely in the LSR. The **opportunity to meet the road density and/or forage objectives is limited**.

One road within the vicinity of a bald eagle nest area **has disturbance potential** during nesting season.

The **effects to other wildlife species should remain static** with a static trend in new road mileage.

One population of the Sensitive plant, Thompson's mistmaiden, is below Road 2106445. The road was constructed at the top of a special habitat. The area **seems to have maintained its hydrological integrity** since the plant was located after construction. We should monitor these populations. One other rare plant that has **probably been affected by roads and/or quarries** is spring phacelia. Further road-building or quarry activity needs to take these species into account.

Forest Use

Reductions in the ability to maintain the current road system will require a plan to redirect or consolidate maintenance efforts. Plans to develop an Access and Travel Management Plan may resolve the dilemma of road mileage exceeding the ability of road maintenance funds to maintain.

Non-Native Species Composition

The **increase in** noxious weeds **is directly attributable to increased management and use** of the national forest. Timber management, from clearcuts to landings to the roads that allow the truck haulers' access, facilitates both the growth and movement of these species. **Approximately 30% of the Watershed is infested**, not counting the roadside populations. These species will eventually be outcompeted by the shading of young trees. Until the trees overtop the weeds, they will be making and distributing seed via the wind, birds, deer and elk.

Past grazing by livestock has **decreased the native vegetation** to the point that **non-native species have been able to outcompete** a number of the native species. This problem is especially evident in the Little Groundhog Mountain area and Bristow Prairie.

Introduced species, Scotch broom, tansy, St. Johnswort, Canada and bull thistle, **are now** established members of our flora. These species are particularly prevalent on the meadows that were heavily grazed and commonly seeded with "good forage," probably non-native species. The native grasses here are bunchgrasses that leave the ground in between them somewhat open and easily colonized by weeds. This **can be detrimental to biodiversity and decrease natural forage** for deer and elk.

New invaders **continue to enter the forest**, by seeds caught on the undersides of vehicles, in lawn clippings dumped near the reservoir, in horse droppings along trails. Continue prevention efforts through public education, eradication of the new invaders, where possible, and continuation of biological control releases on established infestations.

Bullfrogs and barred owls are the main non-native wildlife species of concern. The **expansion in range of both has negative effects to native species**. Bullfrogs prey on native turtles and amphibians' populations. Barred owls displace and interbreed with spotted owls. There is **an increase of these non-native populations** as they continue to expand farther into the Watershed. This results in a decrease in native species.

With programmed timber harvest in the Matrix, the **barred owl will likely become the dominate Strix species**. The barred owl will continue expansion in the LSR until the recent harvested units grow out of early seral habitat. The populations should then level off and begin to decline in the LSR.

Riparian Habitat Quality

Using stream Classes I, II, and III intersections with existing roads, there is a **loss of 806 acres (4%) of riparian reserves** in the MFWDT. **Impacts initially appear minor** to overall riparian habitat quality. Riparian reserve acres for Class IV stream were not assessed. Usefulness of this information is as a component for assessing overall conditions of riparian reserves.

There **will be an increase** in acres of riparian reserves **impacted** by roads **if** analysis **includes** the road intersection with **Class IV** stream riparian reserves. There will be a **slight decrease in riparian reserves acres** due to new road construction as we continue harvest **in the Matrix**.

Riparian Habitat Quality And Migration

This process illustrates the **change from a stream system to a lake**. This change **is permanent until removal of Hills Creek Dam**. The results have been a **change in migration patterns for most terrestrial wildlife, especially riparian associated species, and a total blockage for most**

riparian species, Spring chinook and Bull trout. In addition to the blockage of migration, Bull trout were eradicated from the system prior to lake filling. Whether there is a **viable population of Bull trout is unknown**. Continued monitoring efforts are underway by the Forest Service and OFDW to locate the remaining population.

Riparian Structure

Fuel loadings within riparian reserves **are increasing**. This **increases the risk of stand replacement fires**. High intensity stand replacement fires in riparian zones may jeopardize some of the resource values of riparian zones.

As the risk of stand replacement fire increases, the risk of **significant impacts to** water quality and quantity **increases**. High intensity fire in the riparian zone and adjacent slopes would tend to increase peak flows. Surface erosion would increase due to soil exposure. Erosion of the stream channel and banks would likely increase without the resistance normally provided by vegetation.

Although wildfires and hot slash fires can affect stream conditions, **research indicates** that **prescribed burning**, judiciously applied with awareness of potential impacts, **can be used without significant changes in water quality or quality** (Beschta, 1990).

Landslides

The MFWDT has a **240% increase above natural conditions in harvest related debris slide occurrence.** These landslides have occurred on steep ground with shallow, rocky soil, generally soon after clearcut harvesting. Including Private land, approximately 11,720 acres of the MFWDT has been clearcut in the past 15 years in this geomorphic setting. Roughly half of that was harvested within the past 10 years. This indicates a **strong likelihood that harvest related slope failures will continue at some level above natural background** until root strength and canopy intercept of precipitation is reestablished.

The **frequency of harvest related debris slides are expected to approach natural conditions** with the retention of more trees per acre. This assumes that the effects of increased groundwater levels and loss of root strength are incorporated into the analysis and prescription. This also applies to harvest activities on or upslope of clayey soils which have a tendency toward deep seated slope failure.
Sidecast road construction techniques on steep ground with shallow, rocky soil have resulted in **a 350% increase in debris slides** above natural conditions. The majority of road related debris slides occurred in the Little Pine

West Subwatershed and affected Windfall, Bohemia and Gold Creeks the most frequently with 5 or more occurrences each since 1959. The next most impacted stream is Coal Creek with 3 occurrences during the same period.

The frequency of occurrence appears to be declining. However, numerous locations on the road system in steep ground are showing signs of outside edge cracking, presumably associated with the decomposition of organic material in the sidecast fills. The emphasis of maintenance activities in these areas has been to control road surface runoff. This is accomplished by insloping and frequent cleaning of the ditches. The **frequency and distribution of slope movement** in clayey soil **have mimicked the construction history** (roads and spurs). Slope failure tends to occur relatively soon after construction. Many of the older cut and fill failures have been stabilized with surface and subsurface drainage modification, buttresses, and biotechnical techniques. Some have been of a scale too large to deal with effectively (Tufti Mountain and Powder Creek).

There is relatively recent road construction in clayey soils in the Shady Beach Fire and Packard Creek areas. **Expectation is these areas have the greatest likelihood of future slope movement**. Although the failure mechanism is less dramatic than a debris torrent, slope failure in this geomorphic setting generates persistent fine-grained sediment.

In recent years, the declining maintenance budget has lead to a decision to perform minimum levels of maintenance. This kept the majority of the road system open. This approach leads to a **general degrading of the road system, especially of the maintenance level two roads**. Many of these roads are brushing in or showing signs of neglect or increased risk of failure due to lack of proper maintenance. **Declining maintenance funds** as a result of declining timber sale collections and appropriated money is expected to **result in less frequent maintenance and an increase in road related landslides.**

42% of Rigdon Ranger District's 1200 miles of road are within the MFWDT. Using an average road maintenance cost of $660 per mile and the expected funding level, 314 miles of road per year could be maintained at their current maintenance level on Rigdon. That is approximately 25% of Rigdon's road system.

Hydrologic Recovery

The cumulative harvested acreage of the last 35 years created a landscape with a larger percentage of land occupied by young stands than within the mid 1800's through the mid 1900's. **Currently 37% of the MFWDT is vegetated by stands less than 35 years of age. Historically 1 to 21%** of this area was in a hydrologically unrecovered state. A large portion of the forested area is young and contributing more water to the stream system and groundwater. This is

riparian species, Spring chinook and Bull trout. In addition to the blockage of migration, Bull trout were eradicated from the system prior to lake filling. Whether there is a **viable population of Bull trout is unknown.** Continued monitoring efforts are underway by the Forest Service and OFDW to locate the remaining population.

Riparian Structure

Fuel loadings within riparian reserves **are increasing.** This **increases the risk of stand replacement fires.** High intensity stand replacement fires in riparian zones may jeopardize some of the resource values of riparian zones.

As the risk of stand replacement fire increases, the risk of **significant impacts to** water quality and quantity **increases.** High intensity fire in the riparian zone and adjacent slopes would tend to increase peak flows. Surface erosion would increase due to soil exposure. Erosion of the stream channel and banks would likely increase without the resistance normally provided by vegetation.

Although wildfires and hot slash fires can affect stream conditions, **research indicates** that **prescribed burning,** judiciously applied with awareness of potential impacts, **can be used without significant changes in water quality or quality** (Beschta, 1990).

Landslides

The MFWDT has a **240% increase above natural conditions in harvest related debris slide occurrence.** These landslides have occurred on steep ground with shallow, rocky soil, generally soon after clearcut harvesting. Including Private land, approximately 11,720 acres of the MFWDT has been clearcut in the past 15 years in this geomorphic setting. Roughly half of that was harvested within the past 10 years. This indicates a **strong likelihood that harvest related slope failures will continue at some level above natural background** until root strength and canopy intercept of precipitation is reestablished.

The **frequency of harvest related debris slides are expected to approach natural conditions** with the retention of more trees per acre. This assumes that the effects of increased groundwater levels and loss of root strength are incorporated into the analysis and prescription. This also applies to harvest activities on or upslope of clayey soils which have a tendency toward deep seated slope failure.

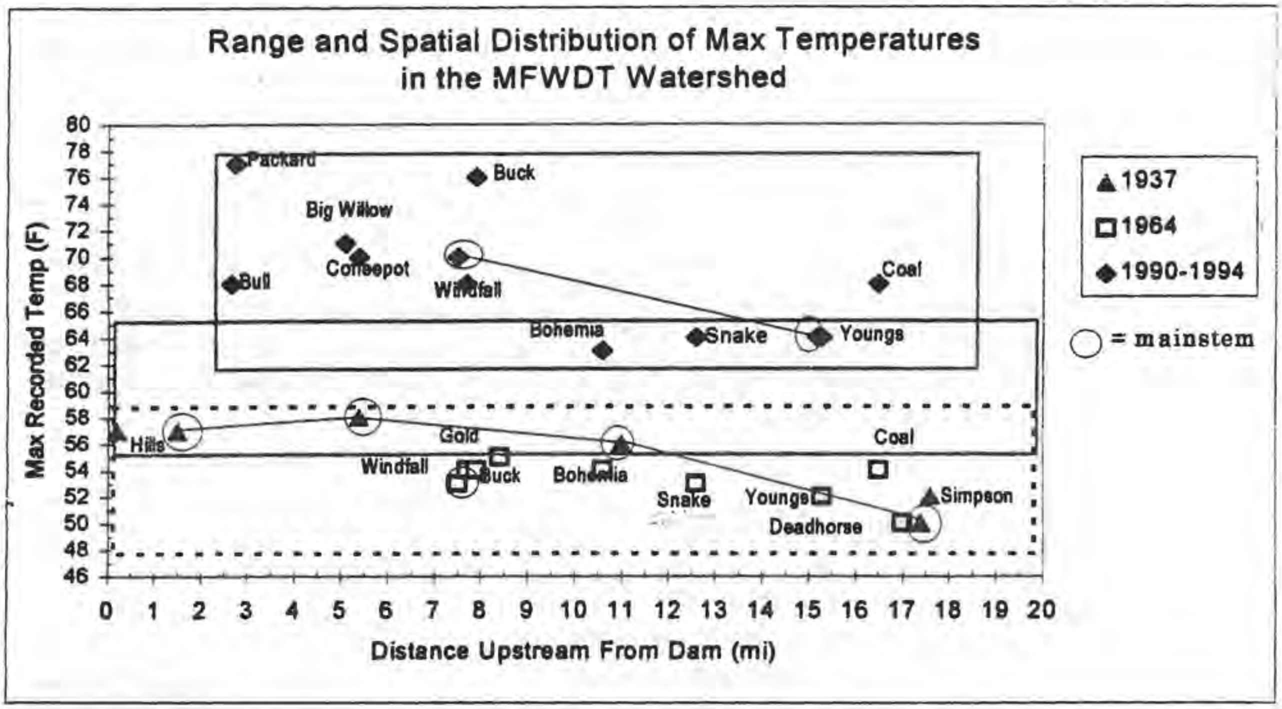
Sidecast road construction techniques on steep ground with shallow, rocky soil have resulted in **a 350% increase in debris slides** above natural conditions. The majority of road related debris slides occurred in the Little Pine important because the **majority of the Watershed has a high runoff rate** producing flashy stream responses to storm events. These high flow events expend a great deal of energy moving through the system, eroding channel banks and beds, and redepositing materials downstream. The repercussion of this activity intensifies where prior harvest activity has removed the rooting strength that formerly held the floodplain and channel morphology together.

Hydrologic recovery is expected to improve over the next several decades as the young stands within the riparian buffers and LSR continue to grow. Periodic harvest of the private lands is expected. We expect that riparian buffers will be left along the streams with the current Oregon State Forest Practices Act regulations. Currently, these **private land riparian areas have a deficit of timber greater than 10 to 20 years old**, and **have little to no LWM** present in the streams.

Wood Recruitment And Shading

Figure 40 was constructed from limited available data from three decades to portray the range of variability in temperature conditions of the MFWDT watershed. The dashed box on the graph outlines the range of the earlier values. These data points **are almost certainly below the true maximum** due to several factors (Appendix G). The range should be adjusted upward, perhaps by approximately six degrees as shown by the center box outlined in gray. This would put the upper boundary of the range at 64 degrees that is generally consistent with the temperature tolerance of salmonids.

Figure 40: Range and Spatial Distribution of Maximum Temperatures



With these considerations in mind, rough comparisons can be made. The upper end of the range from earlier decades slightly overlaps the lower end of the range in the 1990's. This suggests the **center of the range has shifted upward significantly.** The range of recorded temperatures is 14 degrees in the contemporary decade and 8 degrees in the earlier decades that suggests the **amount of variability has increased**. In terms of the spatial distribution of maximum temperatures, there is a **slight general pattern of decreasing temperatures in the upstream direction** in earlier decades for both the mainstem and tributaries. In the 1990's, the pattern is present for the mainstem but is scrambled for many tributaries.

Buck Creek shows the **single most extreme change in maximum recorded temperature**, an increase of 22 degrees. Stream temperatures are thought to reach a theoretical upper limit near the maximum average air temperature for a given region and elevation (DEQ,1994). In the Western Cascades, maximum average air temperatures at 2000 feet (the elevation at the mouth of Buck Creek) were found to be around 74 degrees. The high value recorded in 1992 may be near the theoretical maximum at this location. In contrast, in 1937 the stream temperature in Buck Creek was 54 degrees when the air temperature was 70 degrees. This suggests there has been **a substantial decline in the moderating influence of the riparian zone on the thermal regime of Buck Creek.**

Figures 41 and 42 present a view of the range of temperatures required during different life history stages for Spring Chinook salmon and Bull Trout. The graphs also show a plot of daily minimum and maximum temperature recorded in 1973-1974 at the Sand Prairie gauging station. These years are the most recent two years without a temperature data gap. A review of Figure 26 in the Current Conditions Chapter shows these to be relatively though not uncommonly warm years. Life stage indicators were redrawn from originals created by Dave Buckanan (DEQ,1994).

Figure 41 Annual Temperature Regime of MFW at Sand Prairie with Temperature Requirements of Spring Chinook Life Stages

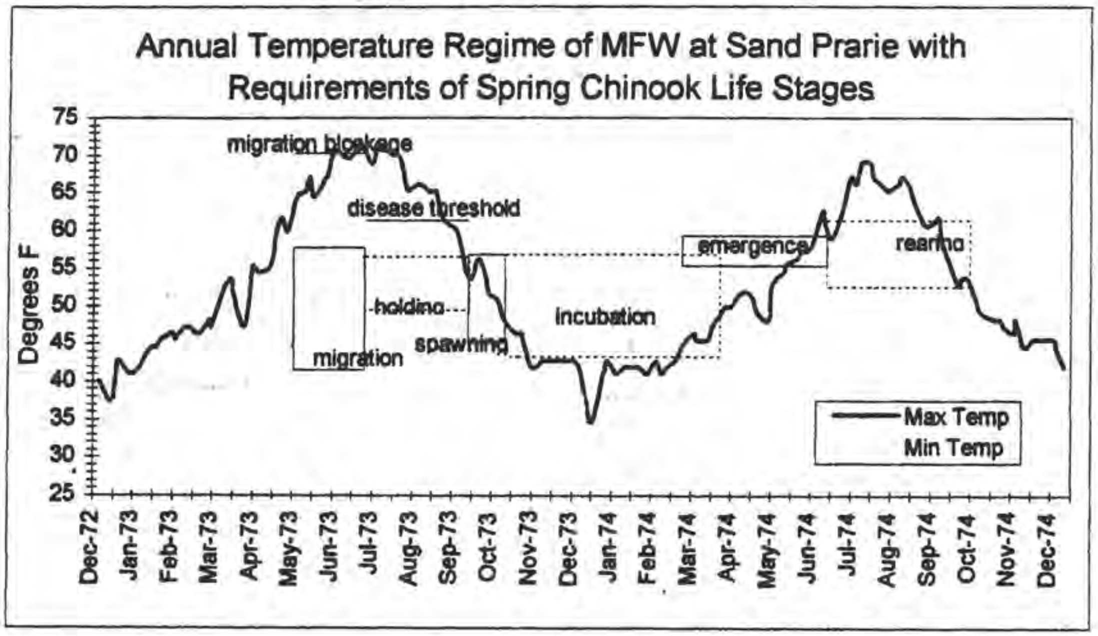
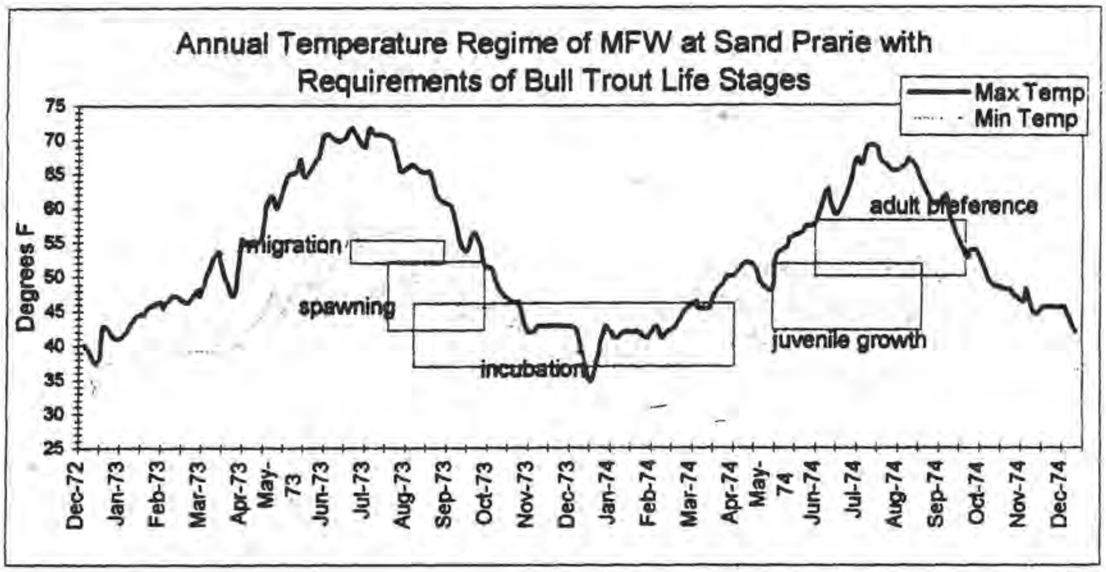


Figure 42 Annual Temperature Regime of MFW at Sand Prairie with Requirements of Bull Trout Life Stages



Minimum and maximum temperatures fall well outside the suitable range for at least one life stage of each species. Concepts of natural selection imply that the range of environmental conditions will not frequently be far outside the range of suitable conditions for naturally adapted species. The range of biologically suitable conditions for these species is a conservative approximation of the natural range of variability in environmental factors. This biological evidence of intolerable conditions for several life stages of two historically present species supports the claim that the **temperature regime in this part of the MFW is outside the previous range of natural variability.**

There is enough evidence of **widespread occurrence of abnormally high summer** stream temperatures to warrant investigation and corrective action. High priority stream for monitoring and restoration are Snake, Young, Coal and the MFW River. This is based on current stream temperatures, historic Spring Chinook use and terrestrial connectivity. Vegetation manipulation is a likely causal factor, but available data is inadequate to determine the magnitude of its direct impact and interaction with other factors

Habitat Complexity

The MFW River morphology and vegetation is **dominated foremost by the natural variation in streamflow. Harvest of riparian vegetation** and **removal of LWM** from the channel and floodplain is the **second factor**. The **third factor** is the **increase in the percent** of **hydrologically unrecovered** forested land within the Watershed.

In 1945 a significant flood event occurred that cleaned out LWM and vegetation. It **simplified the stream pattern** to a single and double threaded channel as seen in the 1946 photos. In 1964, an even larger flood event occurred. Piles of LWM were either removed or burned in subsequent years.

Air photos from 1985 and 1994 show that in some sections a more complex braided channel network is being developed. This development is in response to the influx and retention to smaller substrate sizes related to the occurrence of smaller magnitude flows, roading and harvest of riparian forest. In addition, the **dominant substrate currently is cobble sized alluvial deposits** (Unthank et al.,1992). This **compares to the large rubble** reported in the 1938 U.S. Fisheries Bureau Survey. Floodplain and channel bars continue to revegetate.

The management direction of **no more riparian harvest for timber production will aid in stabilizing the channel banks and floodplains.** This will reduce the amount of sediment transported to the MFW River. LWM recruitment from the riparian will take time to recover naturally. Decreased harvest activity in the upland terrestrial and a slight decrease in the timing of peak flow will help reduce channel erosion. Natural flood events of large magnitude may happen at any time and further rearrange the channel and floodplain. This makes it **important to maintain the structural integrity of the channel and flooplain.**

The comparison of the reference conditions to existing conditions show that **vegetation manipulation impacted channel processes. Riparian harvest has reduced** the amount of streamside vegetation available for **future wood recruitment** into the stream and for **stream shading.** Stream cleanout associated with timber harvest reduced the amount of large wood left in the stream for habitat complexity. **Harvest related debris slides** have **introduced sediment and distributed wood unevenly** throughout most streams. The documentation of monitoring of rehabilitation of these processes by riparian or upland planting and or fertilization has been lacking.

Streams in the MFWDT have been impacted by vegetation manipulation, fire, floods, stream cleanout, and landslides and their associated sediment. These processes all work independently and cumulatively to change channel habitats. Vegetation manipulation also reduced the amount of large seral stage vegetation located along the stream channel. That reduced wood recruitment into the stream. Historical fires influenced the seral stage along the riparian and upslope habitats. Loss of riparian vegetation and increased stream bedload from timber harvest and associated road building resulted in channel widening and canopy opening in several drainages. A summary of channel sensitivity to these processes by channel type is in Table 46. The trend of each channel type will depend on the rate of change in each process.

Table 46: Expected Channel Response to Process

Channel type	Valley Type	Riparian Vegetation	Landslides	Peak flow	LWM
A	8	Low Not essential for stability and energy dissipation of overbank flows and debris torrents	Low Sediment temporarily stored, then transported downstream. Little or no change in channel morphology expected	Low Little or no change in channel morphology expected. Simple expansion of flow, rather than physical channel adjustment	Low Not primary roughness element
B	3 6 10	Moderate Contributes to stream-bank stability and/or energy dissipation of overbank flows and debris torrents	Moderate A minor adjustment in channel width, depth of scour, median bed particle size, bar development and/or pool volume expected. A very large, persistent increase required to trigger significant changes in channel morphology.	Low Little or no change in channel morphology expected. Simple expansion of flow, rather than physical channel adjustment	Moderate Contribute to pool formation, sediment trapping, formation of steps and gravel cleansing, other roughness elements, such as boulders are also available.
C	1	High Critical in providing root strength for streambank stability energy dissipation during overbank flood flows, and/or reductions of energy and travel distance of debris torrents.	High Significant increases in channel width, depth of scour and/or bar development expected. Bed material size and pool volume would be reduced. Channel aggradation and conversion from pool-riffle to plane-bed or even braided channel type could occur.	High Significant increase in bedload transport, depth of scour and/or bank erosion expected. Coarsening of streambed and channel widening or incision, depending on channel confinement and base-level control.	High Critical for forming pools, trapping sediment, creating scour that cleanses gravel and/or dissipating stream energy via steps and deflection

Channel Type

- A Generally steep, high gradient stream
- B Moderate entrenchment and gradient gradient
- C Low gradient alluvial channel

Valley Segment Type

1 - Lower alluvial valley
3 - Steeply incised valley/moderate channel
6 - Moderate-slope bound valley
8 - Valley wall/headwall tributary
10- Alluviated mountain valley

Table 47 summarizes the dominant processes effecting channel conditions that vary slightly across the Watershed. Subwatersheds with similar dominant processes are presented together. An **indicator of channel complexity is the change in the amount of LWM by channel type**. Other parameters, such as the stream width to depth ratio or substrate type and size could also be used. A correlation between process and pools per mile was not evident at this level of analysis with the data available. Generally, the **amount of LWM decreased with increases in the number of processes** occurring in the MFWDT. An exception is in Subwatershed 21-2 East where debris slash remained in the stream after harvest.

Table 47: Dominant Processes Effecting Channel Condition

Sub-watershed	Dominant Process	Channel Type	LWM/ Mile Reference	LWM/ Mile Current	Forest Plan	PAC Fish >24" x 50"
21-4	Riparian Harvest Fire	A	ND	49	NA	80
		B	196	50-64	105	80
21-3 21-2 West	Riparian Harvest Landslides	A	66	16	NA	80
		B	ND	28-38	105	80
		C	ND	12	105	80
21-2 East 21-1	Riparian Harvest Fire Landslides	A	41-46	12-162*	NA	80
		B	ND	18-136	105	80
		C	ND	8-16	105	80

ND -- No Data

*As the stream passes through clearcuts, the abundance of slash overlaying the stream increases dramatically. Fish were not seen in these areas although there was an abundance of frogs.

Surface Runoff And Routing

The **extensive road network** effectively **doubles the drainage density throughout the MFWDT** (Table 34). This decreases time it takes for precipitation and snow melt events to reach the stream channel. The **effect** on the channel **is an increased erosive activity, deposition, and widening of the channel**. This impact to the stream channel and floodplain is exacerbated where past harvest activities have removed the structural integrity provided by large trees and LWM in the riparian area.

The **trend of obliterating some roads** will alleviate some of the disrupted flow patterns on a site by site basis. There may **only be a slight improvement** because of the number of the roads left open for administrative and recreational access.

Culvert Carrying Capacity

Only 8% of the culverts within the MFWDT installed in Class 1 through 4 stream channels have been analyzed for flow capacity relative to a 100-year flood event. Preliminary results show that **approximately 40% represent a strong likelihood of water overtopping the fill**. This value is consistent with results from culvert analyses outside the Watershed on Oakridge and Rigdon Districts. The risks associated with overtopping these culverts, as well as those upslope, have not been fully analyzed. This analysis, combined with the value of the downstream aquatic habitat and the need for fish passage, is essential in developing a prioritization strategy for retrofitting or replacement of culverts.

Species Distribution and Migration Corridor

Roughly 1/3 of the culverts analyzed were on Road 21 that parallels the Middle Fork Willamette River. This road encourages recreation and commercial travel as well as being the main arterial for accessing the Middle Fork basin. These culverts affect movement of fish into and out of the main stem.

One-hundred percentage of the velocities modeled in the inventoried culverts **block anadromous and resident fish migration**. In many cases, vertical drop at the outlet also contributes to blockage. For many fish, migration is essential to survival. Many resident fish species migrate throughout the stream during their life cycle seeking a variety of aquatic habitats. Although these migrations may only be a few miles, they are important for the long term survival of the species and maintenance of fish production. Migration is blocked until the culverts are passable.

Spring chinook were recently reintroduced into the stream system. Historically, Spring chinook migrated throughout this section of the MFW River during spawning. It is **important to re-open passage in the tributaries** to the MFW River that serve as refugia for migrating juveniles. These streams are listed in priority as: Coal, Indian, Snake, Pine, Bohemia, and Estep. Temperature monitoring of these streams would establish if temperatures were suitable for juvenile life stages. The **trend is increased migration passage over time.**

Bull trout migrated through this section to cool water refugia upstream of this Watershed. The **migration corridors for Bull trout are unaffected**. It is unknown if these tributaries were used more extensively historically.

It is assumed that resident cutthroat trout **have established isolated populations** above most of the blocked culverts that will reseed downstream populations. Some of those populations are increasing. These isolated populations would be lost and not re-established if the stream dries during any particular year.

Species composition

The creation of Hills Creek Lake introduced various warm water fish species and the abundance of rough fish species. In the last 5 years, large and small mouth bass, crappie, yellow bullhead and bluegill have been added to the aquatic system. How these new species interact and compete for limited food resources are poorly understood. **The impact** of these fish on remaining Bull trout or introduced Spring Chinook populations **is unknown**. It is assumed that the piscivorous bass may prey on juvenile Chinook and bull trout. The presence of Hills Creek Dam resulted in decrease in Spring Chinook and Bull trout. The **continuing trend is low numbers of Bull trout and increasing numbers of exotic fish.**

Lake Turbidity

Lake **turbidity increases with increased shoreline exposure** at lower lake levels. Several shoreline erosion control projects have been taken to reduce the amount of sediment contributing to the lake. The effectiveness of the projects is currently being monitored by the USFS Supervisor's Office. There is a need to standardize monitoring procedures.

Downstream Habitat Complexity

Very **little is known about the habitat downstream of Hills Creek Dam** and associated species complex. Loss of wood and spawning gravel simplified and channelized the system. Fishing pressure has increased with the increased boating use. There is a need to assess habitat and species composition and conditions for reintroduction of Spring Chinook into this reach. There is a **continuing lack of LWM and spawning gravel in MFW River downstream of Hills Creek Lake.**

Sedimentation

Trail mileage peaked in the 1940's and 1950's from approximately 120 miles to the current 31.5 miles. Trail condition **surveys do not indicate significant erosion problems** associated with trail tread for the 18 miles of trail that are on highly erosive soil types. Localized muddiness in wet areas limits trail use. Condition surveys indicate that waterbars or puncheons are satisfactory for prevention of trail tread degradation. The **major portion of the trail system is quite stable** as noted from past years of maintenance. The **trail system**, regardless of the location, has an **insignificant impact** on the Watershed resources due to the low impact of the tread structure. This low impact is due to the fact that trail routes generally are on the slope contour with a two-foot wide tread, tree canopy is left intact, and stream flows and patterns are undisturbed. The **proposed increase in trail mileage will not have a significant impact** on sedimentation.

Resource Integrity and Function

The facilities are developed campgrounds, dispersed campsites, trails, Oakridge Sewage Treatment Plant, powerlines and telephone lines. **Hills Creek Dam's and the transportation system impacts are discussed under separate processes.** Most of these above mentioned facilities have been in existence for over thirty years. These facilities occupy approximately 278 acres or almost 2 percent of the riparian reserves. No facilities, except trails, are in the LSR. The facilities do not present barriers to wildlife and are not a significant source of sedimentation. **Developed campgrounds, dispersed campsites, trails, the Sewage Treatment Plant, powerlines and telephone lines are an insignificant impact** in the MFWDT. The existing and planned facilities will be consistent with the objectives of the the Aquatic Conservation Strategy.

As visitor numbers increase, **greater demands are being placed** upon developed and dispersed campsites, especially those adjacent to water. Available camp sites remains static while user numbers increase. The results are **campground sites filled more often,** there is a greater **reduction of vegetation** in dispersed campsites, and **more user created dispersed campsites** are appearing.

Acreage committed to facilities has not changed. As recreation use continues to increase in the Oakridge area, greater demands for use of National Forest System land will result. The closeness of the area south of the MFW River and the city will have greater demands placed upon it. The proposed Greenwaters Foot Bridge and trail system of the slopes south of town will increase use of that portion of the LSR.

The effluent discharged into the MFW River from the sewage treatment plant is monitored weekly. Due to the high quality and assimilative capacity of the river and to the improvements to the plant, the **discharge does not significantly reduce water quality** in the MFW River.

Some of the negative affects of developed campsites and dispersed campsites being in the riparian reserves, are bank erosion and loss of vegetation. The random placement of dispersed campsites and additional trails has caused conflicts with other recreation users such as hikers. There are increasing numbers of user created dispersed campsites and recreation use continues to increase.

Existing facilities

Trends in forest visitor use indicate **increasing recreational use**. Water oriented recreational pursuits are extremely popular in the Hills Creek Lake area. Improvement of the fisheries and waterfowl habitat in the upper pool, above the upper crossing bridge, has apparently been successful. This is indicated by the increase in the number of fishing boats now using this area. There is increased demand for more recreational facilities and **existing ones may need upgrading**. Current user fees in developed campgrounds have caused a shift in use to other non-fee areas on Hills Creek Lake.

There are at least two heavily used dispersed campsites adjacent to the lake shore at Coffeepot Creek. **Restoration is needed at Coffeepot Campsite to accommodate current use.** There are **two other dispersed sites** uplake from the upper crossing bridge. Constant camping and day use result in toilet paper lilies near the dispersed sites along with degradation of the vegetation at the site and enlargement of bare soil areas. Environmental Protection Agency personnel evaluated similar sites elsewhere on the forest. The EPA's conclusion is that the **low volume and the biodegradability of the waste does not constitute a threat to water quality**. The sites remain a visual and social concern.

Proposals to place and maintain vault or pit toilets are currently beyond recreation staffing and funding levels. Alternatives could range from portable toilets to limiting access to these sites. Installation and maintenance funding could take the form of water quality improvements.

Eventually, **more** campsites **on Hills Creek Lake** will be needed to accommodate additional campers and day users. There is a need to survey the existing campsites.

The road system around Hills Creek Lake has brought management challenges. The **roads and upslope timber harvest** have **increased the instability of natural slide areas, especially the Modoc Creek slide.**

Recreational Use

Trends in forest visitor use as noted in RRIS indicate **increasing recreational use**. Eventually **more campsites on Hills Creek Lake will be needed**. This rise in Hills Creek Lake recreation use **could conflict with bald eagle management** on the Lake. **Other conflicts could** arise from other water needs and uses or other management objectives for the timing of Hills Creek Lake **pool levels.**

As the Oakridge area expands, its recreational opportunity base in such areas as fishing, mountain biking and being a recreation destination point, more area businesses will realize an increase in income from tourists. One of the goals of the city is to make the area a destination for mountain biking. The area is already being noticed by horse packers, mountain biking, and fishing outfitters and guides.

When **Hills Creek Lake is at full pool, the increased use** indicates another campground may be necessary to meet the demand for water recreational activities. This is provided that full pool levels are maintained until the Labor Day weekend. Proposal to increase the level of recreational use need to be accessed with compatibility of the Hills Creek Bald Eagle Management Plan.

Beginning in 1998, the Corps of Engineers plan to let the first of two contracts to start construction of water temperature control towers at Cougar and Blue River Lakes. The **effects on Hills Creek Lake would be an earlier release of downstream water** to the MWF River to meet minimum flow requirements at Albany and Salem, Oregon. During low flow conditions a decrease in Hills Creek Lake water surface elevation is expected to occur near the end of July. This would mean that C.T. Beach and Bingham Boat Ramps would not be available for use. It is estimated that 60 percent of the general recreationists will seek substitute recreation at another lake. Estimates from other COE Lakes show that approximately 90% of day users will substitute another lake.

Chapter 6

Recommendations

Middle Fork Willamette River Downstream Tributaries Watershed

This chapter presents proposals for managing this Watershed

Five objectives were identified in the Project Initiation Letter for the Middle Fork Willamette River Downstream Tributaries Watershed. Information was to be collected to support future site specific project analysis for:

- Recreation Activities
- Access and Travel Management Plan
- Restoration and enhancement projects
- Vegetation Management activities
- Riparian Reserve management activities

Opportunities and recommendations are given by function or process that will help move the Middle Fork Willamette Downstream Tributaries processes and functions toward the desired conditions and trends.

Habitat Diversity

Priority -- Assess and develop management strategies **to maintain functions of open forest habitats in the ponderosa pine/Douglas-fir area.**

Priority -- During planning efforts, **inventory stand types and plant species in the Calapooya Mountains**. This information will be used to verify the areas high biodiversity.

Priority - Develop implement, and monitor **a prescribed fire plan** outside of the riparian reserves to:

1) **maintain open forest habitats**, with priority emphasis to the ponderosa pine/Douglas-fir area.
2) **encourage germination of fire dependent species** such as Woodland Milkvetch and branching montia in the area east of the MFW River
3) **reduce high fuel hazards** especially in the Fuel Model 10 areas. See Figure 29 in Current Conditions for general location of FM10 areas.
4) **treat areas of diseased trees and insect infestations** especially in the ponderosa pine/Douglas-fir area.

Priority - Develop management strategies in matrix lands to **provide large blocks of forest habitats**, with priority emphasis to the ponderosa pine/Douglas-fir habitats. Use general concepts of J. Franklin's "large, sloppy harvest units".

Priority - Develop and implement **a meadow management plan**. Beginning with Groundhog, Johnson, Bristow, Holland, Lower Coal, Joe's Meadows and Gertrude Lake area.

During precommercial and commercial thinnings, apply silvicuture prescriptions which **promote or maintain what would normally be anticipated up to 10% of the units' site potential in hardwood trees.**

Diversify, or vary, stocking densities during reforestation, precommercial thinnings and commercial thinnings **toward representations of sites' natural tendencies**. Strategies would include maintaining small openings that are difficult to reforest, vary spacing during reforestation, vary spacing during precommercial and commercial thinnings, which include no-thin areas, maintain diversity of tree species during thinnings, and maintain some defective trees during thinnings.

Use mitigation measures outlined in FEAT, Appendix J of the Forest Plan and the forthcoming measures from the REO to **ensure survival of C3 species.** This is especially necessary in Matrix lands and where riparian areas do not provide dispersal corridors.

Underplant and modify understory vegetation to begin **development of multistory stands** in LSR and Riparian Reserves.

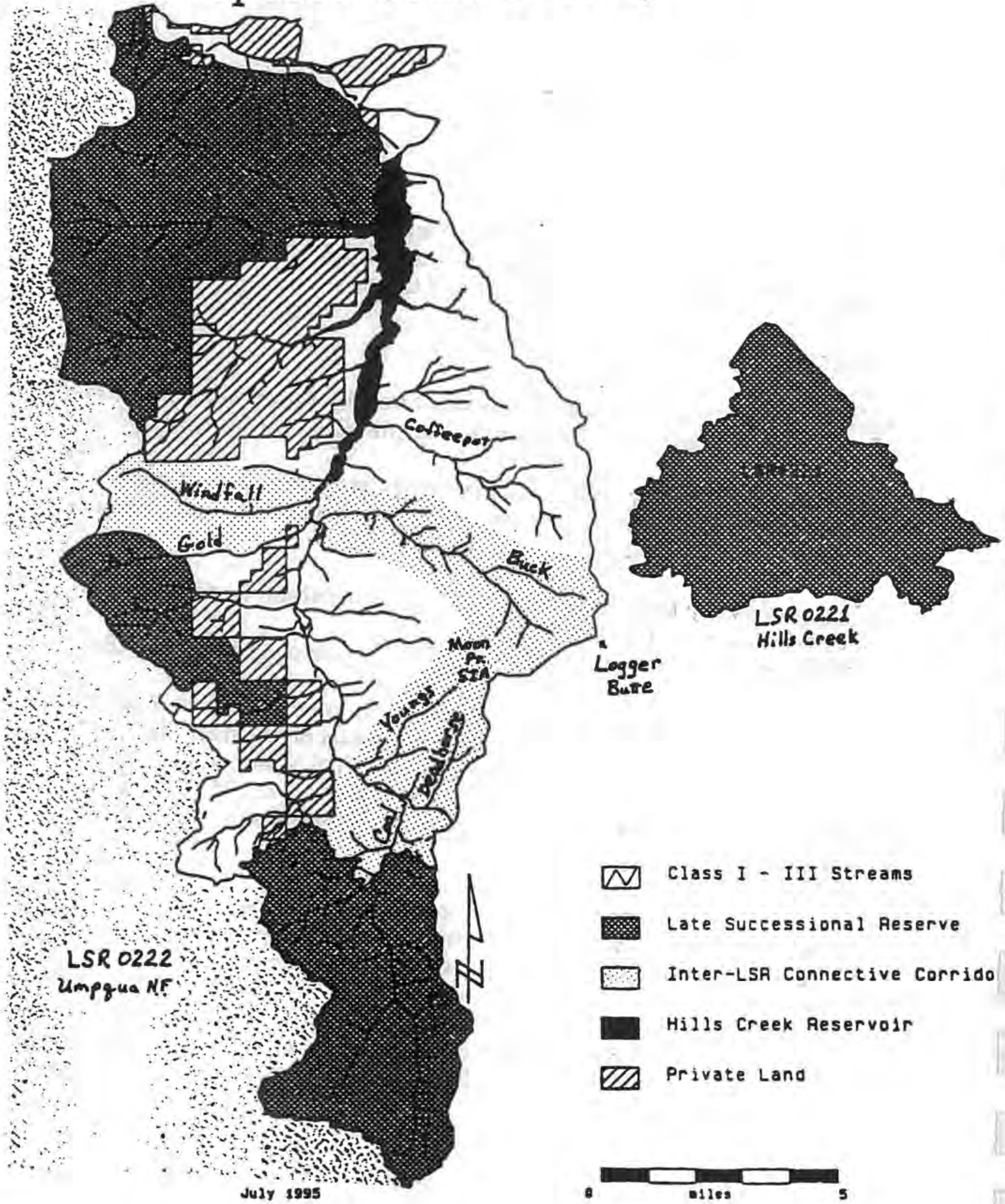
Assess the LSR and LSRS's for fuel loadings and the appropriate area for **reintroduction of low intensity fire**. This will help maintain diversity of Late Successional habitats and for reduce the potential for catastrophic fires.

Habitat Connectivity

Priority -- For connectivity between LSR 0222 and LSR 0221, **design a connectivity strategy for the two routes of Windfall Creek/Buck Creek drainages and Coal Creek/Youngs Creek-Deadhorse Creek drainages,** including riparian and upslope terrestrial habitats. This strategy will stay within the current Standards and Guides. Figure 43 represents the corridors.

Figure 43: Middle Fork Willamette Downstream Tributaries

Proposed Connectivity



Interior Habitat

<u>Priority</u> -- **Assess Matrix** lands **for remaining stands of interior habitats** for attributes of quality and landscape distribution. Then **develop a strategy for prioritizing and managing** timber around those to the extent feasible, considering other resources needs.

Silviculturally treat managed units in LSR, which are <80 years of age, to promote growth and structural diversity leading to late successional forest habitat characteristics, including riparian and upslope terrestrial areas. Priority of managed units are those that likely existed as late successional habitats over many centuries.

Dense, young forest habitats have likely occurred within the LSR. An **assessment is needed to identify** the need for retaining some managed units with such habitat characteristic.

Ecological Site Productivity

<u>Priority</u> -- Prioritize drainages that are not linking the LSR and LSRS. Restore the LWM component of these sites by enhancing the growth of large trees for future LWM recruitment. Restore LWM in units harvested along the mainstem of Indian, Estep, Snake, Coffeepot, Big Willow, Gold Creeks. **Use the Ridgeline Interconnection Map** (Figure 44) as a guide in developing a connectivity plan between riparian areas of different drainages. These areas need to promote characteristics of mature, old-growth habitats and have adequate LWM. Design the retention of LWM, Green Tree Retentions, and Wildlife Trees to facilitate connectivity in interconnection areas with a proposed final harvest.

Vegetation Manipulation Potential

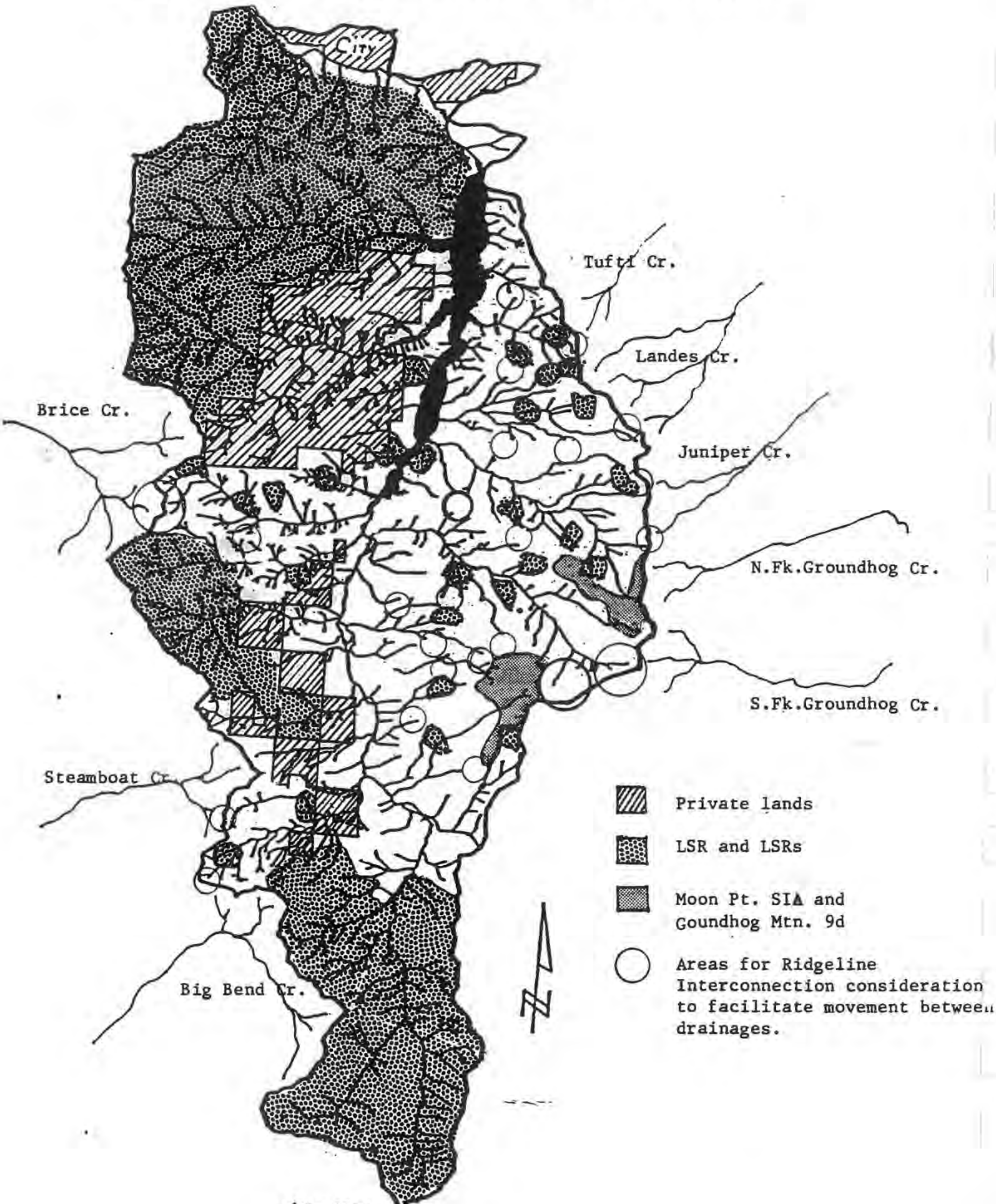
<u>Priority</u> - Look at Matrix lands in **Subwatersheds 21-2 and 21-3** for the majority of **regeneration harvest with tree reserves and commercial thinning and post and pole opportunities.** .

Exams should be done to regional standards to facilitate project scheduling. Exams need to be standardized to be consistent across districts.

Prune to increase product quality and improve tree vigor or to meet other objectives.

Figure 44: Middle Fork Willamette Downstream Tributaries

RIDGELINE INTERCONNECTIONS; MATRIX



June 1995

Reforest for establishment, stocking level maintenance, stand diversity development. Cone and other vegetative collections may be utilized.

Release or removal of vegetation as stand density management, to promote vigor, tree size, stocking protection, or forest user safety or maintaining forest health.

Seedling protection projects such as animal control.
Remove snags and logs along roads, developed campgrounds and dispersed campsites to reduce hazards and utilize in areas deficient of LWM, commodity contract or restoration.

Harvest Special Forest Products when there is no effect or no significant adverse impacts to other resources.

Prioritize vegetation treatments on the 5622 acres of 16 -- 80 year old trees **in the LSR.**

Fire Pattern, Behavior and Intensity

In Matrix lands, **run the current behavior models for Fuel Model 10** areas. Use the results of the behavior models to develop and implement fuel treatment plans to **reduce fuel loadings especially in Fuel Model 10 areas** and to perpetuate desired plant communities.

Wildlife and Plant Habitat Quality

<u>**Priority**</u> - Apply treatments to **reduce or eliminate off-site species** invading special habitats along roads.

Close and rehabilitate the **section of Road 2106445** to restore the hydrologic regime for the Thompson's mistmaiden population on Dinner Ridge adjacent to the Orcal Timber Sale landing.

Identify and rehabilitate non-essential roads to a condition compatible with surrounding special habitats. **Priority areas are**: Loletta Lakes, Little Groundhog Mountain, Holland Meadows and the Gertrude Lake area. Study and implement road rehabilitation efforts to restore meadow habitat and hydrologic regime during ATM and SIA Management planning efforts.

Fire Suppression Response Time

Develop an Access and Travel Management Plan, including the LSR. Will need to balance fire suppression access priorities and need to reduce risks of human caused fires and damage to other late successional resources.

Wildlife and Botanical Disturbance

__Priority__ - **Seventy-one** (71) **miles of open roads**, in four elk emphasis areas, **need closed to meet the Standards and Guidelines** for maximum densities.
Coffeehead in 21 2: ~14 miles to close; Willow Creek to Buck Creek.
Dry Pine in 21 3: ~42 miles to close; Cone Creek to Deadhorse Creek.
Larison in 21 2: ~6 miles; Larison Creek drainage.
Snake Fir in 21 3: ~10 miles; Snake Creek and Fir Creek drainages.

__Priority__ - Submit **Forest Plan Amendment to change** Larison and Coal Head Moderate Elk Emphasis Area **to low emphasis.** Our ability to manage these emphasis areas is limited because **they are mostly within the LSR and private land.**

Close the one open **road** above the **vicinity of one eagle nest**, to alleviate potential disturbance.
Continue **monitoring** the **Coal Creek population** of **Thompson's mistmaiden** to ensure that the hydrologic regime remains intact. Conduct an extensive **survey to delineate** the whole population.

Determine which **roads need closed in the High Elk Use Areas** within moderate and low elk emphasis areas **to meet habitat effectiveness** per verbal agreement with ODFW. Need to **set up a meeting** with ODFW, Herb Wick, South End Ranger Team, and Rigdon Wildlife Biologist **to discuss** the **verbal agreement**.

Non-Native Species Composition

__Priority__ - **Promote native seed production program** for revegetation purposes for restoration and general erosion and forage projects

__Priority__ - **Promote recovery** of managed plantations **in LSR** in a manner that would deter expansion of barred owls.

Control new invader noxious weeds at the following locations:

Common Name	**Location**
Spotted knapweed	Packard CG 21/2135 2102 2120 21
Diffuse knapweed	21/2135
Meadow knapweed	21/2127
Giant knotweed	2106/105,107 2127/180,188

Monitor effectiveness of biological controls on St. Johnswort on Little Groundhog Prairie. If effective, **use same treatment** at Bristow Prairie.

Use the ATM process for possible **roads to decommission** to prevent further travel routes of noxious weeds.

Test and monitor the use of **prescribed fire** to eradicate noxious weeds.

Inventory blackberry and reed canary grass invasion in riparian reserves around Hills Creek Lake. Reed canary grass was planted along Hills Creek Lake for bank stabilization during the 1980's. It has moved up the riparian corridors into the natural stream systems.

Curtail expansion of bullfrogs into the Watershed above Hills Creek Dam.

Riparian Habitat Quality

Apply and monitor silvicultural treatments such as thinning and pruning to enhance growth and structural diversity and to vary stand density.

Retain and replant diverse tree species.

Only modify riparian reserves after an interdisciplinary **site specific** analysis.

Rehabilitate unneeded roads in riparian reserves as determined in the ATM process.

Apply silvicultural treatments to the dense, overstocked young conifers between the high pool line and the road system on **both sides of the lake** to promote growth and canopy structure. Opening these stands by thinning would hasten their development to large trees with deep canopies and facilitate passage around the lake by those species that can or could utilize the shoreline for dispersal and migration.

Manage coves inhabited by the **western pond turtle** for protection from plinkers. For example, plant vegetation for a screen.

Apply habitat enhancement practices within the coves and upslope areas for nesting **to maintain the turtle population** within the lake.

Test low intensity prescribed underburns in some riparian reserves for effectiveness in reducing the 0" - 3" fuel loadings to better reflect historical levels of fuels. This may also help meet the Aquatic Conservation Strategy objective of restoring species composition and structural diversity of plant communities in the riparian area and restoring a less obstructed connectivity route for riparian - dependent species.

Landslides

Priority -- Stabilize slope failures on harvested slopes in Coal and Modoc Creek area and road 5850.

Priority -- Develop an inventory of road failure indicators. Develop a simple form for employees and the public to carry with them when traveling in the MFWDT.

Retain live trees, snags, and distribution of LWM to aid slope stability on harvested units.

Monitor sedimentation amounts from known sources

Hydrologic Recovery

<u>Priority</u> - As supported in this document, the **TSZ should be extended to include the ridgelines** throughout the Watershed.

<u>Priority</u> - **Conduct site specific cumulative effects analysis** by stream watershed of landslide activity, aquatic habitat and riparian vegetation to determine the appropriate threshold for spatial hydrologic recovery. **Until the analysis is complete, do not harvest greater than 35%** of the canopy closure in areas **where more than 35%** of the ground **is in a hydrologically unrecovered state.**

Wood Recruitment and Shading

<u>Priority</u> -- **Conduct site evaluations** of streams having past harvest activities on both sides **for placement of LWM and regeneration success.** Youngs and Coal Creek, the MFW River, and Buck Creek are the high priority areas.

<u>Priority</u> -- Develop and implement a long-term comprehensive **water temperature monitoring program.** Priority areas are the mainstem MFW River, the mouths of major tributaries throughout MFWDT, including private land, and in areas of thermal refuge.

Develop and implement **a monitoring protocol for riparian planting.** See Appendix F, Aquatic Document for areas.

Provide shade for pump chances, excluding area needed for access.

Aquatic Habitat Complexity

<u>Priority</u> - **Add LWM to the MFW River and low gradient tributaries** to aid in short-term recovery and reconnect side channels where appropriate.

Evaluate and implement **placement of LWM in MFW River.**

Evaluate effectiveness of **past restoration efforts.**

Surface Runoff and Routing

Prioritize and implement **maintenance of roadway drainage structures**.

Prioritize **decommissioning of roads** to minimize impacts to stream channels.

Culvert Carrying Capacity

<u>**Priority**</u> - **Hydraulic analysis of culverts** with potential to affect streams with high aquatic value.

If fish passage is not an immediate need, but a desired future condition, less expensive **improvements to accommodate a 100-year flood** (such as the addition of mid-fill culverts and retrofitting the existing culvert) should be considered until such time as a funding opportunity occurs for replacement.

Plan and implement a **program of culvert cleanout.**

Species Distribution & Migration

<u>**Priority**</u> - **Modify or replace existing culverts** in the high priority areas of Coal, Indian, Snake, Pine, Bohemia and Estep Creeks.

Design new **culverts for fish passage**.

Establish baseline information to **identify migration timing and flow characteristics** for design of high priority culverts.

Design and implement a monitoring protocol for **existing culvert enhancements**

Continue to monitor species abundance and distribution

Species Composition

<u>**Priority**</u> -- Continue to **monitor bull trout and Spring Chinook populations.**

<u>**Priority**</u> **--Complete Hills Creek Lake Management Plan**

Hills Creek Lake Turbidity

Work with the Corps of Engineers to **develop monitoring protocol**.

Continue Challenge Cost Share with Corps of Engineers to **continue shoreline stabilization**

Downstream Habitat Complexity

Complete R6, level two survey of habitat below Hills Creek Dam.

Recreational Use

Priority - To accommodate Hills Creek Lake recreationists, **maintain** the water surface at **full pool** until Labor Day Weekend.

Evaluate the **need for additional camping capacity** in the form of developed campgrounds on Hills Creek Lake. This evaluation will need to look at the **impacts of additional recreation facilities** on bald eagle management on Hills Creek Lake.

Investigate the opportunity for **construction of** a hardened surface **bike trail** loop around Hills Creek Lake.

Resource Integrity and Function

Priority -- Using the Limits of Acceptable Change inventory method, **evaluate all dispersed camping site locations on the MFW River** for condition and appropriate location to reduce conflicts with other recreation users and riparian reserve values. **Rehabilitate** sites as needed.

Control poison oak in developed sites

Sell land used for the sewage treatment plant at fair market value to the City of Oakridge.

Evaluate **condition and ability of existing facilities** to meet recreation needs.

Riparian Reserve Widths

The interim riparian reserve widths, as stated in the Northwest Forest Plan, will be maintained until a site specific analysis is conducted and presented through the appropriate NEPA decision-making process. Use of the interim widths will begin the process of restoration and/or maintenance of riparian health for riparian-dependent species and resources in the MFWDT.

Glossary

Age Class - An interval, usually 10 to 20 years, into which the age ranges of vegetation are divided for classification or use.

Anadromous - Going up rivers to spawn.

Baseflow - Baseflow is separated from stormflow for some analysis purposes. Stormflow is direct runoff from the ftorm event. for the MFW River at Sandprairie Campground, baseflow has been determined as 3,500 cfs.

Biological Diversity - Term used in the Forest Plan to provide goals and direction for evaluating the significance of old-growth stands, minimizing fragmentation of existing old-growth forests, and maintaining many of the structural components of unmanaged stands in managed stands.

Breccia - Fragmental rock whose components are angular and therefore, as distinguished form conglomerates, are not waterworn.

Canopy - The more-or-less continuous cover of branches and foliage formed collectively by the crown of adjacent trees and other woody growth.

Clearcutting - The cutting method that describes the silviculture system in which the old crop is cleared over a considerable area at one time.

Climax - The culminating stage in plant succession for a given site where the vegetation has reached a highly stable condition.

Climax Species - Those species that dominate a climax stand in either numbers per unit area or biomass.

Colloids - Substances in a state of fine subdivision having peculiar properties because of their extremely high surface area. Fine-grained materials that are held in suspension.

Colluvium landtype - A landtype of loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity.

Commerical Thinning - Any type of tree thinning that produces merchantable material at least equal in value to the direct costs of harvesting.

Commodities - A transportable resource with commercial value; all resource products that are articles of commerce.

Dendritic drainage pattern - A drainage pattern characterized by irregular branching in all directions with the tributaries joining the main stream at all angles.

Early Forest Succession - The early stage or condition of a plant community that occurs during its development from bare ground to climax.

Ecosystem - An interacting system of organisms considered together with their environment.

Ecological Site Productivity - In this document relates to the function of large woody material.

Earthflow rates -

Element Occurrence Number - A unique number given to a rate plant population by the Oregon Natural Hertiage Database which tracks populations statewide to determine endangerment.

Endemic - Prevalent in or restricted to a particular nation, region, locality, or group; native.

Evapotranspire - The portion of the precipitation returned to the air through direct evaporation or by transpiratin of vegetation, no attempt being made to distinguish between the two.

Even-aged management - The application of a combination of actions that results in the creation of stands in which trees of essentially the same age grow together.

Flow regime - Generally describes the pattern of monthly variation in the volume of water discharged from a stream or river.

Fluvial species - Plant or animal species that live in the water.

Forested Land - Land at least 10 percent occupied by forest trees or formerly having had such tree cover and not currently developed for nonforest use.

Fuel Management - The practice of planning and executing the treatment or control of living or dead vegetative material in accordance with fire management direction.

Fuel Treatment - The rearrangement or disposal of natural or management generated activity fuels.

Fuels - Combustible wildland vegetative materials.

Geometric mean - The mean of the four Habitat Effectiveness Indices (size and spacing index value; road density index value; cover index value; and forage quality index value).

Geomorphic - Of, or pertaining ot, the figure of the earth or the form of its surface; resembling the earth.

Green Tree Retention - A stand management practice in which live trees as well as snags and large down wood are left as biological legacies within harvest units to provide habitat components over the next management cycle.

Habitat - The area where a plant or animal lives and grows under natural conditions. Habitat consists of living and non-living attributes, and provides all requirements for food and shelter.

Habitat Diversity - The number of differenet types of habitat found within a given area.

Land Use Allocation - The commitment of a given area of land or a resource to one or more specific uses.

Large Woody Material - Portion of a tree that has ballen or been cut and left in the woods. Usually refers to pieces at least 20 inches in diameter.

Management Area - An area with a similar management objective and a common management prescription.

Mature Forest - In the WNF, areas containing trees whose average age is 120 - - 200 years old. There is significantly less diversity of plant species and structure than in an old-growth forest.

Migration Corridor - The portion of the landscape serving as a routine passageway for fish or wildlife species as they move from one habitat to another, often on a seasonal basis.

Morphology - The obervation of the form of lands.
Natural Regeneration - Reforestation of a site by natural seeding for the surrounding trees.
Non-forested Land - Lands that never have had or that are incapable of having 10 percent or more of the area occupied by forest trees; or lands previously having such cover and currently developed for non-forest use.
Old-Growth - A forest comprised of many large trees, large snags, and numberous large down logs; having a multi-layered canopy composed of several species of trees; the last stage in forest succession. In the WNF, forests begin to show some old-growth characteristics at 175--200 years.
Over-mature Timber - The stage at which a tree declines in vigor and soundness; past the period of rapid height growth.
Overstory - That portion of the trees forming the upper or uppermost canopy.
Plinkers - A person that shoots at targets selected at whim, for practice or amusement.
Pole/sapling - A successional stage in which trees between five and nine inches in diameter are the dominant vegetation.
Precommerical Thinning - Removal of some trees in a stand before they attain merchantable size so the remaining trees will grow more quickly.
Probable Sale Quantity - Describes the allowable harvest levels for various alternatives that could maintained wihtout decline over the long term if the schedule of harvests and regeneration were followed.
PUM - Piled unmerchantable material; generally unusable woody material less than 8 inches x 10 feet remaining after timber harvest.
Reforestation - The natural or artificial restocking of an area with forest trees.
Regeneration - The renewal of a tree crop, whether by natural or artificial means. Also, the young crop itself.
Rehabilitation - The process of restoring a site to a former state or desired condition.
Release - Freeing trees from competition for light, water, and nutrients by removing or reducing the vegetation growth that is overtopping or closely surrounding them.
Removal Cut (final cut, regeneration cut) - The removal of the last seed bearers or shelter trees after regeneratino is established under a shelterwood method.
Riparian - Pertaining to areas of land directly influenced by water or influencing water. Riparian areas usually have visible vegetative or physcial characteristics reflecting this water influence. Stream sides, lake borders, or marshes are typical riparian areas.
Salvage - The cutting of trees that are dead, dyingm, or deteriorating (before they are "overmature", or materially damaged by fire, wind, insects, fungi or other injurious agencies) before they lose their commercial timber value.
Seral - A biotic community which is a developmental, transitory stage in an ecologic succession.

Seven day peak period - The warnest consecutive 7 day periodof the year used to deterime compliance with temperature standards.

Silviculture - The art and science of controlling the establishment, composition, and growth of forests.

Slash - Residue (leaves, bark, twigs, roots, etc) left on the ground after logging.

Snag - A standing dead tree usually greater that 5 feet high and 6 inches diameter at breast height. Its interior may be sound or rotted.

Stand - An aggregation of trees or other vegetation occupying a specific area and sufficiently uniform in species composition, age arrangement, and condition as to be distinguishable from the forest or other vegetation or land cover on adjoining areas.

Stand Diversity - Any attribute that makes one timber stand biologically or physcially different from other stands.

Stand Examination Surveys - Procedures to collect data on Forest stands.

Stocking - A loose term for the amount of anything in a given area, particularly in relation to pre-determined optimum.

Structure - The configuration of elements, parts, or constituents of a habitat, plant, or animal community.

Succession - The progressive development of vegetation from bare ground towards its highest ecological expression, the climax community; the replacement of one plant community by another.

Tuffs - Rocks formed of compacted volcanic fragments, generally smaller than 4 mm in diameter.

Vegetative management - Activities designed primarily to promote the health of the crop forest cover ofr multiple-use purposes.

Water yield Class - Classification based on the water retention properties of soil types. It is an indication of the rate and amount of water yield expected from each soil based on various factors.

YUM - Yarded unmerchantable material; generally unusable woody material less than 8 inches x 10 feet remaining after timber harvest.

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A

Appendix A

Information Sources and Needs

This describes the information used to analyze the Middle Fork Willamette River Downstream Tributaries Watershed and to document the data needs for future analysis.

ISSUE VM Vegetation Manipulation

VM1 Compared to natural conditions, where has the intensity and pattern of vegetation manipulation affected plant and animal habitat diversity, species composition, amount of interior habitat, and habitat connectivity?

Data Needed	Source	Integrity	Future Needs
Vegetation	VEG/VEGIS	Fair	Complete fields for Year of origin, plant association, major/minor species, special habitats, habitat features. Move MOMS database to Vegis
Historical Vegetation	HVEG	Good	
Stream Buffers	SBUF	Fair	Complete and field verify Class IV streams, add names as an item
Lake Buffers	LAKEB	Good	Add lake names as an item
Late Successional Reserves	LSR3, LSRS	Good	
Special Habitats	SHAB	Fair	SHAB layer 40% complete. Complete point, polygon and habitat features.
Stand Description	Ecoplots	High	Connect database to layer
Series Description	Plant Association Guide	High	Get field information and put into GIS
Insect & Disease Data	USFS & ODFW 1994 Survey Warner Creek GIS	High	
Stand Structure	Silvaculture Prescriptions, Slinky, Stonepot, Boulderdash	High	

VM2 Compared to natural conditions, where has the intensity and pattern of vegetation manipulation affected ecological site productivity?

Data Needed	Source	Integrity	Future Needs
Vegetation	VEG/VEGIS	Fair	See VM1
Ecology Plots	ECOP	Good	Connect database to coverage

VM3 Where and to what extent have the changes in spatial and temporal distribution of vegetation influenced water yield, and peak flow? Where have these changes in hydrology affected channel function and habitat conditions?

Data Needed	Source	Integrity	Future Needs
Vegetation	VEG/VEGIS	Fair	See VM1
Water yield	SRI	Good	
Slope	SLO	Good	
Stream flow data	USGS	Very Good	Get updates from USGS

VM4 What are the most important delivery mechanisms for sediment generated by vegetative disturbances in this Watershed? What are relative rates of delivery by land form or slope to stream? Where are the high risk areas for generating, delivering or depositing sediment?

Data Needed	Source	Integrity	Future Needs
Vegetation	VEG/VEGIS	Fair	See VM1
Unstable Soils	SRI	Good	Manuscript and digitize unstable soils identified in EA's
Slope	SLO	Good	
Streams	STR	Good	Field verify Class IV's and add to GIS.

VM5 Where and to what extent has vegetation manipulation affected riparian and aquatic habitat complexity?

Data Needed	Source	Integrity	Future Needs
Vegetation	VEG/VEGIS	Fair	See VM1
Streams	STR	Good	See VM4
Riparian Area affected by Roads	STR,TRAN		Intersect Class IV buffers with tran to get acreage of riparian reserves.
Stream Temperature Date	USGS District Records	Very Good Good	Continuous daily records; locate temperature monitors with GPS

VM6 Given current Forest Plan land allocations, where and how many acres are available for vegetation manipulation?

Data Needed	Source	Integrity	Future Needs
Allocations	LMP	Good	Submit Forest Plan Amendment for developed recreation sites
Vegetation	VEG	Fair	See VM1
Late Successional Reserves	LSRS	Good	
Ownership	ADMN	Good	Propose logical district boundaries

ISSUE NF Exclusion of Natural Fire

NF1 What is the comparison of the fire pattern, fire behavior and burn intensity between the current fuel loading conditions and the conditions before modern day fire suppression activities?

Data Needed	Source	Integrity	Future Needs
Vegetation	VEG/VEGIS	Fair	See VM1
Historical Vegetation	HVEG	Good	
Ecoplots	ECOP	Good	Connect database to coverage
Conditions & Intensity	J.D.Walstad, OSU, 1990	Good	
Fuel loadings & models	Forest-wide Standards & Guides	Good	
Effects	F.E.I.S. Warner Recovery Project	Good	
Fuel models & loadings	Charlie Martin report - TFM	Good	
Fire ecology regimes	Wright, Bailey, 1982	Fair	
Fuel loadings & models	Maxwell, W. Technical Report PNW-105	Good	
Historical	Carol Winkler - anthropology	Fair	Need specific information for MFWDT
Fire History & pattern	Peter H. Morrison, General Reports PNW-GTR-254, 1990	Fair	
Fire Model and Fuel Regimes	Dennis Sullivan, AFMO, Oakridge RD	Fair	

NF2 How has habitat diversity changed with modern day fire suppression?

Data Needed	Source	Integrity	Future Needs
Historical Vegetation	HVEG	Good	
Historical	Carol Winkler - Anthropology	Fair	Need more info for the area.
Historical Fire	Peter Teensma, PhD., 1987	Good	
Fuel Models	Anderson, H.E., General Technical Repors, 1982	Good	

NF3 How have fire pattern and behavior affected Threatened, Endangered and Sensitive species, and fire dependent species?

Data Needed	Source	Integrity	Future Needs
Vegetation	VEG/VEGIS	Fair	See VM1
Sensitive species	Natural & prescribed fire	Fair	Need more information.

ISSUE TR Transportation System

TR1 Where and to what extent has the density and condition of roads influenced natural and management induced disturbances?

Data Needed	Source	Integrity	Future Needs
Roads	TRAN/TMS	Good	
Soils	SRI	Good	
Vegetation	VEG/VEGIS	Fair	See VM1

TR2 What sections of roads are currently introducing or have the potential to introduce excessive amounts of sediment into the stream system? Where and to what extent does the influx of sediment influence channel conditions?

Data Needed	Source	Integrity	Future Needs
Roads	TRAN/TMS	Good	
Streams	STR	Good	See VM4
Soils	SRI	Good	

TR3 Where and to what extent has the density and configuration of roads affected surface and subsurface hydrology.

Data Needed	Source	Integrity	Future Needs
Roads	TRAN/TMS	Good	
Streams	STR	Good	See VM4

TR4 Where are high risk or high priority road/stream crossings which do not have drainage structures designed to withstand 100 year events?

Data Needed	Source	Integrity	Future Needs
Streams	STR	Good	See VM1
Roads	TRAN/TMS	Good	

TR5 What are the possible resource effects of maintaining system roads at expected funding levels?

Data Needed	Source	Integrity	Future Needs
Miles of road by maintenance level	TMS	Good	
Current & projected RM budget	Program data	Good	

TR6 Where and to what extent have roads affected fish passage and riparian reserves?

Data Needed	Source	Integrity	Future Needs
Stream Buffers	SBUF	Good	See VM1
Lake Buffers	LAKEB	Good	
Roads	TRAN/TMS	Good	
Vegetation	VEG/VEGIS	Fair	See VM1

TR7 Where and to what extent are the road locations and their use affecting wildlife and botanical species and special habitats?

Data Needed	Source	Integrity	Future Needs
Roads	TRAN/TMS	Good	
Special Habitats	SHAB	Fair	See VM1

TR8 Where and to what extent has the condition and use of trails altered earth movement disturbances?

Data Needed	Source	Integrity	Future Needs

TR9 How and to what extent does changed travel access influence potential human caused fire ignitions and suppression response time?

Data Needed	Source	Integrity	Future Needs

TR10 How does changed travel access effect public and administrative use of the forest and local economics?

Data Needed	Source	Integrity	Future Needs

ISSUE NS Introduction And Spread Of Non-Native Species

NS1 Where and to what extent has introduction of non-native species affected native flora and fauna?

Data Needed	Source	Integrity	Future Needs

ISSUE EI Infrastructure

EI1 Where are existing and potential infrastructure land uses?

Data Needed	Source	Integrity	Future Needs
Inventory of structures	FLUR database Case files	Good	Continually update - install into GIS
Mining Claim Location	BLM database	Poor	Get current & complete data.

EI2 Does the presence and use of these facilities affect the Watershed resources?

Data Needed	Source	Integrity	Future Needs

ISSUE HL Hills Creek Dam And Lake

HL1 How has the change from a river system to a lake (reservoir) system affected the aquatic ecosystem? What are the fish and wildlife species that have blocked or disrupted migration patterns?

Data Needed	Source	Integrity	Future Needs
Affected Environment	1979 COE Reservoir EIS	Good	
Affected Environment	Aerial photos 1959	Excellent	

HL2 How has species composition changed with the filling of the lake? what are management opportunities?

Data Needed	Source	Integrity	Future Needs

HL3 What is the affect of the lake drawdown on lake turbidity? What are the restoration opportunities?

Data Needed	Source	Integrity	Future Needs
Rehabilitate History	District files	Excellent	
New Methods	Reservoir Shoreline Revegetation by A.Leiser	Good	
High Tubidity Areas	1990 Aerial photos	Excellent	

HL4 How has the channel downstream of the dam been altered since the construction of the dam? How has this alteration affected the aquatic ecosystem?

Data Needed	Source	Integrity	Future Needs
Storage & Minimum flows	1979 COE Reservoir EIS	Good	

HL5 To what extent has the dam modified the average flows during all times of the year, and the average annual peak flows? How have these modified flows affected flood plain processes, functions, and their associated riparian area habitat?

Data Needed	Source	Integrity	Future Needs
Flows	1979 COE E Reservoir EIS	Good	

HL6 How has the dam affected the sediment distribution and transport capability of the channel downstream of the dam?

Data Needed	Source	Integrity	Future Needs
Sediment Transport	1979 COE Reservoir EIS	Fair	

HL7 How has the cooler water released from the dam in the spring and early summer affected aquatic species? How has the warmer water released from the dam in the late summer and early fall affected aquatic species?

Data Needed	Source	Integrity	Future Needs
Water Temps	1979 COE Reservoir EIS	Good	

HL8 What recreation opportunities are provided by Hills Creek Lake? How can these opportunities be enhanced? What is the affect on local economy?

Data Needed	Source	Integrity	Future Needs
Affects on Economy	1979 COE Reservoir EIS	Fair	

OTHER DATA NEEDS

Data Needed	Source	Integrity	Future Needs
Valley Segments	GIS		Manuscript, digitize, move to ARC INFO
Fire History	Fire Occurrence		Finish manuscripting, digitize, move to ARC INFO. Review Augusta Creek for their techniques
Resource Values	Resource Specialist		Create Access Travel Management Plan
Recreation Opportunity Spectrum	ROS		Manuscript, digitize, move to ARC INFO
Time safety road cutoff	GIS		Need to get into GIS for fire.
Helispots, pump chances, turn arounds, h20 areas for engines	GIS		Need to get all this information into GIS. This manuscripting was done at one time but the manuscripts have since disappeared.
TSHE/RHMA/ OXOR	Botanist, Silviculture		Field identify, input into SHAB layer and VEGIS
Private Lands	Private Landowners		Acquire stand information for GIS
LSR Assessment	District Specialists		Create an LSR Assessment Plan
Thompson's Mistmaiden	Botanist,		Manuscript on SHAB, input into VEGIS
WIN	Hydrologist		Link database to STR layer
Levels of Acceptable Change	Recreation		Link to dispersed site layer
STR	Hydrologist, Fisheries Biologist		Link SMART database to STR layer
White Oak	Botanist		Need field verification of white oak component of stands, input into GIS
Stream Temperautes	Aquatic Biologist, Hydrologist		Need stream temperature information for sites below Hills Creek Dam

B

Appendix B

Team Membership and Other Contributors

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C

Appendix C

Shady Beach Fire Document

SHADY BEACH FIRE

EFFECTS & REHABILITATION EFFORTS

D'Lynn Williams, Biological Technician

1995

Shady Beach Fire occurred in September and October 1988 and was comprised of 9,163 acres. Approximately 3,300 acres of this fire occurred within the Middle Fork Willamette Downstream Tributaries Watershed Analysis area. An Environmental Impact Statement was completed in June, 1989 and is the main reference document for this summary.

"In addition to the fire-kill of merchantable timber, the fire had important effects on wildlife habitat, water quality, and long-term site productivity. There were some minor direct fire effects on soils but most of the site productivity effects involve reductions of organic material that affects nutrient supplies to the soil. Mass wasting would be increased on steeper slopes near stream channels where the fire has consumed all slope stabilizing woody material." (p.S-4)

Geology & Soils

"On landslide-prone slopes where forest fires have killed most of the vegetation, pre-existing landslides may be reactivated and new landslides may occur. "(p. III-3) " Soil-erosion potential is aggravated by the rerouting of water associated with road drainage. Roads may intercept ground and surface water, concentrate it, and route it into land areas that may not be able to absorb additional water input without some slope failure. Road placement and construction practices are the most important factors in minimizing the increase in erosion as a result of management activities in the analysis area."(p.III-10)

Water & Fish

"The quality of the water flowing through and coming from the analysis area and in the Hills Creek Reservoir is considered to be good except during high winter flows when turbidity may be high, or during summer low-flow periods when segments of some streams exceed 58 degrees F. Concerns for water quality have centered on turbidity (fine sediment that is suspended in the water), sediment loads (coarser sediments that are moved along a stream channel), peak flow increases, and water temperature. All these characteristics directly affect fish habitat and indirectly affect recreational experiences. In addition, sediment loads can affect downstream improvements such as the Hills Creek Reservoir which will eventually be filled with these fine and coarse bedload sediments. Other pollutants, such as sewage, hydrocarbons, or other toxic chemicals do not occur in this area." (III-11)

"Nearly all the streams in the analysis area have incised channels as a result of the erodible nature of the soils and parent material....most of the streams are in alluvial or colluvial material. Pieces of large woody debris play an important role in stabilizing alluvial channels. ...Streams within the fire area where this debris was partially or wholly consumed will produce high amounts of sediment during winter peak flows until the stored sediment moves out of the system or until stabilizing debris is replaced."(III-13)

"Stream temperatures have increased over natural levels as a result of management activities such as road construction and timber harvest.... The United States Geological Survey (USGS 1988) has monitored water temperatures at a stream gauge on Hills Creek from 1958 to 1984. These data show that the temperature of Hills Creek exceeds 58 degrees F. for 91 percent of the days recorded in August for the period of record. Temperatures as high as 70 degrees F have been recorded." (III-14 & 15)

"Studies show that the removal of forest cover increases streamflow and flood frequency. The effect is believed to be caused by a reduction in melting and evaporation losses and increased snow accumulations in cutover areas. (III-17)

"High flows from post-fire storms in the fall of 1988 have resulted in some channel erosion. The turbidity levels of the streams appears to have risen. ...Shoreline turbidity caused by summer wind-wave activity produces locally turbid water that extends as much as 200 feet from the shore at exposed headlands". (III-20)

"Fish in both the stream systems and the reservoir are affected by changes in water quality. Stream temperature affects the amount of dissolved oxygen that water can absorb....Sedimentation affects the structure of spawning beds and by suffocating juvenile fish or by trapping them in spawning gravel." (III-21)

Wildlife

"The analysis area provides habitats for a wide variety of animal species that can be considered typical of western Cascade Douglas-fir forests....The analysis area provides winter and summer habitat for Roosevelt elk, black-tail deer, cougar, black bear, coyotes and numerous small mammals....The winter range provided within the analysis area is a particularly important and limited resource. In part, this is due to the loss of about 2,000 acres of valuable winter range that was eliminated with the construction of the Hills Creek Reservoir and in part due to the fact that the site of the City of Oakridge was once part of this low-elevation winter habitat....Road use, whether from logging, recreational activities, or hunting is the main human activity besides hunting that has the largest effect on these elk herds. Disturbance by road traffic increases stress on the animals by causing them to expend energy and driving them away from forage. (III-32)

Cultural

There are 25 inventoried prehistoric sites in the Shady Beach Fire analysis area. All these sites are estimated to date from prehistoric times to about 2,500 years ago. It is thought that all these sites represent hunting and gathering camps since no indication of any permanent dwellings have been found. Of the 25 sites, 10 are located within the fire area. Of these 10, eight have been disturbed by previous road-building or timber-harvest activities. The undisturbed condition of the remaining two sites is enough to make them eligible for the National Register of Historic Sites. The fire had no effect on these sites. There are no known historic cultural resources located in the analysis area except for the old Central Oregon Military Wagon Road and a homestead site located at the bottom of Hills Creek Reservoir."(III-40)

Rehabilitation Efforts

Aerial seeding and fertilizing was completed in October 1988 to help prevent excessive erosion possibilities. Item 1.8 Bull Creek (244 acres) was fertilized using 12.2 tons of 20-10-15-7 fertilizer and 4880 pounds of Shady Beach seed mix. Item 1.9 Modoc Creek (87 acres) was fertilized using 4.35 tons of 20-10-15-7 fertilizer and 1740 pounds of Shady Beach seed mix. The Shady Beach seed mix consisted of 40% Orchard grass, 50% annual ryegrass, 10% Dutch white clover by weight. The decision to use non-native plant species was made because of the lack of native species' seed available and the prohibitive costs of this seed. Introduction of non-native species and the possibility of noxious weed species is always a concern. The Shady Beach seed mix which was used had been certified by the State.

Additional rehabilitation efforts included: installation of silt fencing and hay bales to catch sediment from surface erosion sites before the runoff entered stream channels; installation of hay bales within stream channels to catch sedimentation; installation of additional catch basins to serve as settling ponds to prevent transportation of sediment; seeding/fertilizing of several miles of firelines within the Watershed Analysis area of the Shady Beach Fire, and large material placement on steep slopes to prevent surface erosion.

Several temporary roads were closed to benefit big game and to help decrease erosion potential. In particular, Road 2302200 and its spurs were considered maintenance problems and closed immediately after logging. The 220 spur of this system failed between construction in 1989 and logging the next spring.

road was built approximately 500 vertical feet above Rd. 2118 which is the east access to Hills Creek Reservoir, so was a major concern of sedimentation directly to the Lake. The Forest Service installed silt fencing and hay bales to stop sedimentation from entering the Lake, and the road was closed for the winter to allow the surface to dry out before use. The road was reconstructed in Spring of 1990 and all timber was cut and hauled that summer. The road was bermed the fall of 1990.

The size of an existing slide on Rd. 2302 at the top of Tufti Mountain was increased by the effects of the Shady Beach Fire. Several road surface/fill failures occurred after the Fire and during/after subsequent salvage logging.

A slide on Rd. 2118 south of the mouth of Modoc Creek has been triggered since the Fire. This slide is several acres in size. The Forest Service is currently studying the area to determine an appropriate rehabilitation method.

Reforestation efforts for the Shady Beach Fire have been a challenge--many of the units have been planted three times and barely meet the NFMA (National Forest Management Act) direction for stocking levels.

The need for snag habitat for future years has been supplemented by partial topping green trees. The purpose of topping these trees is two-fold: reducing windthrow potential, and introducing heartrot into the crown of the trees to provide snags in 20 or 30 years. Snags are an integral part of a "natural" forest.

D

Appendix D

Fire Document

Fire Input

Charlie Rasler, Fire and Fuels Management

1995

Fire History

Because of the importance of fire in shaping vegetation structure, density, and species composition, it was felt that an overall description of the fire history and present risk in the Watershed was appropriate and important part of the analysis of the biological domain.

The information in this document is based on what is know about the fire history of the Middle Fork Willamette Downstream Tributaries Willamette Watershed. Currently, the likelihood of fires that are primarily stand replacement events is not very high. Replacement fires in the modern era are significantly less frequent and smaller than they were between the years 1680 through 1918. This century, fire suppression activities have also repressed low intensity fires. Natural underburns, which are fairly easy to control, have been virtually eliminated.

Between 1949 and 1994 there were 383 fires and the largest of these was a portion of the Shady Beach Fire in 1988. This human caused fire burned approximately 3,300 acres in this watershed----total acres for the fire was 9,987. Below is a list of fires that were 15 acres or bigger, before 1949 records were poor and scattered:

Fire Name	Year	Acres	Cause
Shady Beach Fire	1988	3,300	Human
Packard Fire	1987	255	Human
Salix Fire	1985	15	Human
Bohemia Fire	1980	518	Human
Deadwood Creek Fire	1966	50	Human
Buck Creek Fire	1952	40	Human
Johnson Meadows Fire	1919	420	Lightening

The rest of the fires were under 15 acres - leaving 376 fires. 271 were lightning and 112 were human caused.

The Middle Fork Willamette Downstream Tributaries Willamette Watershed has a relative low risk to moderate risk of significant fire, since this area typically receives a greater amount of moisture. The moisture decreases the likelihood of significant fires. At the same time, the MFWDT Watershed is one of the highest fire areas for Willamette National Forest.

Continued fire suppression will result in increased in mortality, species conversion to plants less resistant to fire, and further accumulation of both horizontal and vertical fuels. Without the reintroduction of fire or other treatments that mimic fire, the likelihood of stand replacement fires will continue to increase, and overall forest health will decline.

"Fire has been an important disturbance process in the western Cascade Mountains landscape," (Teensma,1987 & Morrison and Swanson, 1993). "In temperate forest ecosystems fire influences species composition and distribution, initiates succession, controls the patterns and scale of the vegetation mosaic and governs ecological processes by regulating fuel accumulations. Fire is also important in maintaining wildlife habitat, reducing forest insects and diseases, and influencing ecosystem stability and diversity" (Burke,1979; Teensma,1987; Morrison and Swanson, Swanson, Agee,1993).

Fires of varying intensities and diverse temporal and spatial extent have resulted in an extremely complex mosaic of forest composition and stand age stand age structure. This complexity of forest composition and structure has created a diversity of habitats for biological organisms.

"The maintenance of this rich biological diversity might be achieved by managing the forest landscape more closely along the patterns of natural disturbance. The patterns of historical fire occurrence and extent might be used as "template" for forest management" (Connelly and Kertis,1991).

Fire

Periodic fire has been a normal and recurring component of the Middle Fork Willamette Downstream Tributaries Watershed since the retreat of the last glacier. The forests periodically experience both large and small disturbances that destroy less than an acre, to thousands of acres at a time. New forests regrow through a succession of plant communities and forest structures.

Many fires were probably ignited by lightning, particularly along prominent ridgelines. Fire spread depends on a host of climatic and fuel factors including fuel biomass and moisture content, ambient air temperature, humidity, wind direction, and wind speed. Fires may be localized small events that follow topographic contours related to parameters of weather and fuels. Conversely, during drought conditions and extreme fire weather, fires may be topographically independent.

A probable scenario is that a stand replacement type fire burned through an area creating lots of snags and over time, a large amount of fuels on the forest floor. Several years or decades later, a second fire came through that was carried by these heavy fuel loads and burned up snags and down wood and the duff layer even more thoroughly than the first fire.

FUEL LOADING AND MODELS FOR THE WATERSHED.

A representation of fuel loading and an average site condition was arrived at by Ecosystem Plot --- (a series summary of this watershed), this will be arranged by dead fuels. A average for each fuel size class, the fuel size class will be catagorized by 1,2,3 and 4, 1 being the lowest and 4 being the highest, this will be described in the natural forest residues in common vegetation photo series - (USDA Forest Service General Technical Report Pnw-105 May 1980 - Types OF The Pacific Nothwest) The Residue Descriptive Code in the upper right hand corner will be the fuel class. Also Aids to Determining Fuel Models for Estimating Fire Behavior (General Technical Report Int - 122) April 1982 Hale Anderson will be used as a guide for estimating fire behavior in these types of fuel size class, these will be fuel Model 8 and 10.

Natural stands were categorized as stands with 0-3 inch material less than 5 tons per acre >5t/a or greater than or equal to 20 total tons per acre >=20t/a were given a fuel model 10 (FM10).

Stands with 0-3 inch material less than or equal to 5 tons per acre <=5t/a and less than 20 total tons per acre <20t/a were given a fuel model 8 (FM8).

Fire Behavior for Fuel model 8, Slow burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional jackpot or heavy fuel concentration that can flare up.

Fire Behavior for Fuel Model 10, The fires burn in the surface and ground fuels with greater fire intensity than the other timber litter models. Dead down fuels include greater quantities of 3 inch or larger limbwood resulting from overmaturity or natural events that create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation, leading to potential fire control difficulties.

Fuel Loading class and Fuel Models, For the MFWDT Watershed

Fuel Model	Fuel Loading Class			
	1	2	3	4
8	23%	35%	0%	0%
10	0%	0%	26%	16%

FM 8 - Fuel Loading 1@2 total for watershed 55%

FM10 - Fuel Loading 3&4 total for watershed 42%

The fuel models that were used are the most common there could be a mix of fuel models in this Watershed, the other models that would fit most likely would be FM 5 which is a Brush model--(Fires are generally of low intensity as surface fuels loads are light), The other fuel model would be a FM 12---(logging slash or wind, floods), Fire Behavior would be Rapidly spreading fire with high intensities capable of generating firebrands. The amount of the FM 8 will change as time goes by and most likely the fuel model will go up to model 10. conclusion the historic role of fire is an important element of baseline information useful in integrating fire strategies with the larger land management picture. It can be helpful in estimating which species are likely to dominate and Fuel Models the landscape if fire is eliminated as a management tool, and which species will have a relative advantage in the presence of fire.

Fire models and Conclusion.

In general, fire is less prevalent on today's landscapes than in prehistoric times, due to effective fire control policies. Ironically, success in fire suppression has allowed more uniform and increasing fuel loads across the landscape, shifting forest fire effects that were typically of low and moderate severity in historic fires to more severe fire effects today. Fire management objectives must be broader than simply fire suppression if broader goals are to be met. Prescribed fire, and in some cases natural fires, may be useful strategies to integrate with fire suppression to meet land management objectives.

Effects of fire intensity and consumption

The moisture content of a fuel determines if the fuel will ignite readily and how it will burn (Table 22.1). Dry fuels ignite readily and burn efficiently. Fire intensity (in units of Btu per ft per second) is a rate of the amount of heat production at the flaming front of the fire. High intensity, resulting from efficient combustion, indicates high temperatures. Temperature thresholds are critical for killing living tissue (e.g., unwanted vegetation or seed) and chemical reactions (e.g., volatilizing nutrients). Low intensities result from scant fuel loadings or inefficient combustion of moist fuels. Inefficient are too moist to ignite on their own may dry out as surrounding, drier fuels provide heat to drive off that moisture. How quickly the moist fuels dry controls duration. Tables 22.2 Summarize the influence of fire intensity and duration on consumption and the subsequent effects on resource values.

Fine fuels (smaller than 3 inches in diameter) are the first to ignite during a fire. They act as kindling, burning rapidly because of their low moisture content and high surface-to-volume ratio. Fuel managers prescribe moisture contents of the fine fuels low enough to allow the spread of the fire throughout the area intended to be burned. These low fuel moistures insure nearly complete consumption of the fine fuels (Fig. 22-1)

In general, large fuels (greater than 3 inches in diameter) burn according to their moisture content, provided that the small fuels are dry enough to consume and ignite the larger material. During the flaming stage of the fire, fine fuels are consumed. The heat generated from this consumption serves to ignite and sustain the consumption of larger logs. After the flaming front has passed, large logs continue to smolder until the moisture within them quenches the fire. If fine fuels are dry enough to be totally consumed during the fire, the percent of large fuels consumed is proportional to the moisture content of those large fuels. Hence, reducing the amount of large fuels prior to burning, or burning when their moisture content is high.

Large, decaying logs are usually slow to ignite because of their relatively high moisture content. Consequently, once lit, they burn primarily during the smoldering phase of the fire.

22.1

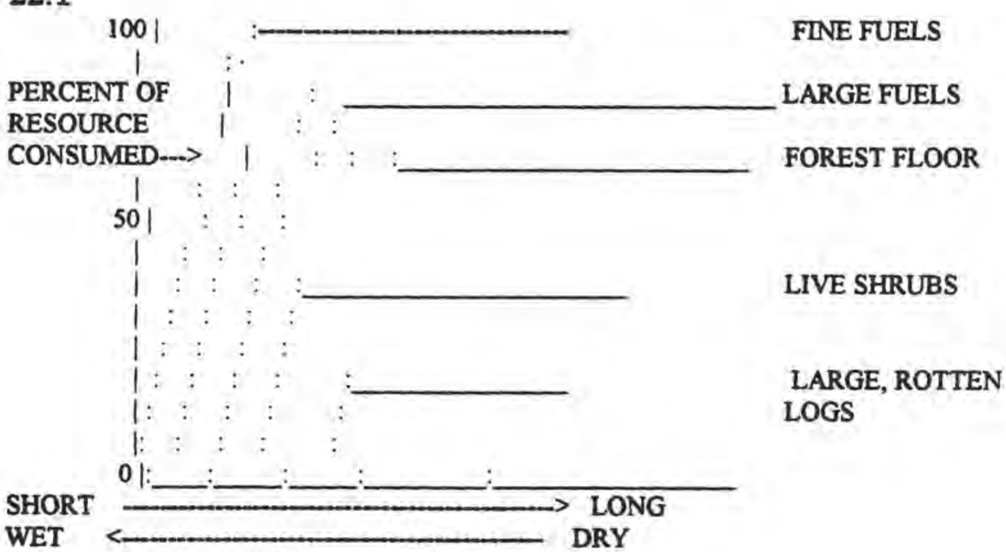

Figure 22-1 . Relationship of fire duration and moisture content to the amount of resources consumed.

Table 22-2 Effects of fire intensity and duration on resources

	High Intensity		Low Intensity	
Fuels and Fires	**Long Duration**	**Short duration**	**Long Duration**	**Short Duration**
Consumption of fine fuels	Nearly Complete	Nearly Complete	Incomplete	Incomplete
Consumption of Large Fuels	High consumption; with smoldering	Low consumption little smoldering	consumption varies; occurs mostly as smoldering	little consumption little smoldering
Consumption of forest floor	High consumption; long smoldering	Consumes only dry forest floor	Mostly smoldering consumption	Very little consumption
Mortality and consumption of live shrubs and trees	High mortality; high consumption	High mortality; some consumption	Some mortality; low consumption	Some defoliation
Exposure of mineral soil	High exposure; some damage to chemical and physical properties	Depends on forest moisture	Some exposure	Little exposure

Historic Information

This area is dominated by timber stands averaging 100 to 160 years old, a date which coincides with the cessation of aboriginal burning in the area. General Land Office survey maps from the mid-1800's show that much of this area had been burned over, due to fires that may have been of annual frequency, as had been reported for the Willamette Valley by the exploring expeditions of the have been a Molala winter village, (Baxter,1986), and was maintained as an oak woodland. Prairie landscape into historic times, lends credence to the notion that the Middle Fork drainage was annually intentionally burned off (Winkler,).

Thus it seems likely that both annual firing of the prairies and underburning of the forest were intentionally utilized by native peoples throughout the Willamette Basin to increase the range and abundance of game and edible and useful plants. According to John Minto, an early Oregon settler: "Fire was the agency used by the Calapooia tribes to hold their camas grounds and renew their berry patches and grass-lands for game and the millions of geese, brants, cranes, and swans which wintered in Western Oregon...On the west face of the Cascades the Molallas claimed dominion, and fire was their agency in improving the game range and berry crops (1908).

"Frequent fires swept the forest floor and very little old growth timber exists here as well as elsewhere in the district that does not show fire scar or charred wood at the base of the tree trunks. There fires were either from lightning or from Indian burning of prehistoric days. Early pioneers claim that the forest floor was so open that stock and horses could be driven or ridden through the timber in many places. It is said only in the last twenty years has the present dense thickets of brush and saplings growth made its appearance. Younger stands are more noticeable which aids the thought of man made-light burning (Breim,1937).

Native American ignitions would, of course, alter the natural range of variability for fires. "There are at least 13 documented reasons for American Indians ecosystem burning. "(Williams 1994). The emerging evidence of extensive burning in the Northwest reinforces the belief that the Native American attitude towards the role of fire in the ecosystem is nearly opposite of the views today. Unfortunately, there is no documentation that specifically records the use of fire by Native Americans.

In his analysis of the developmental history of dry coniferous forests in the central Western Cascades, Means (1980) found, "that dry site stands are burned at intervals averaging 100 years,(and probably less), by fires that destroy only a portion of the canopy, resulting in uneven-aged stand structures which are in striking contrast to the usually much more even-aged structure of Douglas-fir on moister sites. The fact that such periodic, non-catastrophic fires are common on dry sites in the pre-fire suppression period suggests the possibility of intentional underburning by aboriginal peoples." Thus the pre-1850 fire-adapted forest had an open character and greater species diversity than the present closed forest, a result of fire suppression.

Settlers used fire extensively. Ranchers preferred fire to rejuvenate their fields: To kill previously-girdled trees, a rancher set fire on the lee side of ranch buildings and allowed to burn across his field; "no effort whatever was made to prevent it from reaching the neighboring timber. Even his own fences would fall as prey to devouring element, which a high wind soon places beyond his control" Gorman,1899).

Gorman continues, "Among the principle causes of forest fires may be named sheep herders, campers, hunters, prospectors, miners, trail and road makers, and the settlers. The first named are generally most culpable. Fires were rarely extinguished before the fall rain or until they burn out for lack of material on which to feed."

This information was taken from the Historical Vegetation map of the Watershed. The Forest surveys correspond to county boundaries. Lane County maps postdate 1949 and Douglas county maps predate 1947. The codes used in this map are major vegetation codes which provides data as to dominant tree species and size.

Table Decades of Historical Fires for MFWDT

Age of Stand in Years	Year of Origin Range	Acres	% of MFWDT
300 - 500	1495 - 1695	61,464	56%
140 - 160	1835 - 1855	23,475	23%
80 - 119	1876 - 1915	13,728	11%
Non-forested		6,145	6%
seedling		4,719	4%
Total Acres		109,531	100%

Fire has played a very important part in this Watershed. Past wild fires occurred relatively frequently. The 300 to 500 year old stands have had not just one stand replacement fire over the period of time but have had several fires. Stand replacement fires burned through creating lots of snags and created a large amount of fuels on the forest floor. A second fire came through that was carried by the fuel loads. Some of these areas have been burned four to five times depending on the season and other factors such as temperature, aspect, slope, live fuel moisture, wind, and fuel loadings. This information was gathered from field surveys, fuel photos, ring counts and the vegetation map.

This Watershed has been burned just about throughout the whole area. About seventy-eight percent has had some type of fire in it. The period of time would be from 300 years to 160 years old, 12 percent of the Watershed has burned about 80 years to 119 years ago. Stands that are seedlings and samplings are about 50 years of age represent about 4%, the rest is nonforest 6%, since 1949 there has been 383 fires in the Watershed. 271 were lightning fires and 112 were human caused. Modern fire control policies have been effective at reducing acreage burned by free ranging wildfire. Ironically, success at fire suppression has allowed more uniform and larger fuel loads across this Watershed that could result in more severe fire effects. The objectives of fire management must be broader than simply fire suppression if land management objectives are to be met. Simply fire has been a big part of the disturbance factor for this Watershed.

In 1910 the Forest Service established a fire suppression policy. Steady advances in fire control including the use of telephones quickened the response time of organized fire fighting crews. A primary duty of personnel staffing guard stations was "in case of fire, become acquainted with the trails, springs, campsites, and the presence of horse feed. The Great Depression emergency programs contributed to improvements and fire control, including construction of roads which increased access to fires in the area. Consequent construction of lookouts and stringing telephone wire reduced detection and reporting time.

The establishment of organized fire fighting crews, smokejumpers, prevention programs, state of the art communication, aerial retardant, helicopters, fire detecting aircraft, sophisticated computerized dispatch, and line resources available all helped to minimize acreage burned by wildfire in the watershed.

Lightning and Human Caused fires in the MFWDT Watershed

Lightning Fires	271
Human Caused	112
Total	383

95% of the human caused fires are along Hills Creek Reservoir and Road 21 to the end of the Watershed --South End--around Campers Flat. The lightning caused fires are evenly dispersed throughout the Watershed. All information was taken from individual fire reports, we have fire records going back to 1949 also have a fire map with individual areas of the fires. From 1949 until the present time we have an average of 8.5 fires a year, but this is just a point in time for the measurement and it could be a lot lower or higher. Fire history - past wildfire occurrence has been relatively frequent in the Watershed area and has played a large part in driving plant succession, creating stand structure and determining the amount of fuels in the Watershed.

Fire Regimes

Fire suppression since the turn of the century has resulted in a disruption of the natural fire cycle, causing a decreasing frequency but increasing intensity of fires (Agee, 1993). The change in fire frequency, management, has changed vegetation and fuel models, therefore changing fire intensity.

Today's high hazard conditions are in those areas that are now overstocked in the understory. Historic insect and disease occurrences were kept in check by a mosaic of fire-regenerated succession stages that limited insect and disease outbreaks to relatively small acreage. Those areas were periodically cleansed by wildfire.

The long term health of the Watershed ecosystems is strongly linked to the public's perception about fire in their forest and fire management strategies that will be constructed and implemented in the future.

Table Relative Fire Resistance of The Most Import Trees of Oregon and Washington in Order of Greatest Resistance

Species	Bark Thickness of Old Trees	Root Habit	Branch Habit	Canopy Cover	Lichen Growth and Color	Foliage Inflammability	Most Common Way of Killing
Western Larch	very thick	deep	high & open	open	light/black	low	most resistant
Douglas-fir	very thick	deep	high&dense	dense	none-heavy/gray	high	crown fires
Ponderosa Pine	thick	deep	moderately high & open	open	light/black	low	crown fires
White/grand fir	moderately thick	shallow	low & dense	dense	none-heavy/gray	medium	root char, crown fire
Western redcedar	thin	shallow	low & dense	dense	none-moderate/gray	high	root char, crown fire, burn down
Mountain Hemlock	medium	medium low	low & dense	dense	none-moderate/gray	high	root char, crown fire
Noble fir	moderately thick	medium thick	high & dense	dense	medium-heavy/gray	high	foliar scorch or crowning, core burn
White pine	medium	medium	high & moderate	dense	moderate/gray & heavy	medium	scorching cambium or crowning
Lodgepole pine	very thin	deep	moderately low & open	open	moderate-heavy/gray, black	medium low	scorching cambium or crowning
Western hemlock	medium	shallow	moderately low & dense	dense	non-heavy/gray	high	root char, crown fire, core burn
Engelmann spruce	very thin	shallow	low & dense	dense	none-heavy/gray, black	very high	root char,scorching cambium, crowning
Sitka spruce	very thick	very shallow	moderately high & dense	dense	none-heavy/gravy, yellow	high	root char, occasional crowning

Tree ring counts, fire scars, historic vegetation maps and aerial photos were used to construct a rough fire history for the Watershed. These observations corroborate fire patterns described by studies done in the Central Cascades (Swanson and Morrison,1990). from these observations it is possible to reconstruct a fire regime in which fires played a large roll in shaping south and westerly aspects, from very high intense fires to low intensity underburns - depending on the time of year and fuel loading, some of these fires that were highly intense on these types of aspects, leaving occasional Douglas-fir survivors to reseed the area.

Brush fields and grasses often grew up in these areas, especially where burned stands re-burn shortly after the initial fire, resulting in a rather slow (perhaps 30 to 60 years) return to canopy forest we see today. The term reburn is used here to describe fires which burn in a fuel bed of snags, brush and grasses created by an earlier fire. Reburns may retard the of closed forest.

On north slopes, flats and in the deeper canyons, fires have been less intense, and may have alternated between low intensity underburning and infrequent stand replacement fires.

On ridge tops and upper side slopes, fires played a role in the maintenance of meadows and restricted tree survival to rocky micro sites, where fuel to carry fires was lacking (Agee,1990).

Fire created snags and coarse woody material have historically existed in large quantities during periods of stand development in all forested series present in the fire area, especially during the early regeneration phase (Scott,1980). In totally killed stands on harsh southerly slopes, such fire remnant snags provide shade and other microclimate moderation for conifer seedlings.

Effects of Fire on Water Quantity and Quality

The effects of fire on the hydrology and water quality of forested watersheds are varied in time and space. Wildfires that destroy overstory forest vegetation will generally increase annual water yields; this increase will decrease with time as regrowth of forest vegetation occurs. Short-term increases in base flow may also occur. Prescribed burning will generally have little impact upon water yields.

Catastrophic wildfires and hot slash burns can cause undesirable impacts to the water quality of forested mountain watersheds. Accelerated erosion represents one of the primary problems associated with these types of burns. Erosional effects become increasingly greater as terrain steepness increases. Where logging slash is machine piled and burned, the piling operation is more likely to cause accelerated surface erosion than either the burning of scattered slash piles or broadcast burning without piling.

Where low-severity burns occur, much of the organic matter comprising the forest floor may remain following burning. In these situations, the effects of burning are generally insignificant with regard to a wide range of hydrologic and water-quality variables.

In a few studies of small watersheds, increased concentrations of selected ions have been measured for several days following burn or during the first couple of rainfall events after the fire or burns. However , in most studies, either no change or relatively small changes in nutrient export have been found within the first several years following burning. A concurrent increase in water yield due to the loss of overstory vegetation by wildfire or harvesting may limit concentration increases (because of dilution effects of many nutrients.

The MFWDT Watershed is made up of many fuel Models, but as a whole, the main Fuel Models are 8 and 10 and the majority of the Watershed has had some type of historical fire history in it. The unpredictability of many fire effects upon water resources relates, in part, to the wide range of topographic conditions, site differences in soil characteristics and moisture content, variations in fuel moisture and fuel loads, density of vegetation, various microclimates associated with a given slope, aspect and topographic position, and variability in weather patterns before, during, and after the occurrence of a fire. The result is a mosaic of fire severity and effects across a hillside or landscape, even from the "same" fire. In similar fashion, hydrologic processes across the landscape are affected to various degrees.

Although wildfires and/or hot slash fires can affect stream conditions and water quality, research results indicate that prescribed burning, judiciously applied with an awareness of potential onsite and offsite impacts, can be used without causing significant changes to the water quality of streams draining forested ecosystems in the Pacific Northwest---(Natural and Prescribed Fire in Pacific Northwest Forests-Robert L. Beschta 1990). For those advocating prescribed burning as a necessary and important forest management tool, the hydrologic challenge is quite simple. Fire prescriptions should be planned and implemented to prevent the occurrence of severe burns. In doing so, any potentially adverse impacts to the hydrology and water quality of forested watersheds will generally be minimized.

Prescribed Burning

Prescribed burning is a valuable technique in the management of natural resources. Use of this technique involves a systematic series of decisions beginning with the overall philosophy and goals of the organization and culminating in a thorough evaluation of burns after they are completed. Intermediate steps in this process include reconnaissance of the proposed areas, obtaining permits and resources needed, checking weather and fuel conditions, selecting ignition patterns and tools, conducting the burns, mopping up, and documenting the results of the burns.

The effects of fire on vegetation are still not completely understood, nor are the interactions between fire and of the disturbances such as floods, logging, grazing, and introduced species.

Current trends in fuel accumulation will increase the likelihood of extreme fires in the future. Carefully controlled prescribed fires may be an effective way to reduce fuels and perpetuate desired plant communities in the area.

Compared to historic or modern-day wildfires, prescribed burns are generally much smaller and less intense. This reduces the impacts on other resources.

Acres of fire activities and management on the MFWDT:

BCB	Broadcast Burns	16,542.83 acres
Y.B.	Yarded and Burn (Decks)	2,483.87 acres
BMP	Burn Machine Piles	151.75 acres
M.I.	Manual Ignition	131.71 acres
	Total	19,310.16 acres

Total Acres under some type of management activities	34,869.20
Total acres that were treated with prescribed fire	19,310.16
Total of acres not treated with prescribed fire	15,559.04

Thre was no data on Hand Piling and Burning, Aerial Ignition and Underburning

Uses of Prescribed Burning

1. Site Preparation.
2. Reduces Fuels
3. Favorable seedbed
4. Regulation of stand composition
   Decrease the number of some tree species.
5. Reducing competition
   Competition from shrubs and trees in a developing stand can be reduced by burning
6. Insect and disease reduction
   Fire may be important in reducing insect and disease problems.

7. Fire hazard reduction
   One important use of fire is to reduce or modify fuels to lessen the likelihood of wild fires and ensure that those that do occur will be less damaging and easier to control.
8. Wildlife habitat management
   Prescribed fire is often used to improve wildlife habitat.
9. Range improvement
   Livestock forage is generally improved by fire.

Water Management

Prescribed burning is a tool that can help land managers achieve management objectives. Fire may be used alone or in conjunction with other tools-mechanical, manual, chemical, or biological to achieve desired ends. Prescribed burning is an important tool because of its versatility, usually low cost, and ecological similarity to natural fire in many respects. Prescribed burning may simulate prehistoric fire regimes, or it may be quite distinct from them, depending on the conditions of use. It is the overall short and long term results of prescribed burning that are the measure of its success.

Air Quality

The Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl, Volume I, states in chapters 3 & 4 on pages 96-98 that for the selected Alternative 9, PM10 emissions and Total Suspended Particulates (TSP) emissions have dropped and currently exceeds goal of 50 percent reduction of these emissions by the year 2000 for the State of Oregon. This reduction will allow for fire use and will not compromise our ability to reach prescribed burning emissions reduction goals. The production of smoke from wildfires is considered natural and exceptional by air resource managers, so does not influence the regulations of prescribed fire emissions. In the publication A First Approximation of Ecosystem Health on National Forest System Lands, (Pacific Northwest Region, June 1993), an assessment was completed that compared smoke emissions and acres burned annually from presettlement times to current smoke emissions due to wildfire and prescribed fire. For Western Oregon, historic estimates were more that double current estimates of PM10 emissions and acres burned.

E

Appendix E

Social Documents

Reference Conditions for the Social Domain of the Middle Fork Willamette Downstream Tributaries Watershed

Frank Carson, Recreation Forester

1995

Settler activities began in earnest in the Oakridge area in the mid 19th century with the settlement of the Sanford Ranch in 1860, which was later subdivided in the year of 1909 into tracts for the town. Use of the natural resources in the area began with grazing and logging. In 1875, the first logging on the Middle Fork was done above Deception Creek for sugar pine logs by a man named Packard. Moving on up river, the Grays Creek Project was logged in 1905, by J.B. Hills. Stumpage price was $ 0.25 per thousand board feet.

The origin of the names of some of the streams and mountains are as follows:

Bristow Prairie was named for Elijah Bristow, founder of Pleasant Hill. He hunted this prairie and his descendants were the first to run cattle there.

Coffee Pot Creek was named for a coffee pot that fell off of an emigrant's wagon and was run over by a wagon wheel.

Packard Creek was named for a logger who took a contract for getting out sugar pine logs in the early 1870's.

Tufti Mountain was named for Indian Charlie Tufti.

Staley Ridge and Staley Creek was named for W.F. Staley.

Recreation

Wheeled access to the area was first provided by the construction of the Oregon Central Military Wagon Road. Although dispersed camping took place at an early date, the developed campgrounds in this Watershed were largely constructed in the mid to late 1960's. An exception was the Campers Flat area which was a well established campground used extensively by Native Americans as late as 1910. Packard Creek, and Sand Prairie Campgrounds and CT Beach Boat Ramp and Picnic Area and Gingham Boat Ramp were built in response to the construction of Hills Creek Dam and pooling of Hills Creek Lake in 1961.

Cline-Clark Picnic Area was constructed in 1962 as a memorial for two local boys that drowned in an accident in Advise Lake in the late 1950's.

Other campground construction during this time include Secret, Cynosure, and Campers Flat Campgrounds. Cynosure Campground was washed away during the 1964 flood as the Middle Fork Willamette channel moved. All that remains is a small area for a dispersed campsite. This campground was located between Secret and Campers Flat. An interesting note by a retired Forest Service employee was that during the beginning of the storm, they were driving by Cynosure campground and noticed that the river was running through the campground so they chained one of the picnic tables to a tree to keep it from washing away. After the flood receded, not only were the picnic table and tree gone, so was the entire campground.

Recreational use within the Middle Fork Willamette Downstream Tributaries Watershed had steadily increased over the years. Estimated recreational use which largely takes place in the vicinity of Hills Creek Lake has been a combination of estimates and counts from camping fee envelopes and survey forms.

Visitation Data in Thousands of Recreation Visitor Days

YEAR	RVD'S
1985	85.0
1986	84.7
1987	82.4
1988	90.0
1989	90.1
1992	91.1
1993	126.6
1994	122.3

It has been observed that years when Hills Creek Reservoir does not fill to full pool, recreational use such as swimming and other water sports such as water-skiing become almost nonexistent, and camping in the Packard Creek Campground drops as much as 50 percent. This not only is a reduction in recreation use but also a significant reduction in camping fee collections in the fee campgrounds.

Until the major road construction activities of the 1970's and 1980's, trails were the facilities that provided the access to much of the Watershed. As of the early 1960's, and much of the district western portion of the Watershed was unroaded and many trails that had been the transportation facility were still in existence. There were at least seventeen major trails, with so me still in the current trail maintenance system, totaling 89.2 miles. These trails included:

Major Trails in the MFWDT

Trail Name	Length (miles)
Larison Rock	4.3
Larison Creek (on ridgetop)	7.4
Minick Way (current Larison Creek)	5.8
Dinner Ridge	7.0
Packard Creek	5.8
Rocky Point Way	4.0
Grass Mountain	5.6
Johnson Meadows	4.2
Indian Creek	5.4
Bristow Trail	4.4
Staley Ridge	10.7
Coal Creek Way	5.8
Moon Lake Way Staley Ridge	3.0
Pine Creek Way	1.7
Star	2.3
Tufti Mountain	5.1
Holland Meadows	6.9
Calapooya Trail	31.0
Total	120.1

Except for Dead Horse, Moon Lake, Pine Creek, Star, and Tufti Mountain, the trails all accessed the Calapooya Divide. These mileage's are approximate and taken from a 1950 district map. Already, roading was in the process of reducing trail mileage by this date. By the mid 1970's, much of this trail mileage had been eliminated due to logging roads being placed over the top of or segmenting these old transportation routes. It should be pointed out that at one time these historic trails, with many of the trails being built during the CCC era of the 1930's, were the only facilities available to provide access to much of the Watershed. After roads provided vehicle access to the same areas originally accessed by these trails, use dropped off considerably since these trails did not provide a recreation experience except for hunting and there was no real need to continue to maintain the remnants of these trails.

In 1983 an environmental analysis was written to evaluate the trails management program and write a trail operation and maintenance plan. The environmental analysis reviewed existing trails and dropped the maintenance of many of these trails and recommended the construction of 68.5 miles of more recreationally oriented trails across the ranger district of which there were 22.5 miles of proposed trail within the Middle Fork Willamette Downstream Tributaries Watershed. The longest of these proposed trails is the Middle Fork Trail. The Middle Fork Trail extends from the south end of Hills Creek Lake to Timpanogas Lake and is nearly completed. The 10.2 miles of Middle Fork Trail within this Watershed has become a popular hiking, fishing, and mountain bike trail.

TR9 - Although this Watershed contained some 89 miles of trail, approximately one trail per drainage for access to high ridges and mountain peaks, the impact of sedimentation was not significant since most trail treads are usually less than two feet in width and did present a large base surface as compared to roads. A visual review of trail location and SRI maps most of the trails were not locate din the highly erosive soil types.

TR11 - From the early 1900's to the 1960's, trails were the primary transportation system when the road system began to be developed in earnest. The trail network was the access to many of the higher elevation and essential in moving persons throughout the Watershed. This network provided access for administrative, public transportation, and recreational needs.

Lands

Land uses within the Watershed are varied. There have been numerous land exchanges within the past fifty years. One of the earliest exchanges involved 1,557.5 acres of land in the Packard Creek drainage. Pope & Talbot, Inc. exchanged lands along Lookout Point Lake for equivalent lands in Packard Creek.

In the 1954 Booth-Kelly land exchange, the Willamette National Forest acquired 1,080 acres on the Rigdon District, of which 160 acres were located at Moon Lake.

A large land exchange in 1969 with Pope & Talbot, Inc. involved 10,450 acres. The Willamette National Forest was able to acquire scattered Pope & Talbot sections along the Middle Fork Willamette River in exchange for two blocks of lands located in Packard and Larison Creeks and the Simpson Creek drainage. This exchange allowed the consolidation of lands adjacent to the Middle Fork Willamette River and gave to the Forest Service management of the riparian areas.

One of the final lands acquisition in this watershed was the 1989 settlement with Pope & Talbot, Inc. default on unlogged timber sales. Rather than make a cash settlement, P & T decided to trade a portion of their lands in lieu of cash. Although the acreage settlement amounted to 6,519.62 acres on the Rigdon Ranger District, only 120 acres were involved in the Middle Fork Willamette Downstream Tributaries Watershed. This 120 acres included bald eagle habitat that was felt necessary to acquire for National Forest System lands management.

A major commitment of lands for the City of Oakridge Liquid Waste Disposal Area (sewage treatment plant and irrigation area) involves 13 acres southwest of the city. This area contains the sewage treatment plant for the City of Oakridge and an irrigation area where the treated liquid waste (sludge) is spread by irrigation sprinklers. The sludge does not contain significant amounts of heavy metals and is not hazardous. Calculations indicate a site life of 40 - 50 years. Prior to the approval of the irrigation site in March, 1989, sludge was hauled by tanker truck to the Lane County Landfill on the Oakridge Ranger District. DEQ had only permitted this method of disposal on an interim basis since the landfill site was not well suited for this as a long-term site. The city of Oakridge reconstructed the sewage treatment plant in 1991 to comply with State of Oregon DEQ regulations. This area is eventually planned to be disposed of by the Forest Service to the city.

Other land uses that date back at least thirty years include memorandums of understanding and special use authorizations for Bonneville Power Administration powerlines, Lane Electric Cooperative powerlines, U.S. West Communications telephone lines, and Corps of Engineers Hydromet Station above Sand Prairie Campground on the Middle Fork Willamette River.

Construction of Hills Creek Dam began in May, 1956 and was placed in service for flood control in November, 1961. The project was completed in June, 1963. This project displaced structures located in the valley floor upstream from the dam site.

There are two long term recreation special uses, a black powder 1840's rendezvous that has used the Hills Creek Lake lower pool area in upper Larison Cove for the past 13 years, and a sports car hill climb competition on Forest Road 2102.

Minerals

Mining activities have not been a major activity within the Watershed. Traditionally, prospecting has been for gold and silver. Mining claims have also included barite in the upper Larison Creek drainage. The number of mining claims vary from year to year. This Watershed has always contained the largest number mining claims due to its proximity to the Bohemia Mining District which is located to the west. There always has been prospecting but never any major location activities. In addition, the Bristow Prairie area has been the object of the never ending search for the legendary Lost Frenchman's Mine. According to a 1961 mining claim record, there were 89 claims scattered throughout the Watershed. The claims were for both placer and hardrock. The search for types of minerals ranged from gold to uranium lodes.

Social

Although logging of the timber stands began over one hundred years ago, major efforts really began in the 1920's with the construction of the Westfir Lumber Company sawmill which was built by George Kelly, who had an interest in the Springfield Booth Kelly Mill. The economies of both Westfir and Oakridge were driven by the operation of the Edward Hines Lumber Mill (old Westfir Lumber Mill) and the later operation of the Pope & Talbot, Inc. lumber mill east of Oakridge. These two mills and Southern Pacific railroad fueled the economy of the Cities of Oakridge and Westfir. Timber harvest volumes began to rise beginning in the late 1960's and peaked in the middle 1980's. During this time, Pope & Talbot, Inc. liquidated its remaining timber stands in the Packard Creek drainage. Upon completion of removal of all the standing timber on private lands, Pope & Talbot, Inc. divested itself of all its Oakridge holdings. Prior to this, the Edward Hines Lumber Mill had closed which began the downward economic spiral for the number of business's and services in the Westfir/Oakridge area. As the major employers of the area disappeared, many people and families were forced to leave the area in search of new employment.

Visual Resource

The visual experience of forest visitors in this Watershed is of the Western Cascades which is characterized by a general conformity in ridge crests separated by deep valleys with moderately steep, dissected side slopes. Change in the Forest's landscapes in recent centuries was due primarily to wildfires, but since the early 1900's, noticeable change has been due to a variety of land and vegetation altering activities, such as road and railroad construction, timber harvesting, and dam building, as well as wildfires. Human-caused changes are most apparent in the Western Cascades character type, as evidenced by a mosaic of harvest areas in various stages of regeneration. Because of this landscape change, Forest managers recognized and wanted to manage portions of the landscape for its scenic value by establishing water and travel influence zones. The public's desire for scenic quality has increased over the years. As resource management activities have extended into previously undisturbed and undeveloped areas the public has become more vocal about protecting scenic values. This increasing desire for scenic quality in the Forest is partially reflected by increased demand for recreational opportunities in which scenic quality is an integral part, such as driving for pleasure, hiking, camping, and fishing.

The Willamette National Forest land management plan of 1977 originally allocated certain lands as Scenic I and II allocations that were to be sensitive to management activities so the resulting activities were not the dominant feature of the landscape in these land allocations. However, in the search for better direction, the Middle Fork Willamette Viewshed Corridor Study was initiated in 1987 and completed April, 1988. This study re-mapped the Middle Fork Willamette viewshed corridor and provided more direction in developing timber harvest units in the sensitive recreation corridor of the Middle Fork Willamette River. It was felt crucial to maintain the integrity of the scenic resource due to the high summer recreational use of this viewshed. The most critical portion of the viewshed is within the Middle Fork Willamette Downstream Tributaries Watershed as Hills Creek Lake is located here along with the most heavily used (recreation) portion of the Middle Fork Willamette Downstream Tributaries River. As a result of this, the current Willamette National Forest Land and Resource Management Plan refined the visually sensitive boundaries along the Middle Fork.

References

C.B. McFarland. Early History of the Upper Willamette Valley.

Trails - 1964 Rigdon Ranger District maps and USGS Quadrangle maps dated 1957.

Land Exchanges - Ridgon Ranger District files.

Jody Stix. Middle Fork Willamette Viewshed Corridor

Current Conditions
Frank Carson, Forester

Recreation

Trails

There are 31.5 miles of recreation trails that are maintained and listed in the forest trails inventory. These trails consist of a combination of trails constructed beginning in the 1930's to more recent times with trail construction still continuing. The most recent include Moon Point, Youngs Rock, Stony Creek, and the Middle Fork Trails. A listing of trails in the Middle Fork Willamette Downstream Tributaries Watershed are as follows:

Trail Name	Trail No.	Length in Miles
Dome Rock	3644	0.5
Larison Creek	3646	6.3
Moon Point	3688	1.1
Stony Creek	3696	.03
Youngs Rock Tie	3685	.01
Larison Rock	3607	4.3
Staley Ridge	3637	2.2
Youngs Rock	3685	5.4
Bearbones	3612	1.1
Total Miles		31.5

These trails provide access and recreational experiences more compatible with today's forest users. For example, the Moon Point/Youngs Rock trail is considered a premier mountain bike trail for the advanced biker. When combined with Roads 21 and 21 2129 a loop of 21 miles is available for mountain bikes. The Middle Fork Trail begins with the first 5.6 miles as easy and progressively becomes more difficult and technical for mountain bikes farther upriver. Another very popular but more difficult mountain bike trail is the Larison Rock Trail. Except for the Larison Creek and Larsion Rock Trails, all are currently open to motorized use though some not well suited for motorized use. An example of this is single log stringer bridges that can not accommodate motorized vehicles such as motorcycles. This is typical of the Middle Fork Trail and so this trail has become a popular hiking and mountain bike trail with some horseback riding use. All of the stream crossings where there are single stringer log bridges have fords for horse crossing of the streams.
When the 1983 Rigdon Ranger District Trails Management Plan was written, the emphasis was to maintain and/or build trails to accommodate hiker and

horse use. The major growth in the mountain bike industry due to the popularity of mountain bike use was not foreseen as a factor in trail construction and maintenance for mountain bike single track use.

Although recognized as a need by hikers and horseback riders, the need for loop trails has been emphasized by mountain bikers. Public input has requested the development of a trail system to be developed in the portion of this watershed immediately south of the City of Oakridge including Gray Creek. The identified need here is for trails close to the city and easily accessible from homes in the city. The idea of accessing trails without the need for driving great distances from one's home has been a common request from forest users for many years.

There are another five trails totaling 15.5 miles proposed to be constructed. A portion of the mileage will be located in riparian reserves as well as hill slopes and ridge tops. These trails are listed in Appendix D of the Willamette National Forest Land and Resource Management Plan. These trails are:

Name of Trail	Number	Length in Miles
Deception Way	3601	1.5
Alias Larison	3605	2.0
Larison Deception	3622	2.0
Gray Deception	2623	5.0
Total		15.5

Issue #3 - Trails

In this watershed, there are 16.6 miles of trail located within riparian reserves and 14.6 miles of trail located outside the riparian buffers. The watershed trail system traverses 26 different landtypes. Of these landtypes, seven are considered poor or poor to moderate for trail suitability. SRI landtypes in this group are 3, 6, 25, 35, 235, and 335. A total of 4 miles of trail is located within these seven landtypes. Limitations for trails are generally wet areas, muddiness, and unstable soils. As a whole, it is recommended that waterbars be added to trails located in all twenty-six landtypes. Trail condition surveys indicate that waterbars are necessary in the wet areas to direct water flows and prevent erosion and degradation to the trail tread. The major portion of the trail system tread is quite stable as noted from past years of maintenance.

(Recommendation: Future trail construction should consider tread location outside of the poorly suited SRI's).

TR11 - The massive road construction efforts for timber harvest in the 1970's and 1980's developed road access to the majority of the Watershed. The many miles of roads offered easy vehicle access that is desired feature by much of the public. The current 540 miles of road system has been maintained primarily with timber sale revenues. However with the declining timber revenues and shifted resource management emphasis, many roads are not being maintained to required maintenance levels and decisions have to be made to deal with this fact. Much of the road system impacts other resource values in the Watershed through deterioration and placing riparian areas at risk, fragmenting habitat, and the like. The abundant roads ensure greater hunting success for such species as elk, access for harvesting of special forest products, firewood gathering, and driving for pleasure. This translates into greater revenue from hunting licenses, firewood permits, and the need for purchases from merchants for supplies and services.

Developed

There are four campgrounds and two day use areas, of which two include boat ramps to access Hills Creek Lake.

Name	Number of Sites	PAOT's*
Cline-Clark Picnic Area	3	15
Packard Creek Campground, Boat Ramp and Swimming Area	33	697
Bingham Boat Ramp		60
Sand Prairie Campground	21	250
Secret Campground	6	30
Campers Flat Campground	5	25

* Persons At One Time

These sites are generally open year-round except Sand Prairie and portions of Packard Creek Campgrounds. All have reduced services during the winter months. From mid-April through September, the campgrounds are operated with full services. These services include water testing on a monthly basis for those sites that supply potable water. In addition, the lake water at the swimming area is tested during the summer for ensure a safe swimming area. Normally the swimming area test results are 500 - 750 coliform counts per 100 ml of water. State Health Division limits are a maximum of 1000 coliform counts per 100 ml of water. The testing has helped stopped rumors concerning contaminated waters in the swimming area. The campgrounds are then operated on a reduced service schedule for the period of mid-September to the end of November to accommodate persons during various hunting seasons. During the recreation season of mid-April through September, Packard Creek, Sand Prairie, Secret, and Campers Flat

Campgrounds are currently being operated and maintained by a concessionaire under special use authorization. These campgrounds are operated as fee sites. The special use authorization is in its second year and is renewable in increments of one year for five years.

Another form of recreational camping is the use of dispersed campsites which are located throughout the watershed, but largely concentrated along the perimeter of Hills Creek Lake and Middle Fork Willamette River. Other dispersed campsites located in the watershed are generally hunter camps and used in the fall hunting seasons. There are approximately 55 maintained dispersed campsites in the watershed with 51 of them located on Hills Creek Lake and Middle Fork Willamette River all which require regular visits and debris removal.

It has been observed that recreational camping and day use has increased significantly during the last two - three years. (Use RVD's values from the Reference Conditions section) It appears that any site associated with water is in demand during the summer months. Especially in demand are dispersed sites located on Hills Creek Lake by groups that do not want to associate or stay in campgrounds and prefer the privacy of dispersed sites. Typically, the group will launch a boat, load all the picnic supplies and water skis and cruise the lake in search for a dispersed site. The existing dispersed sites are filled to a maximum on warm weather weekends as well as the campgrounds.

The increased use, especially on Hills Creek Lake, indicates that another campground is really necessary to met the demand for water recreational activities, provided that full pool levels are maintained until the Labor Day weekend. Recreational use as shown in the Reference Conditions section indicate that forest use has increased by almost 40 percent over the last two years. Much of the recreational use is influenced by pool levels and weather conditions, but a general increase in use has been observed by the persons administering recreational use in the watershed. There are just more people using the forest than in the past, but it is not known if the increase means more of the general population is now using the area or if they have been displaced from some other area.

Lands

Infrastructure associated with special use authorizations include U.S. West Communications telephone lines, Lane Electric Cooperative powerlines, and the City of Oakridge Liquid Waste Disposal Area and sewer lines. The Bonneville Power Administration power lines are authorized under a Memorandum of Understanding. These uses are generally located near the

City of Oakridge and in the Middle Fork Willamette River corridor. Other facilities found in the watershed are the Warner Mountain Radio Relay and Warner Mountain Lookout found on the eastern edge of the watershed.

Special Use Name	Type	Size
Bonneville Power Administration	Powerline (MOU)	2.46 miles 148.6 acres
U.S. West Communications	Telephone Lines	12.98 miles
Lane Electric Cooperative	Powerlines	3.40 miles
City of Oakridge Liquid Waste Disposal Area	Sewage Treatment Plant	16 acres

A major commitment of lands involving the City of Oakridge Liquid Waste Disposal Area (sewage treatment plant and irrigation area) covers 16 acres southwest of the city. This area contains the sewage treatment plant which was reconstructed in 1992 to meet DEQ standards and an irrigation area where the treated liquid waste (sludge) is spread by irrigation sprinklers. The plant now has sufficient capacity to contain all storm water runoff and sewage without allowing any influent to overflow from the treatment plant during storm events. The irrigated sludge does not contain significant amount of heavy metals and is not hazardous. Calculations indicate an irrigated site life of 40 - 50 years. The limiting element has calculated to be zinc. Since Oakridge has no industrial activities and little growth, the heavy metal accumulation is not expected to be of any significance. Nitrogen loading continues to be near the 200 pounds per acre per year established for the site. The city plans to use the 200 pound figure in limiting sludge applications.

This area is eventually planned to be disposed of by the Forest Service to the city through the Small Tracts Acts.

Other short-term recreational uses are an 1840's style black powder rendezvous held annually in the upper arm of Larison Cove. This event takes place on a weekend near the end of the month of April in the Hills Creek Lake pool area prior to filling of the lake. This event has taken place since the early 1980's. The event takes place over a three day period and can involve upwards of 200 persons. Since the major activities such as camping takes place in the lake area prior to filling of the pool, there are no lasting effects. The other recreational event occurs in July and involves a sport car hill climb on Road 2102. This is a two mile course on an asphalt road in which single cars race against the clock with the winner taking the least amount of time to cover the race course.

Although a working lookout during fire season, Warner Mountain Lookout has been operated as a recreation rental cabin during the winter. The lookout is rented to the public from November 1 though May 10 and has become a very popular rental. The use is authorized by a special use authorization under Granger-Thye authority. The 1994 - 1995 season is the third year of the rental program and the most busy to date. The lookout was rented out for a total of 66 day or 35 percent of the available time. Almost every weekend from late November to May 10 was reserved.

In 1991, Pope & Talbot, Inc. approached the Willamette National Forest about the purchase of P & T lands located on the Rigdon Ranger District. The proposal included the Packard Creek block of lands and the Simpson Creek block which was to be purchased by the Bonneville Power Administration to replace the big game winter range inundated by Hills Creek Lake. The Simpson Creek lands were to be managed by the Forest Service. Pope & Talbot, Inc. gave the Forest Service a timeline of two years to obtain the necessary funds. However, in July, 1992 Seneca Timber Company purchased all Pope & Talbot, Inc. timber lands with the reasoning that these lands should remain in private holdings. This purchase involved 21,648 acres.

Issue #7

Existing land uses are discussed above.

Potential land uses could involve such facilities as RV parks on the south side of the river near the city as proposed by potential investors. There could be conflict with riparian reserve values and needs and bald eagle habitat.

All of the recreational developed sites and most of the dispersed campsites are located in riparian reserve areas along Hills Creek Lake and Middle Fork Willamette River. Some of the negative affects are bank erosion and loss of vegetation by recreational uses of both developed and dispersed sites. Most dispersed campsites are the result of past timber harvest activities that access river and stream bottoms with spur roads and landings. This random placement of sites has caused dispersed sites to be located either within or on river banks, thus causing conflicts with other recreation uses such as hikers. The construction of the Middle Fork Trail and existing dispersed campsites on the river has caused conflicts between campers and trail users. Experience in resolving these conflicts shows that this use should be separated in future consideration of trail location and dispersed campsites.

However, on the positive side is the public demand for water oriented camping and day use in this watershed.

Improvement of the fisheries and waterfowl habitat in the upper pool (above the upper crossing bridge) has apparently been successful by the increase in the number of fishing boats now using this area. It has been observed that a bald eagle from one of the resident pair seems to tolerate this use since it can be seen standing on logs floating in the water as boats troll for fish. The upper crossing bridge is a very popular fishing spot.

(Recommendation: Evaluate all dispersed camping site locations on the Middle Fork Willamette River for appropriate location to reduce conflicts with other recreation users and riparian reserve values.)

(Recommendation: Evaluate the need for additional camping capacity in the form of developed campgrounds on Hills Creek Lake.)

(Recommendation: Investigate the construction opportunities for a hardened surface bike trail loop around Hills Creek Lake.

Wild and Scenic River

In 1988, the Middle Fork Willamette River was among nine rivers on the forest to be evaluated for possible nomination to the national wild and scenic river system. The river was divided into two segments due to different characteristics between the upper and lower reaches. This division was at the confluence of Echo Creek. After an interdisciplinary team process of listing the river's attributes, the decision was that the portion downstream from Echo Creek and that located within the Middle Fork Willamette Downstream Tributaries Watershed was eligible for possible inclusion into the national wild and scenic river system. The IDT process recognized a number of values to be Outstandingly Remarkable Values (ORV's) but did not describe them in sufficient detail for the District Ranger to protect them. A resource assessment was conducted to describe in detail the river values.

The resource assessment findings are that the fourteen mile section of the Middle Fork Willamette for Echo Creek to slack water of Hills Creek Lake has as outstandingly remarkable values, recreation, geologic/hydrologic, and wildlife resource values.

Recreational opportunities are, or have the potential to be, sufficiently unique to attract visitors from outside of the geographic region. River opportunities could include, but not limited to, sightseeing, wildlife observation, photography, hiking, fishing, hunting, and boating. The recreation value for this segment of river includes many items. Forest Road 21 parallels the river providing easy access to the river. The road follows the historic Oregon Central Military Wagon Road. This river segment is most popular for dispersed camping because of the wide floodplain and ease of accessibility. There are three developed campgrounds. Put and take recreational fishing make fishing the second most popular activity on the river. There are numerous opportunities for hiking with the Middle Fork Trail paralleling the river and adjacent trails. This corridor offers high potential for interpreting the fall colors, viewing osprey and eagles, elk and deer. An interpretive drive and sign program is planned for along the Oregon Central Military Wagon Road.

Geologic and Hydrologic criteria is the river or the area within the river corridor contains an example(s) of a geologic feature, process, or phenomena that is rare, unusual, etc. The braided river channel in this watershed is unique feature. The length of the braided channel may be unique to the region. This represents a classic outwash channel very similar to channels in Alaska's presently glaciated valleys.

Wildlife values in the river corridor includes high use of the lower third of the corridor by bald eagle for foraging habitat. Under the existing Bald Eagle Management Plan, the corridor up to Skunk Creek is managed for perch tree habitat. There are known nest sites for osprey. A variety of game and non-game species exist in the corridor. The corridor habitat provides a migratory and geographic link between Hills Creek Lake and the Cascade Wilderness area.

During the interim time of the suitability studies, the identified ORV's will be protected to prevent degradation and insure potential classification. The interdisciplinary team recommended that this portion of river be classified Recreational because it is readily accessible by road, or has existing parallel roads; it has developments along the shoreline, including developed campgrounds, dispersed campsites, and evidence of past and present harvest activity.

A suitability study is currently in process to determine whether the river will be designated.

Hills Creek Lake and Dam

Recreation use of Hills Creek Lake is a year round activity with moderate fishing pressure during the winter months from both boat and bank fishing. Crappie fishing is an attraction after the lake fills. Fishing activities decline during the warm summer months and other sports such as water skiing occur during the months of July and August. During the normal years when the pool fills, the swimming area and beach at Packard Creek Campground become enormously popular with crowds of up to several hundred persons per day on weekends. Dispersed sites located adjacent to the lake are almost continuously occupied during the summer.

13) Recreational use of Hills Creek Reservoir was not always satisfactory. Until the 1983, the Corps of Engineers draw down schedule for Hills Creek Lake was to begin lowering the pool level as early as the first week or two of the month of August. The result was to leave the swimming area at Packard Creek and all three boat ramps high and dry. This early draw down had a major negative on recreational use of the lake area. The campgrounds were basically empty, especially Packard Creek, during the last week of August and Labor Day weekend. During that year, personnel at the Rigdon Ranger District negotiated a change in beginning draw down of the pool. The agreement was to leave the lake level at no more than six feet from full pool by the end of Labor Day weekend. This occurred during the first years of the agreement, but more recently, the pool level is still held at full pool or just one or two feet below full pool by Labor Day. The first year of leaving the lake level near full pool resulted in Packard Creek Campground being nearly full of campers and an increase of nearly $ 2,500 in camping fees. Now the campground is fully occupied during August and early September. Occasionally, the Corps of Engineers has to be reminded that outflow rates are 300 cfs during August to prevent early draw down.

Records for the years of 1991 and 1993 when Hills Creek Lake did not reach full pool and the swimming area at Packard Creek was dry, camping use dropped by 50 percent as shown by the loss in camping fee receipts and the nonexistent day use at the beach. The same drop in use was noticed for swimming and water skiing since the water was not accessible except by crossing mud flats.

There are several water rights involved with the Middle Fork Willamette River downstream from the dam. There are domestic uses involving the City of Oakridge for irrigation in Greenwaters Park; and a well of sorts on Pope & Talbot, Inc. lands adjacent to the river for the Summit View Water District which includes the Dink's Market area; and the Hemlock Water District near the Oakridge Middle School; and the City of Lowell.

Issue #8

8) Recreational opportunities offered by Hills Creek Lake include fishing during both winter and spring. During the warm summer months, swimming and water skiing become the major water sports. Because the Packard Creek Campground area is sheltered from the afternoon winds, it is very attractive to the water skiing crowd. Camping in both developed and dispersed sites is heavy and the demand for more camping facilities need to be supplied. The local economy is boosted by recreationists making Hills

Creek Lake a destination point and stopping Oakridge to buy supplies. Long term recreating does produce a benefit for Oakridge businesses in terms of services, supplies, and food.

Excerpts from a 1982 feasibility study of tourism and recreation in the Oakridge and Westfir areas indicated that the most popular recreation uses were camping and lake use. Surveys of businesses in Oakridge show that many visitors inquire about fishing, hunting, and camping. It appears that many people stopping in Oakridge are interested in the recreational opportunities in the area. Two surveys were conducted at Sand Prairie and Packard Creek Campgrounds in 1979 and 1980. In the surveys, 60.7 percent of the people surveyed came from the Eugene region, another 10.9 percent from the Salem region, and about 6 percent from the Portland region. Of the remaining visitors, only a small percentage (1.1 percent) venture over the Cascades from the Bend region. The Medford and Klamath Falls regions together comprise just over 5 percent, and out-of-state people - mostly from Washington and California - amount to almost 16 percent.

The feasibility study concluded that tourism and recreation provided a significant amount of business to about 40 firms in Oakridge. It was found that residents from outside of Lane County provided 25 percent of the local business during the summer and 10 percent during the winter. According to proprietors in Oakridge, fishing is the most asked about attraction or facility in the Oakridge/Westfir area, followed by hunting and camping.

Other considered recreational opportunities include siting a marina, placing floating rafts in various coves on the lake to provide dispersed sites accessible by water craft for water skiing and picnicking, construction of another 40-50 site campground with a boat ramp on the lake.

10) Beginning in 1998, the Corps of Engineers plans to let the first of two contracts to start construction of water temperature control towers at Cougar and Blue River Lakes. These towers will allow water to be released downstream that will more closely resemble water temperatures that naturally existed prior to construction of the dams. The first project at Cougar Reservoir will be four years long and result in the lake level being drawn down to an 80 acre pool. Upon completion of this project in the year 2002, then work will begin on the tower at Blue River Reservoir for a period of three years.

The effects on Hills Creek Lake are to begin an earlier supply of downstream water to the Willamette River to meet minimum flow requirements at Albany and Salem, Oregon. For construction during low flow conditions a decrease in Hills Creek Lake water surface elevation is expected to occur near the end of July and the C.T. Beach and Bingham Boat Ramps may not be available for use. It is estimated that 60 percent of the general recreationists will seek substitute recreation at another lake. Approximately 90 percent of the day users will substitute for another lake.

(Recommendation: In order to accommodate Hills Creek Lake recreationists, maintain the water surface at full pool until Labor Day Weekend. This is could be a major impact to recreation use on and adjacent to the lake. Maximum outflow during low flow periods (summer) should be 300 cfs to accomplish this as shown by past management).

Minerals

A survey of the August, 1994 Bureau of Land Management mining claim records show there are only three active claims in this watershed. These are located near Rocky Point, the south slope of Grass Mountain, and one about one-half mile northeast of Bristow Prairie. A Plan of Operations and Decision Memo has been approved for exploratory work on the Grass Mountain and Bristow Prairie claims. Core drilling and hand trenching is scheduled for the claim on Grass Mountain during the 1995 season.

Mining has not been a significant activity within this watershed or even on the district. Prospecting and staking claims is common and ongoing, but little development takes place. Occasionally there is some interest in the use of small suction (3 - 4 inch) dredging on the Middle Fork and tributaries such as Coal Creek. This activity is more recreational rather than mining interest due to the lack of gold deposits.

Collection of common variety minerals such as flagstone amounts to approximately one-half dozen minerals permits per year. Each permit averages one cubic yard of material. There is an occasional request for minor amounts (five gallon buckets) of pumice to mix with garden soils.

(Recommendation: For mining activities, follow guidelines in the Forest Plan Merger by requiring a reclamation plan, Plan of Operations, and reclamation bond for minerals operations in riparian reserves and late succession reserves.)

Economics

The local economies of Oakridge and Westfir have changed from the past. Both communities were established primarily as logging and sawmill communities in the 1940's. The mill in Oakridge closed permanently in 1990, and had supported approximately 250 mills jobs and 100 logging jobs. The population of Oakridge dropped by 550 people between 1989 and 1990. Manufacturing still plays a role in the Oakridge economy. A molding firm employs 15 people. A traffic counter firm employs 25 and a chipping company employs about five people (W. Hare 1992). The lumber and wood products industry still employs loggers, log truck drivers, and various service workers connected with logging and forestry. Most of this work is related to activities of the Oakridge and Rigdon Ranger Districts.

The community has taken a number of initiatives to revitalize the economy. These initiatives include a rest area for Highway 58 travelers, trail and trailhead development, various festivals, and work on the appearance of the community.

The community of Oakridge is surrounded by National Forest System lands and expansion of the community for industry or recreation is difficult if not limited. Desirable areas for development are located in riparian reserves, especially south of Oakridge along the Middle Fork Willamette River and Hills Creek Lake. Other limiting factors include bald eagle nests and habitat especially on Hills Creek Lake.

References

Willamette National Forest Land and Resource Management Plan

Tourism & Recreation: A Feasibility Study For Oakridge and Westfir, Oregon. University of Oregon Dept. of Urban and Regional Planning, Robin Bradley, Tom Durant, and John Johnson. June 1982.

Warner Creek EIS

LMF - INTERPRETATION AND CONCLUSIONS (and recommendations)

TR - Existing Transportation System

TR9

Trail mileage peaked in the 1940's and 1950's from approximately 89 miles to the current 30.4 miles. A total of four miles of the current trail system is located in SRI landtypes that are considered poor or poor to moderate for trail suitability. Past maintenance of the trail system has not indicated problems with stability. There are areas on the Youngs Rock, Larison Rock, and Larsion Creek Trails that require annual work on waterbars and structures such as puncheon or turnpikes to deal with wet tread areas. These wet areas are generally the result of very small springs and/or seepage from high water tables during periods of storms. The small volume of water involved with these wet areas have an insignificant impact to water quality.

(Recommendation #2: Open trails to mountain bike use during spring, summer, and fall seasons to reduce sedimentation and degradation to trail tread as is occurring during winter months.)

TR11- Conclusions - Reductions in the ability to maintain the current road system will require a plan to redirect or consolidate maintenance efforts. Plans to develop a Travel Access Plan will resolve the dilemma road mileage exceeding the ability of road maintenance funds to maintain. Reductions in road maintenance might include such factors as considering what is the highest resource value for a particular road. Does keeping the road open with no maintenance place riparian reserves at risk? If a road is closed, does it provide a greater experience of some other sort rather than driving a vehicle over it? will a road closure discriminate access to members of the public, i.e. physically challenged persons? Is there a need to provide access other than vehicular? How ill fire suppression response change? These only some examples of factors that could be addressed. Public input will be necessary to formulate a travel access management plan.

TR11 - Recommendation - Develop a Travel Access Management Plan to appraise resource values, access needs, and budgets.

EI - Existing Infrastructure

E11

Current recreation use trends as noted by visitor numbers in the Recreation Resource Information System (RRIS) are continue to increase. Greater demands are being placed upon both developed and dispersed campsites, especially those located adjacent to water, be it a lake, river, or stream as visitor numbers increase. Camping capacity in terms of available campsites has continued to remain static while user numbers increase. The results are campground sites filled more often and greater reduction of vegetation in dispersed campsites as more campers try to use the same acreage. As a result, more user created dispersed campsites are being created.

Acreage committed to other facilities has not changed. However, as the City Oakridge continues to increase recreational use in the area, greater demands for use of National Forest System land will result. An area that has potential is that south of the river and the city. This area's close proximity to the city will have greater demands placed upon it as the recreation demand grows. The proposed trail system of the slopes south town will increase use of that portion of the LSR adjacent to the community. The Greenwaters Foot Bridge, to be constructed over the Middle Fork Willamette River in August, 1995 at Greenwaters Park will provide shorter and more immediate access to the area south of the river than the current road system. This bridge has the potential to become a segment of the Eugene to Crest Trail system that is nearly in place.

E12

The infrastructure in this watershed is located within much of the riparian reserves area. Most of the facilities have been in existence for thirty plus years and are considered to be an insignificant impact to other resources in the watershed. The campgrounds and the majority of all other structures are located outside of Late Successional Reserves. These structures do not present barriers to wildlife movement and are an insignificant contributor to sedimentation.

Recommendation - Using the Limits of Acceptable Change (LAC) inventory method, evaluate dispersed campsites for condition. Use this information evaluate impacts of dispersed sites on riparian reserves and water quality. Data need.

HL - Hills Creek Dam and Lake

HL8

Trends in forest visitor use as noted in RRIS indicate increasing recreational use. Water oriented recreational pursuits are extremely popular in this urban setting. Eventually more campsites on the lake will be needed to accommodate additional campers and day users. This rise in Hills Creek Lake recreation use could conceivably conflict with bald eagle management on the lake. Other conflicts could arise from other water needs and uses or other management objectives for the timing of Hills Creek Lake pool levels.

As the Oakridge area expands its recreational opportunity base in such areas as fishing, mountain biking, and the like, and make the area a destination point rather than a place that tourists pass through, more of the area businesses will realize an increase in income from providing services to tourists. One of the goals of the city is to make the area a destination for mountain biking. Already, the area is being notice by outfitter and guides in the form of horse packers, mountain biking, and fishing guides.

(Recommendation: Evaluate the impacts of additional recreation facilities on bald eagle management on Hills Creek Lake.)

There are a least two heavily used dispersed campsites adjacent to the lake shore at Coffee Pot Creek and another two dispersed sites uplake from the upper crossing bridge. Constant camping and day use results in toilet paper lilies near the disperesed sites along with degradation of the vegetation at the site and enlargement of bare soil areas. Sites similar to these have been evaluated elsewhere on the forest with reviews by Environmental Protection Agency personnel. the conclusion I that the low volume and since all is biodegradable, it does not constitute a threat to water quality. However, they are visual and social issues as recreation concerns.

Proposals to place and maintain vault or pit toilets are currently beyond recreation staffing and funding levels. Alternatives could range from portable toilets to limiting access to certain sites. Installation and maintenance funding could take the form of water quality improvements.

F

Appendix F

Aquatic Documents

ISSUE 1 - VEGETATIVE MANIPULATION

Aquatic Domain Report
Existing Condition
Interpretation
Recommendations

Prepared by:
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June 18, 1995

EXISTING CONDITION AND TREND

Vegetative Manipulation

The processes that affect the aquatic domain from vegetative manipulation were identified as: 1) Hydrologic recovery (VM); 2) Landslides (VM); and 3) Wood recruitment and shading (VM ; and 4) Habitat complexity (VM). In general, mass wasting in the form of landslides has increased sediment reaching stream systems. The reduction of wood in the riparian area has reduced the potential for large woody debris to enter the stream system and has reduced the amount of shade afforded by the riparian canopy resulting in increased stream temperatures. The lack of LWM as a result of stream cleanout and flooding has reduced channel complexity as evidenced by an increased channel width and decreased stream depth over time. The following existing condition of the landscape validates this summary.

Hydrologic recovery

INSERT WATER YIELD FROM MAUREEN

INSERT FLOW INFO FROM MAUREEN

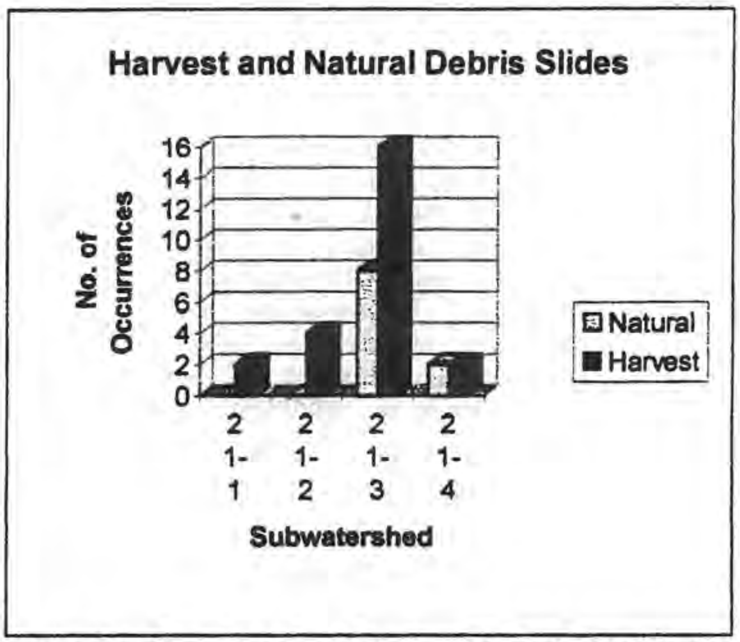
Landslides

Vegetation manipulation , especially clearcut harvesting and associated road construction, has affected the spatial and temporal distribution of landslide occurrences, particularly with respect to debris slides. A detailed discussion of road related landslides is included under Existing Transportation System.

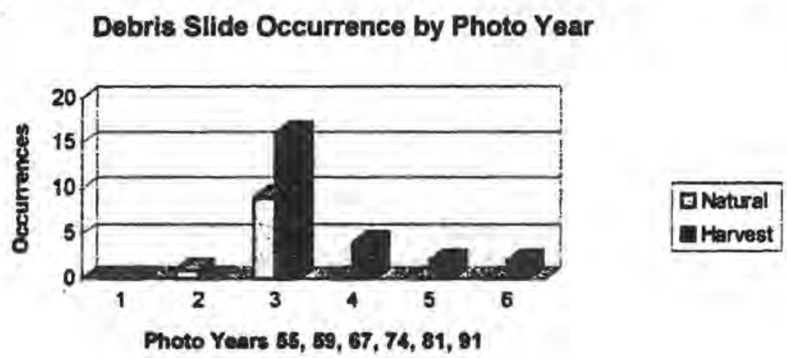
Clearcut harvesting on steep slopes with shallow, rocky soil reduces root strength and increases groundwater height until such time as the area recovers vegetatively (approximately 5 to 20 years). During this window of time, the probability of shallow, rapid slope failure on steep ground is significantly increased (Gray and Leiser, 1982).

Approximately 66% of the Watershed Analysis area is characterized by steep ground with shallow, rocky soil (see Soil and Geology report in Appendix XX for process and validation). Between 1940 and 1995, approximately 26,219 acres of this area have been harvested using clearcut methods (including Private land). Approximately 45% of this harvest occurred between 1980 and present. This implies that 11,720 acres of steep ground with shallow, rocky soil are in some stage of redeveloping pre-harvest root strength and groundwater levels and is therefore at elevated risk of producing a debris slide. Of this, approximately 5,400 acres are on Private land, most being in the Packard Creek drainage.

Air photo reconnaissance spanning 1955 to 1991 indicates that 88% (21 of 24) of harvest related debris slides occur in the geomorphic category described above. Bohemia Creek and Buck Creek drainages have had 6 occurrences apiece; Windfall Creek and Indian Creek drainages have each had 2 occurrences; Short Ridge, Gray, Bull, Willow, Coffeepot, Coal and Deadwood Creeks have each had 1 occurrence.



Of the 24 harvest related debris slides mentioned above, 16 appeared in the 1967 photos, presumably in conjunction with the 1964 flood. 4 were identified in the 1974 photos and 2 each in the 1981 and 1991 photos. Deep seated landslides typically occur in clayey soils. The failure mechanism is less dramatic than with debris slides and therefore more difficult to identify using air photos. Like debris slides, landforms that contain significant amounts of clay are more prone to slope failure with vegetation removal. Even though the transport distance and energy are less than with debris slides, deep seated landslides create a persistent input mechanism of suspended sediments, thus affecting water quality and spawning habitat.



Approximately 11% of the analysis area is characterized by deep, clay soil usually on gentle, hummocky ground. Between 1940 and 1995, approximately 5904 acres of this area have been harvested using clearcut methods (including Private land). Approximately 38% of this harvest occurred between 1980 and present which implies that 2230 acres of clayey soil are in some stage of redeveloping pre-harvest groundwater levels. Unlike debris slides, the deep seated landslides take much longer to redevelop pre-failure shear strength regardless of whether they are revegetated or not. Therefore, sediment input occurs long after slope failure.

Known deep seated landslides which have either been aggravated or initiated by harvest activity occur in the headwaters of Bull Creek (Tufti Mountain), Modoc Creek, Tea Creek, Powder/Buck Creek, Windfall Creek, Big Willow Creek, and Coffeepot Creek. Tufti Mountain and Powder/Buck Creek are two of the more spectacular landslides.

Wood recruitment and shading

INSERT RIP. VEG CONDITION FROM MAUREEN

INSERT TEMP INFO FROM VAL

Habitat complexity

Coal Creek Subwatershed

Aquatic habitat is provided in the Coal Creek Subwatershed, in principal, by Loletta and Bradley Lakes, and Coal and Deadwood Creeks. Loletta and Bradley Lakes are 2.9 and 4.0 acres in size, respectively, with maximum depths of 7 and 13 feet. Coal and Deadwood Creeks are primarily third order, Class II streams. General habitat characteristics have been quantified for Coal Creek using the Level II Stream Survey (USDA, 1993; Table). The average gradients of Coal Creek range from 2 to 6 percent, with gradients increasing in the upper reaches. Level I Rosgen typing indicates that channel types exhibited are predominately A, which are expected in headwater tributaries (Table). The function of these tributaries is to "transport" sediment and gravels to the lower stream systems over time. These higher gradient tributaries are prone to debris torrents in unstable conditions.

Table . Stream surveys completed in Coal Creek Subwatershed in the MFW Watershed.

Stream -shed	Streamshed Acres (CFS)	Elevation (FT)*	Gradient (%)	Valley type Rosgen Level I	Stream class	**Stream name**	Survey Type Date
Coal	7277 (30)	4200	6	8.5A 3.5A	III II	**Coal Creek**	OSGC 1964 R6-94
		3860	-		II		
		3600	0		II		
		2600	-		II		
		2380	3		II		
		1120	2		II		
	3358 (3)	5040- 4200-3120		8.5A 3A		**Deadwood Creek**	No survey
	1122 (<0.1)	5000- 2600-2040		8A 3A	IV II	**Deadhorse Creek**	OSGC 1964
	269	2640-2000		8A	III	**Jim's Creek**	No survey
	193	2600-2040		8A	IV	**Gravel Creek**	No survey

* Elevation given is at the upper end of the reach or change in valley type.

The lower reaches of coal Creek transform in to a Rosgen B channel type as the valley opens, with the lower 2.5 miles of Coal Creek opening into a lower alluvial valley and C channel type with potentially excellent fish habitat. (Table).

Table : Stream Class mileage by valley segment an dRosgen Classification for the Coal Creek Subwatershed

	Stream Class Miles				
Valley Segment Rosgen Type	I	II	III	IV	Total Miles
1C	1.3	1.2	0	0	2.5
10B	0	0.6	0	0	0.6
6B	0	1.25	0	0	1.25
11A	0	1.75	0	0	1.75
3A	0	5.5	2.75	0	8.25
8.5A	0	0.3	9.25	11.5	21.05
8A	0	0.25	9.5	26.0	35.75

Legend: 1C = lower alluvial valley - Rosgen type C
10B = alluviated mountain valley - Rosgen type B
6B = moderate-slope bound valley - Rosgen type B
11A = moderately incised s - Rosgen type A
3A = steeply incides valley/moderate channel gradient
8.5A = valley wall/headwall tributary, moderate gradient
8A = valley wall/headwall tributary, steep gradient

The main channel forming process in this area is the past glacial carving and valley formation, however, management influence from vegetative manipulation is evident in terms of seral stage class and species of trees in the riparian areas and amount of large woody material (LWM) in the channel. In Coal Creek, the Level II stream survey suggests that the inner riparian seral class, generally defined as 25 feet from the streambank, is dominated by small pole and small trees of alder and willow, with a higher percentage of larger trees in the outer riparian width, dominated by Western red cedar (Table).

Table . Physical characteristics of streams in the Coal Creek Subwatershed in the MFW Watershed.

Stream Name	Reach	Lg/Sm Wood/ Mile	Brush /Mile	D Seral Stage % Inner Rip	Veg Species	D Seral Stage % Outer Rip	Veg Species	Species
Coal Crk	6	196	194	SP/ST 60/40	HA/HW HA/CY	SO/LT 50/50	CD/CF CD/CH	cutthroat
	5	40	80	SP/SP	HV/CY	SP/LT 33/33	CD/CH CD/HV	cutthroat
	4	49	89	SP/ST 89/11	HW/HA CH/HV	SP/LT 22/56	CD/HB CD/CC	cutthroat, tailed frog, bat
	3	196	32	SP/ST 71/29	HA/HA HA/CC	SP/LT 14/71	CD/HV CD/CC	cutthroat, dace Cascade frog, goshawk
	2	50	3	SS/SP/ST 35/59/6	HA/HB HA/HA	ST/LT 6/94	CD/CD CD/CD	cutthroat
	1	64	11	SS/SP/ST 71/14/14	HA/HB HA/HB	ST/LT 29/57	CD/CD CD/CC	cutthroat

Legend
HA= Alder HB=Bigleaf HC=Cottonwood, ash, poplar
HD=Dogwood HV=Vine Maple HW=Willow GF=Grass forb

The Level II stream survey suggests stream sinuosity and width to depth ratio increases downstream in Coal Creek, with a marked reduction in LWM and pools per mile in Reach 1 and

2. The marked reduction of wood in the lower section is not clear, with the harvest map showing a riparian buffer being maintained by the road for most of this section. It is probable that these reaches were "cleaned out" in a similar fashion to the Middle Fork in the early 70's or scoured by the flood of 1964. Shade cover was also considered poor. In the 1964 survey, holding pools 3 to 6 feet in depth occurred on the average every quarter mile at a discharge of 15 cfs.

Based on a qualitative description of Deadwood Creek in 1964 and 1988, the lower reaches exhibit a lack of LWM in clearcut sections, with debris jams present in every bend of the forested areas. Log jams occur after bedrock falls, around bends, and in the transitional zones between forested and clearcut units. The stream had a discharge of 3 cfs.

Table . Physical characteristics for streams in the Coal Creek Subwatershed in the MFW Watershed.

Stream Name	Reach	Channel Entrench	Sinuosity	W/D Ratio (Ave Width Ft)	Temp F	Pools/ Mile	Residual Depth
Coal Crk	6	Mod	1.05	14	51	22	2.7
	5	Mod	1.15	14	53	13	2.3
	4	Mod	1.11	16 (10)	57	22	2.4
	3	-	1.12	17	55	22	2.9
	2	Mod	1.03	22	50	9	2.0
	1	Mod	1.50	17 (25)	55	9	2.3

Deadhorse Creek had a width of 2 in 1964, with bedrock and rubble substrate, with spawning gravel negligible. The stream was of little value to game fish with steep gradients and low flows.

Cutthroat trout 6 to 11 inches long were present throughout Coal Creek and are probably present throughout the other class III and larger streams. **Sculpin and rainbow trout** were reported in Reach 1, with **dace** in Reach 3. **Red-legged**, *Rana cascadae*, **Cascade**, *Rana cascadae*, and **tailed frogs**, *Ascaphus truei*, were identified in Reaches 1, 3 and 4, respectively.

Completed Restoration

Restoration completed in this Subwatershed is summarized below. Generally sale areas were replanted after harvest. No documentation of the success of the revegetation is available.

Table .Restoration in the Coal Creek Subwatershed

Streamshed	Stream	Sale Name	Treatment	Year	Quantity	Species
Coal Main	Brandy Creek	Vine 10	fertilize	1991	2.25 ac	urea
Coal Main	Bristow Cr.Trib	Steeple Bend 5	plant	1994	1 ac	willow
Coal Head	Coal Cr. & Trib.	Jagger Resale 5	plant	1990	1 ac	willow
Coal Head	Coal Cr. & Trib.	Jagger Resale 6	fertilize	1889	3.5 ac	urea
Coal Head	Coal Cr.	Rocky Dome 10	plant	1990	0.5 ac	willow
Coal Head	Coal Cr.	Rocky Dome 10	fertilize	1990	6 ac	urea
Coal Head	Coal Cr. Trib.	Rocky Dome 11	plant	1990	0.5 ac	willow
Coal Head	Coal Cr. Trib.	Rocky Dome 11	fertilize	1990	5 ac	urea
Coal Head	Coal Cr. Trib.	Rocky Dome 13	plant	1990	0.5 ac	willow
Coal Head	Coal Cr. Trib.	Rocky Dome 13	fertilize	1990	6 ac	urea
Coal Head	Coal Cr. Trib.	Rocky Dome 14	plant	1990	0.5 ac	willow
Coal Head	Coal Cr.	Rocky Dome 3	plant	1990	1.5 ac	willow
Coal Head	Coal Cr. Trib.	Rocky Dome 5	plant	1990	1 ac	willow
Coal Head	Coal Cr.	Rocky Dome 6	plant	1990	0.5 ac	willow
Coal Head	Coal Cr.	Rocky Dome 9	plant	1990	1 ac	willow
Coal Head	Coal Cr.	Rocky Dome 9	fertilize	1990	6 ac	urea
Coal Main	Coal Cr. Trib.	Stubble 2	plant	1991	1 ac	willow
Deadhorse	Deadhorse Cr.	Colt 10	fertilize	1988	2 ac	urea
Deadhorse	Deadhorse Cr.	Colt 11	fertilize	1988	3 ac	urea
Deadhorse	Deadhorse Cr.	Colt 12	fertilize	1988	3 ac	urea
Deadhorse	Deadhorse Cr.	Colt 8	fertilize	1988	2 ac	urea
Deadhorse	Deadhorse Cr.	Colt 9	fertilize	1988	2 ac	urea
Deadwood	Deadwood Trib.	Jagger Resale 2	Plant	1990	2 ac	willow
Deadwood	Deadwood Trib.	Jagger Resale 2	fertilize	1990	0.5 ac	urea
Coal Main	Pogo Cr.	Vine 11	fertilize	1991	2.25 ac	urea
Coal Main	Pogo Cr. Trib.	Vine 13	fertilize	1991	2.25 ac	urea

Middle Fork Willamette/Little Pine Subwatershed

Middle Fork Willamette/Little Pine Subwatershed - West

The existing condition of the streams in the Middle Fork of the Willamette/Little Pine Subwatershed, west of the Willamette, will be referenced to other streams of similar geomorphology and stream size in the watershed, when possible. The condition of several streams are derived from past stream surveys (Table) (Gangle et al. 1993).

Table . Stream surveys completed in the MFW Little Pine Subwatershed-West.

Streamshed	Streamshed Acres	Elevation (FT)	Gradient (%)	Valley type Rosgen Level I	Stream class	Stream name	Survey Type Date
Windfall	3269	3400- 1600-1560	17 3	10B 1C	II II	**Windfall Creek**	OSGC 1964 Pre-GP 1989
Gold	3546 (1)	4160- 1600-1560	9 3	10B 1C	II II	**Gold Creek**	OSGC 1964
Bohemia	3663	3520- 2400- 2160- 2000- 1800-1760	21 4 4 5 1	8A 10B 3A 6B 1C	III II II II II	**Bohemia Creek**	OSGC 1964 R6-93
Snake	2483	4000- 2600- 1800-1760	27 6 3	8A 3A 1C	III II II	**Snake Creek**	No survey
Spring Butte	1169	3880- 2780- 1680-1600	21 16 6	8A 3A 1C	III III III	**Spring Butte**	No survey
Indian	4817	3760- 2160-1800	9 6	3A 10B	III,II II	**Indian Creek**	No survey
Fir	1317	3560- 1760-1720	23 3	8A 1C	III II	**Fir Creek**	OSGC 1964
		2800-1720	19	8A	III	**Emile Creek**	No survey

* Elevation given is at the upper end of the surveyed Reaches or changes in valley type.
* OSGC - Oregon State Game Commission

In this Subwatershed, the geomorphology of Windfall, Gold, Bohemia and Fir Creeks can be considered similar. From the stream survey on Windfall Creek (USDA, 1989), we know that the lower end of Windfall streamshed greatly resembles Snow Creek (*Hills Creek Subwatershed - WEST*) with shallow rocky soils and dissecting hillsides, particularly on north-facing slopes. The upper end is generally less dissected and includes a large area of clay-rich soils and active landflow. Red alder has established itself along the streamside units that have been harvested. Since 1982, a total of 8 debris avalanches and debris torrents have occurred in this block of units, with 7 of the landslides reaching the creek. Three of the slides appear to have been initiated by road runoff from Road 2117. The deposition of the material from these slides, coupled with the removal of streamside vegetation, eliminating future wood sources, has all but eliminated pool habitat in this section. Approximately 5 acres of land has been lost as a result of these events. All of the slides occurred within SRI landtypes 8 and 313 (see Table ____ for characteristics of these soils).

Table . Characteristics of soil types in the Windfall Streamshed.

No	Landform	Parent Material	Nature of Mass Movement
31	Steep, smooth to dissected sideslopes and ridges, frequent stream scour	Residuum and colluvium, green tuffs and breccias	Debris avalanche and torrents
8	Steep dissected landform	Green and Red Breccias and Tuffs	Debris slides and channel scour

Two of the slides traveled to Windfall Lake and deposited their debris in this body of water. At the point where the landslide impinges on the stream (or lake), there is extensive bank instability. Ancient movement of this flow constricted channel flow and formed Windfall Lake. The area comprising the lake consists of two bodies of water separated by a debris deposit isthmus, and a 75 ft length of stream. These deposits and other recent deposits have a 20 to 25 year old stand of red alder, indicating a likely 1964 vintage. An abundance of trout and salamanders live within the lake (USDA, 1989).

To the east of the lake is a swamp which spans the entire stream channel from lower bank to lower bank. This area is covered by an abundance of aquatic plants and a muddy substrate with an abundance of fallen rotting logs. Beyond the swamp, the stream gradient increases with continuos bare soil. The topsoil is unstable. A large debris jam is just downstream of this area. In general the stream characteristics can be described as:

1) Fallen timber and rootwads are common on the upper and lower banks, creating large log and debris jams throughout the reach;
2) These debris jams in combination with high stream gradients deflect flow into downstream banks;
3) Deflected flow erodes unstable bare soil banks promoting channel widening;
4) Small areas of widened stream channel exist as a result of channel widening by wide and well consolidated debris jams. Marsh type vegetation thrives in these areas of low channel gradient, low flow velocity, with fine sediment buildup;
5) Unconsolidated bare dirt exhibits sliding and slumping along most of the stream and above bedrock sections.
6) Rootwads and complex root systems aid in the stability of a majority of the lower banks; and
7) Sporadic bedrock outcroppings narrow the stream channel and creating large waterfalls

The unharvested reaches of this stream are primarily lined with old-growth Douglas-fir forest type. Large woody debris is copiously present and the channel is, in general, completely shaded. The understory vegetation is moderate to dense with vine-maple being the principle species (USDA, 1989). In 1964, the stream width of Windfall Creek was 5 feet at the mouth, with a 70 to 30 percent, riffle to pool ratio. Native cutthroat trout, cottids, dace, rainbow trout and redside shiners, were all present in the stream. The stream has a moderate value for trout, with summer low flows being a possible limiting factor.

The logging road parallels the creek between miles 0.5 and 2.0.

Gold Creek is 6 ft in width at the mouth, with bedrock and rubble substrate. There is a 50 square yard area of marginal salmon spawning gravel. The riffle to pool ratio is 80 to 20 percent. Impassable jams occur at mile 0.7 and 1.2, with 2 to 3 foot water heads. Pools 1 to 2 feet deep occur on the average of one every 50 yards. Native cutthroat trout were present in the lower three miles. Fir Creek is 2 ft in width, with a rubble and silt bottom type. Gravel is

negligible. A debris jam near the mouth backs water for 100 yards. The stream holds little value for game fish.

Bohemia Creek is broken into five valley types (Table). The headwaters are **valley headwall tributaries**, with rubble, boulder, cascade/stairstep pools. There is a high volume of clumped wood in the channel. The reach experiences high amounts of natural erosion. Banks are undercut almost continuously in non-bedrock habitats. Many areas, composed of alluvium or other unconsolidated material, are slumping into the channel. Such instability is considered a function of the steepness of the terrain and expected to continue until a lower threshold is reached on the oversteeped slopes. The bankful width to depth ratio reflects the entrenchment of this reach at 9.2. One **fish**, and several **Pacific Giant Salamander,** *Dicamptodon tenebrosus*, **crayfish,** *Astacidae*, and **tailfrogs,** were observed (Gangle et al., 1993).

Downstream, Bohemia Creek cut through an **alluviated mountain valley** changing the habitat complex to cobble meanders. The open alluvial valley was reflected in the increase in channel width to depth ratio from 9 to 13. There are many places along the channel exhibiting active erosion, particularly sections of unconsolidated alluvium. Bank armoring was good to excellent in bedrock habitats. Natural bank cutting and erosion increased in stretches with unconsolidated substrates and steep channel banks.

Further downstream, the stream enters a more **steeply incised valley with moderate channel gradient**. Four debris dams are entrenched in this tight valley; however, the presence of wood virtually ends when the stream enters clearcut land. Bank undercutting is intermittent, with interwoven root masses offering protection. Broken wood and overhanging willow correlated with the highest number of **fish** sightings (101 total).

The last reach, located 0.75 mile up from the confluence, is a **moderate slope bound valley**, with a habitat complex of low gradient riffles, glides and bedrock controls. The width to depth ratio is 33 (Table). The amount of wood in the stream smaller that brush size is high (Table). Twenty **fish** were sighted almost exclusively in pool habitat created by wood jams.

Table . Physical characteristics for streams in the MFW Little Pine Subwatershed-West.

Stream Name	Reach	Channel Entrench	Bed Sub-strate	Sinuo sity	W/D Ratio (Ave Width Ft)	Temp F	Pools /Mile	Resid Depth
Bohemia Creek	5	Moderate	CO/GR	1.1	9	-	27	1.3
	4	Slight	BR/CO	1.1	13	58	19	1.4
	3	Moderate	GR/CO	1.0	20	63	54	1.7
	2	Slight	GR/CO	1.0	33	56	30	1.3
	1	Slight	GR/CO	1.2	24 (7)	55	24	1.5

The mouth of the stream is a **lower alluvial valley** stream. The habitat complex is low flow over gravel and cobble substrate. There is little woody debris in the stream. No jams. Vegetation near the channel edge is sapling pole alder and maple, with larger conifers upslope. This reach is characterized by undercut banks, many protected by mats of rootwads, others exposed. Channel armoring by bedrock is covered with a film of unconsolidated alluvium. The low entrenchment results in a high width to depth ratio of 24. Fish observed were **cutthroat trout, dace,** and unknown. In 1964, **"blackside dace"** were reported in the lower reach, with a 60 to 40 percent riffle to pool ratio..

Table . Biological characteristics for streams in the MFW/Little Pine Subwatershed-West.

Stream Name	Reach	Lg/Sm Wood/ Mile	Brush/ Mile	D Seral Stage % Inner Rip	Species	D Seral Stage % Outer Rip	Species
Bohemia Creek	5	66	18	SP 100	HV/CD	ST/LT 33/67	CH/CD
	4	38	46	SP 100	HA	SP/MT 25/75	CH/CD
	3	16	18	SP 100	HW/HA	SP 100	CD/HV
	2	28	84	SP 100	HA/HW	MT 100	CD/CH
	1	12	73	SP 100	HA/HB	ST/LT 40/60	CD/HC

Legend
HA= Alder HB=Bigleaf HC=Cottonwood, ash, poplar
HD=Dogwood HV=Vine Maple HW=Willow GF=Grass forb

The only chemical data available for this Subwatershed, other than water temperatures collected during stream surveys, is for Windfall Creek (Table). The instantaneous measurements did not exceed State standards.

Table . Water chemistry for the streams in the MFW Little Pine Subwatershed-West.

Stream	Date	Time	Temp (F)	Discharge (CFS)	Turbidity (NTE)	Suspended Solids (mg/l)
Windfall Creek	12/17/76	1020	34	0.3	-	0.2
	1/14/77	0950	-	0.4	-	1.7
	2/25/77	0950	30	0.4		0.2
	3/09/77	0955	42	1.2	-	55.0
	4/11/77	1440	51	0.8	-	35.3
	5/27/77	1450	49	0.9	17.0	32.2
	6/6/77				93.0	260.2
	6/6/77				-	10.9
	8/24/77	0945	56	0.2	2.9	2.1
	9/26/77	1040	13C	0.4	2.1	2.3
	9/30/77	1010	9C	0.6	4.0	3.0
	10/7/77	0955	50	0.4	1.5	0.0
	10/21/77	0940	8C	0.3	0.6	0.0
	10/25/77	0745	51	0.4	1.1	2.2
	11/17/77	1400	47	1.0	20.0	44.6
	11/22/77	1120	43	0.9	110	174
	11/25/77				340	551
	1/06/78				42	69
	1/18/78				53	99

Middle Fork of the Willamette/Little Pine Subwatershed- East

There is very little information on the streams east of the Hills Creek Lake. The **existing condition of the streams in the Middle Fork of the Willamette/Little Pine Subwatershed, east of the Willamette**, will be referenced to streams in the eastern section of the Hills Creek Lake Subwatershed, which are similar in geology and valley type. Buck, Boulder, and Butcherknife Creeks are the only streams that have been surveyed in this area and the information is limited (Table).

Table . Stream surveys completed in the MFW Little Pine Subwatershed-East.

Streamshed	Stream-shed Acres (cfs)	Elevation (FT)*	Gradient (%)	Valley type Rosgen Level I	Stream class	Stream name	Survey Type Date
Youngs	1827 (0.7)	5400-3800- 2600-1920	0.8 mi 2.0 mi 1.6 mi	8A 8.5A 6B		**Young Creek**	OSGC 1964
What	(<0.1)	3400-1920	1.5 mi	8.5A	III	**What Creek**	OSGC 1964
Dry	(dry)	2760-1800	1.0 mi	8A	III	**Dry Creek**	OSGC 1964
Boulder	2776	3200-2760- 1800	1.2 mi 0.8 mi	8.5A 3A	III II	**Boulder Creek**	OSGC 1964
Butcher-knife		2680-1800	0.5 mi	8A	III	**Butcher-knife Creek**	OSGC 1964
Pine	1277	5000-2240- 1800-1760	3.5 mi 0.5 mi 0.3 mi	8.5A 3A 8.5A	III II II	**Pine Creek**	No survey
Estep	1325 (1)	4400-2400- 2000-1720	1.6 mi 0.5 mi 0.6 mi	8.5A 3A 6A	III II II	**Estep Creek**	No survey
Bill's		2680-1800- 1780	1.0 mi	8.5A 1C	IV III	**Bill's Creek**	No survey
Cone	1354 (2)	2800-1740- 1700	1.1mi 0.3 mi	8.5A 1C	III II	**Cone Creek**	OSGC 1964
Buck	7482 (4)	5200-3800- 1600-1560	3.5 mi 5 mi 0.1 mi	3A 10B 1C	III II II	**Buck Creek**	GP-91

* Elevation given is at the upper end of the surveyed Reaches or changes in valley type.
* OSGC - Oregon State Game Commission

Youngs Creek is 6 ft in width at the mouth, with a riffle to pool ratio of 80 to 20. There are 4 foot falls upstream 150 yards. Sandbags dam the creek at 200 yards to provide a reservoir from which water is drawn for road maintenance projects. Many **native cutthroat trout** were observed. The creek is of moderate value to trout. The culvert outlet of Youngs Creek (Rd. 21 crossing) was also enhanced by log structures the summer of 1988. Several logs were placed immediately below the culvert outlet to improve fish passage upstream. The streamside was also planted with willow and alder to improve shading to the stream channel.

The stream width of Way Creek is 2 ft at the mouth, with large rubble substrate type. The steep gradient and low summer flow limit the habitat for game fish. Dry Creek was dry at the time of survey, with a rubble and silt bottom type. Boulder Creek has an average width of 4 ft at the mouth of the creek, with a bedrock and boulder bottom type. The riffle to pool habitat ration was 90 to 10 percent. The stream has a very steep gradient with a low flow. There was several falls 3 to 4 feet high and cascades in the first 30 yards of the stream. The stream is considered to be of negligible value to fish.

The headwaters of Buck Creek begins with a **moderate gradient** and descends into an **incised till/colluvium**, before dropping into a **moderate slope bound valley**, and finally an **alluviated mountain valley** at the mouth of the stream. The habitat type in the upper reaches is **cascades with stairstep pools**. The bed substrate was predominately large and small boulders, with 24 pools per mile and a residual pool depth of 2.1 ft. There was 4 pieces of large and small wood per 100 ft and 5 pieces of brush. The inner riparian seral stage was 69 and 19 percent sapling pole and small trees, respectively. It can be assumed by the lack of LWD in the stream and sapling serial stage, that the timber harvest in this Subwatershed has resulted in habitat simplification.

The average width of this tributary at the mouth is 15 feet, with a bottom type of boulder and rubble. The riffle to pool ratio was 80 to 20 percent, with a flow of 4 cfs. Pools 1 to 2 ft deep occurred every 30 yards on the average. Noon, Tea, and Powder Creeks are all tributaries with flows of less than 0.1 cfs. The fish species present included: **native cutthroat trout, cottids, dace, rainbow trout and redside shiners**. There was practically no spawning gravel in the stream.

Butcherknife has a width of 4 feet at the mouth, with bedrock and boulder bottom type. There are 35 ft falls 30 yards from the mouth. This stream holds little value for game fish. Cone Creek has a width of 6 ft at the mouth and 3 ft upstream 0.3 miles. The riffle to pool ratio is 90 to 10 percent. A three foot falls created from a road culvert 500 yards upstream of the mouth prevents a barrier to fish passage. Because of the steep gradient, however, the value of the creek is limited for game fish.

Estep had a width of 6 feet, with boulder and rubble substrate. **Native cutthroat trout** were present in the stream, however, a two foot falls from the culvert just above the mouth of the stream blocks passage and a natural falls occurs 100 yards above this. The stream provides some value as a trout stream.

Completed Restoration

Fertilization and planting also occurred after each timber sale (Table). Monitoring suggests that approximately 60 percent of the planting has been successful (Williams, pers. comm., 1995).

Table .Restoration completed in the MFW Little Pine Subwatershed.

Streamshed	Stream	Sale Name	Treatment	Year	Quant.	Species	Moni-tored
Pine	Pine Creek	Moonbeam 1	fert	1991	2 ac	urea	yes
Estep	Estep Cr.	Beldar 5A	fert	1994	6 ac	urea	
Estep	Estep Cr.	Parch 17	fert	1991	3.25 ac	urea	
Estep	Estep Cr. Trib	Parch 25	fert	1991	3.25 ac	urea	
Indian	Indian Cr. Trib.	Indian TBV 5	fert	1990	1 ac	urea	
Pine	Pine Creek	Moonbeam 18	plant	1991	1 ac	willow	yes
Pine	Pine Creek	Moonbeam 18	fert	1991	7 ac	urea	yes
Pine	Pine Creek	Moonbeam 19	plant	1991	1 ac	willow	yes
Pine	Pine Creek	Moonbeam 19	fert	1991	9 ac	urea	yes
Pine	Pine Creek	Parch 18	fert	1991	3.25 ac	urea	
Spring Butte	Spring Butte Cr.Trib.	Indian TBV 1	plant	1990	1 ac	willow	
Lower Buck	Tea Cr.	Cone 10	fert	1991	1.5 ac	urea	
Youngs	Youngs Cr.	Moonbeam 20	plant	1991	1 ac	willow	yes
Youngs	Youngs Cr.	Moonbeam 20	fert	1991	9 ac	urea	yes
Youngs	Youngs Cr.	Moonbeam 6	fert	1991	2 ac	urea	yes
Youngs	Youngs Cr.	Luna TBV 2A	plant	1990	1 ac	willow	yes
Youngs	Youngs Cr.	Luna TBV 2A	fert	1991	3 ac	urea	yes
Youngs	Youngs Cr.	Luna TBV 3	plant	1990	1 ac	willow	yes
Youngs	Youngs Cr.	Luna TBV 3	fert	1991	2 ac	urea	yes
Youngs	Youngs Cr.	Luna TBV 4	plant	1990	1 ac	willow	yes
Youngs	Youngs Cr.	Luna TBV 4	fert	1991	4 ac	urea	yes
Youngs	Youngs Cr.	Luna TBV 6	plant	1990	1 ac	willow	yes
Youngs	Youngs Cr.	Luna TBV 6	fert	1991	4 ac	urea	yes
Youngs	Youngs Cr.	Luna TBV 7	plant	1990	1 ac	willow	yes
Youngs	Youngs Cr.	Luna TBV 7	fert	1991	2 ac	urea	yes
Boulder Face	Boulder Creek	Parch 19	Fert.	1991	3.25 ac	urea	
Lower Buck	Buck Creek	Cone 1	Fert.	1990	4.5 ac	urea	yes
Lower Buck	Buck Creek	Cone 15	Fert.	1991	1.5 ac	urea	yes
Upper Buck	Buck Cr. Trib.	Puff 4	LWM place.	1990	6 ea	on cutbank	
Upper Buck	Buck Cr. Trib.	Puff 4	plant	1990	15 ac	willow	
Lower Buck	Buck Cr. Trib.	Puff 5	LWM place.	1990	9 ea	on cutbank	
Lower Buck	Buck Cr. Trib.	Puff 5	plant	1990	20 ac	willow	
Cone Face	Cone Creek	Beldar 2	Rip.Fert.	1994	1 ac	Urea	yes
Cone Face	Cone Creek	Puff 7	Plant	1990	4 ac	willow	

Hills Creek Reservoir Subwatershed

Hills Creek Subwatershed - West

The existing condition of the streams west of the reservoir, except for Upper Larison Creek and Snow Creek, will need to be referenced to other streams of similar geomorphology and stream size in the watershed, since surveys have not been completed in the other drainages.

Table . Stream surveys completed in Hills Creek Subwatershed-WEST. in the MF Watershed.

Stream-shed	Streamshed Acres (CFS)	Elevation (FT)*	Gradient (%)	Valley type Rosgen Level I	Stream class	Stream name	Survey Type Date
Upper Larison	4038	4000-2720-2180	24 10	8A 3A	III II	**Upper Larison Creek**	1989 survey
Larison Main	5658 (2)	2180-1660	7	10B	II	**Lower Larison Creek**	OSGC 1964
Packard	5737 (2 to 3.5)	4500-2600-1560	18 4	8A 10B	III II	**Packard Creek**	OSGC 1964
Stony	827 (0.2)	2760-1960-1560	15 8	8A 3A	III II	**Stony Creek**	OSGC 1964
Snow	1044 (0.1)	3120-2000-1580	21 8	8A 10B	III II	**Snow Creek**	OSGC 1964 Pre-GP 1989

* Elevation is given at the upper end of the reach of change in valley type.
* OSGC - Oregon State Game Commission.

The **class III section of Upper Larison Creek is typical of headwall tributaries** with steep gradient. The creek flows through a densely forested area with steep gradients, 25 percent, at all times. Most trees within 100 feet of either side of the stream have uprooted and fallen into the lower banks. Debris piles of 6 to 36 in diameter trees, sharp angular rocks (1 to 3 ft), overlie steep sections of moss laden bedrock creating 10 to 20 ft waterfalls. Bedrock caves occur sporadically along the lower banks. No fish were present, however, **salamanders** existed in abundance in the pooled areas.

The existing physical component of the **class II section of Upper Larison Creek is typical of streams with steeply incised valleys with moderate channel gradients** in the watershed. For the most part, the riparian reserve of this stream has remained intact with some harvest in the headwaters. Recreational use occurs along a foot trail which follows the creek. The attributes of the stream are best described by a quote from the 1989 stream survey:

> "This stream is well vegetated with ferns, moss, complex root systems and a variety of angular rock sizes. Patches of highly fractured bedrock (Andesite Tuff) obstructs and diverts stream flow intermittently. Two to three foot waterfalls can be found flowing off of rocks and small log jams. Old rotten logs (3 ft+) in diameter have been caught up behind a majority of boulders. Pooling and waterfall activity increases throughout this area due to association with debris dams. Processes behind the jams include: 1) channel gradient decrease; and 2) ancient log barriers that have rotted out and failed, but have left debris piles in place where new fallen logs have created fresh jams. Many down logs occupy not only the streamshed but also overhead. These logs wedge between narrow steeply sloped banks. Pooling also occurs in relatively sparse areas, generally 5 by 5 by 1/2 ft depth. **Cutthroat trout** (3 inches in length) can be found in and amongst these well shaded pools."

The lower reach of Larison was surveyed in 1964. The mouth of the stream is 5 ft in width, with a mixed bottom type of bedrock, rubble, gravel, and sand. The riffle to pool ratio is 70 to 30, with 2 to 4 ft deep pools occurring every 100 yards. 104 square yards of marginal salmon spawning gravel is available and 42 yards of good trout spawning gravel (Thompson, 1964). **Native**

cutthroat trout 6 to 8 inches long were seen throughout. Shade cover is sparse for the first half mile.

Although the processes occurring in Packard Creek may be similar to Snow Creek, the amount of timber harvest in the Packard Creek streamshed based on aerial photos is significantly higher. There are most likely opportunities for Challenge Cost Share rehabilitation projects with private partners in this drainage.

Packard Creek is 4 feet in width at the mouth, with bedrock, boulder and rubble bottom types. The average width, however, is 12 ft. Good gravel was negligible, with 75 square yards of marginal salmon and steelhead spawning gravel. Riffle to pool ratio was 80 to 20, with 2 to 4 foot pools occurring every quarter mile. Two logs jams occur (both passable). Shade cover over the creek is slight. A few **native cutthroat trout** 6 to 9 inches long were present along with **dace**. A Forest Service trail provides access to the stream for 2 miles upstream.

Stony Creek is 3 ft wide at the mouth, with rubble and boulder substrates. Gravel is negligible. Steep gradients and low summer flows limit the value of these size streams to game fish.

The existing physical component of the **class III and IV tributaries of Snow Creek represent the steep gradient, headwall tributaries in this drainage**. The tributaries have all experienced debris torrent activity in the past (Kretzing, 1989). The steep (70 to 100 percent) sideslopes and shallow, gravely soils derive a significant portion of their cohesive strength from the root networks of the forest cover. In harvested units, the channel is primarily bedrock with little or no woody debris incorporated into the channel. Pools tend to be limited and spawning gravels non-existent.

The **class II section of Snow Creek represents the alluviated mountain valley streams** in this Subwatershed. The soils tend to be shallow, rocky and non-cohesive in a flat valley bottom of soil, gravel, and rock debris. The extensive landslide history of this streamshed has supplied more material than the stream is capable of removing, resulting in a flat floodplain-like character more typical of larger watersheds. Streambanks are generally unstable with the channel being carved into the deposits on the valley floor. The stream width is 4 feet at the mouth, with boulder and rubble substrate. Gravel is negligible. Pool habitat is well developed and supports **cutthroat trout** populations.

Hills Creek Subwatershed - East

The existing condition of the stream east of the reservoir can be generalized by the stream surveys completed in this area (Table). In general, these streams exhibit the unstable geology of the area by being naturally unstable, slightly drier than other areas (as evidence of fire history), and particularly susceptible to perturbations.

Table . Stream surveys completed in Hills Creek Subwatershed-EAST. in the MF Willamette Watershed.

Stream -shed	Stream-shed Acres (CFS)	Dominate Geology	Elevation (FT)*	Gradient (%)	Valley type Rosgen Level I	Stream class	**Stream name**	Survey Type Date
Modoc	460		2760- 1720-1560	26 12	8A 8.5A	III II	**Modoc Creek**	No survey
Bull	1906		3440- 2200-1560	26 8	8A 3A	IV III	**Bull Creek**	Pre-GP No date
Little Willow	476		2600- 1800-1560	22 9	8A 6B	IV III	**Little Willow**	R6-94
Big Willow	3090 (0.4)		4160- 3000- 1860-1560	6 8 6	8.5A 3A 10B	II II II	**Big Willow**	OSGC 1964 R6-94
Coffee Pot	6584 (1.0)		5440- 4040- 2280-1560	27 14 7	8A 3A 10B	III II II	**Coffee Pot**	OSGC 1964 R6-94
Way Face	764		2000-1560	17	8A	III	**Way Creek**	Pre-GP 1989

* OSGC - Oregon State Game Commission

No survey has been completed for Modoc Creek, which is a headwall tributary with steep to moderate channel gradients. It is evident by the large slide at Modoc Creek near the reservoir that the instability of the drainage has increased with harvest. It can be assumed that this channel is similar to Bull Creek, just a mile south.

Bull Creek, is a Class II moderate gradient channel, in a steeply incised valley. The streamshed has also sustained a high harvest rate. According to the stream survey (USDA, 1993, unpublished data):

> **"Much of the terrain above the channel is steep and slumping with hummocky, unconsolidated material. Slopes with timber are actively delivering woody debris to the valley bottom below. In the upper reaches the stream undercuts its banks severely in places increasing the potential erosion on land upslope of the stream. Cutthroat trout and crawfish were observed in the stream below the falls."**

Little Willow Creek, is similar to Bull Creek in the headwaters, but opens into a moderate-slope bound valley. Almost the entire length of the streambed is entrenched, with undercut or unstable banks. The stream bottom is gravel and cobble. The stream contains a large amount of wood that is old and decaying. Similar to the bedload laden stream of Snow Creek, the present discharge in Little Willow is insufficient to move the large logs (Anderson and Stone, 1994, unpublished data).

Way Creek is a Class IV headwall tributary. Way Creek has an abundance of woody debris in the stream channel and some brush (Howland and Gangle, 1989, unpublished data). It is essentially in pristine condition with only a small clearcut at the time of the survey. Bank stability was fair with 50 percent bare bank loose soil and very little rock content. The stream bottom material ranged from small rock (3 to 6 inch diameter) to clay. Overall canopy was moderate to open. According to Howland and Gangle:

"At the lower part of the stream, the water is running. There are plenty of aquatic insects and the presence of **Dunn's salamanders**, *Plethodon dunni*. The canopy is good here. There is a small one foot waterfall and small shallow pools."

The stream survey for Big Willow divided the stream into four geomorphic types, with the upper reach being a typical **valley wall/headwall tributary with a moderate channel gradient** and deep channel entrenchment through sand and gravel substrate. The stream had a high wood recruitment rate with 129 pieces of wood per mile, although the majority of the wood was of the brush size category (87 pieces per mile). With approximately 95 percent of the area unaffected by past timber harvest, the inner riparian serial class was predominantly large tree, consisting of Douglas-fir and scattered Western Red Cedar. Active wood recruitment was observed for most of the reach (Anderson and Stone, 1994).

Downstream from the headwalls, the stream enters a **steeply incised valley with a moderate channel gradient** and moderate channel entrenchment. At this point the stream is confined by sideslopes. The habitat complex consisted mostly of rubble, boulder Cascade-stairstep pools with bedrock. Similar to the headwaters, this reach has a high wood recruitment with 165 pieces per mile (121 pieces of the brush size category), with active recruitment from large trees throughout most of the reach. The major habitat was cascading and regular riffles.

The stream survey broke this homogeneous valley type into two reaches to capture the channel changes with increased riparian harvest. Within the harvested area (percent), the habitat complex consisted mostly of rubble, boulder Cascade-stairstep pools. The reach appeared to have been affected by high flows in the past with portions of the stream flushed to bedrock. The riparian seral class was no longer dominated by large trees and the recruitment of wood dropped to 76 pieces per mile (45 of the brush size category).

The percent harvest within the riparian area increases downstream as the stream opens into an **alluviated mountain valley**. By the mouth of Big Willow Creek, the substrate is predominately bedrock, with fine rubble in deep plunge and trench pools. Wood recruitment is reduced to 42 pieces per mile (24 pieces brush). The inner riparian area is 50 feet wide on average, and dominated by red alder and Bigleaf maple.

The upper Class III headwall tributaries of Coffeepot consist of large 7 to 10 foot waterfalls. Many of the small trees along the upper banks have bent trunks, with old growth trees tilted as much as 35 degrees toward the stream in the direction of the mass movement. As the stream passes through a nearby clearcut area, the abundance of slash materials and downed timber overlaying the stream increases dramatically. There are no fish in this area, although there is a variety of small **"yellow and green" frogs** (USDA, 1989).

The rest of Coffeepot shows the same geomorphic character as Big Willow with the stream downcutting through the steeply incised valley and opening into the alluviated mountain valley. Coffeepot, like Way, Bull, and Willow Creeks, is plagued by unstable geology, with natural as well as management induced mass wasting. The vegetation around the stream is not thick or vigorous. The upper bank slope gradient is 60 percent with mass wasting occurring and continuing. Vegetation density is only twenty percent. The stream has cut through Andesite capping and a series of poorly indurated Andesite lava flows. Rocks in the stream are mostly loose and easily moved throughout this section of Coffeepot (USDA, 1989). Many **native cutthroat trout** were seen. Cottids, dace and rainbow trout were also present. The lower mile surveyed provided good trout habitat, steep gradient above this would limit potential use by anadromous fish.

Table . Physical characteristics for streams in the Hills Creek Subwatershed-EAST, in the Lower MFW Watershed.

Stream Name	Reach .	Channel Entrench	Bed Substrate	Sinuos ity	W/D Ratio (Ave Width Ft)	Temp F	Pools/ Mile	Resid Depth
Little Willow	1	Moderate	GR/CO	1.2	10	55	-	-
Big Willow	4	Deep	GR/CO	1.0	8	51	-	-
	3	Deep	CO/GR	1.1	9	56	1	2
	2	Deep	BR/CO	1.0	25	57	1	2
	1	Slight	BR/BR	1.2	11 (3)	58	14	3
Coffeepot	5	Moderate	CO/GR	1.1	5	-	-	-
	4	Moderate	CO/GR	1.2	9	48	6	3
	3	Moderate	CO/GR	1.2	8	53	-	-
	2	Moderate	CO/GR	1.1	16 (6)	56	16	3
	1	Moderate	CO/GR	1.1	13 (8)	58	11	2

Table . Biological characteristics for streams in the Hills Creek Subwatershed-EAST in Lower MFW Watershed.

Stream Name	Reach	Lg/Sm Wood/ Mile	Brush/ Mile	D Seral Stage % Inner Rip	Species	D Seral Stage % Outer Rip	Species	Aquatic species
Coffeepot	5	57	11	SS 100	HA/HV	SP 100	CD	None observed
	4	136	14	SS/ST 40/40	HV/HV CD/CC	ST/LT 30/50	CD/CD CD/CC	Cutthroat, sculpin
	3	162	33	SS/SP 50/50	HW/HV HA/HV	SP/LT 50/50	CD/CD CD/CC	Cutthroat, sculpin
	2	136	19	SS/SP 35/59	HA/HB HA/HA	ST/LT 6/94	CD/CD CD/CD	Cutthroat, sculpin
	1	49	6	SS/SP/ST 71/14/14	HA/HB	ST/LT 29/57	CD/CD CD/CC	Cutthroat, sculpin
Big Willow	4	41	88	LT 100	-	LT 100		None observed
	3	46	121	SS/SP 50/50	HA/HB CH/HA	SS/SP/LT 50/25/25	CD	None observed
	2	30	45	SS/SP 75/25	HA/CD HA/HB	ST/LT 25/75	CD	Cutthroat
	1	18	24	SS/SP 76/33	HA/HB HA/HB	ST/LT 33/47	CD	Cutthroat

Legend
HA= Alder HB=Bigleaf HC=Cottonwood, ash, poplar
HD=Dogwood HV=Vine Maple HW=Willow GF=Grass forb

Completed Restoration

Table . Completed restoration in the Hills Creek Subwatershed in the MFW Watershed.

Streamshed	Stream	Sale Name	Treat-ment	Year	Quantity	Species	Comments
Bull	Bull Cr. &Trib	Bull Fly S.B.10	survey	1993	16 ac	--	photos
Bull	Bull Cr. & Trib	Bull Fly S.B. 4	survey	1993	3 ac	--	photos
Bull	Bull Cr. & Trib.	Bull Fly S.B. 5	survey	1993	6 ac	--	photos
Upper Coffee	Coffeepot	Buckhog 17	Plant	1991	1ac	willow	
Upper Coffee	Coffeepot	Buckhog 18	Plant, Fert.	1992	1 ac each	willow/ urea	
Upper Coffee	Coffeepot	Buckhog 19	Plant	1992	1 ac	willow	
Upper Coffee	Coffeepot	Perk 50	Plant	1991	2 ac	willow	
Lower Coffeepot	Coffeepot	Perk 52	Plant	1993	1 ac	willow	
Lower Coffeepot	Coffeepot	Perk 53	Plant	1993	1 ac	willow	
Lower Coffeepot	Coffeepot	Perk 54	Plant	1993	1 ac	willow	
Upper Coffee	Coffeepot Trib.	Sidemeat 14	Plant	1991	0.5 ac	willow	
Upper Coffee	Coffeepot Trib.	Sidemeat 15	Plant	1991	1.5 ac	willow	
Upper Coffee	Coffeepot Trib.	Sidemeat 15	Fert.	1991	4 ac	urea	
Upper Coffee	Coffeepot	Stoneover 2	Fert.	1991	0.5 ac	urea	
Upper Coffee	Coffeepot	Stoneover 3	Plant	1991	0.25 ac	willow	
Upper Coffee	Coffeepot	Stoneover 3	Fert.	1991	0.75 ac	urea	
Upper Coffee	Coffeepot	Stoneover 4	Plant	1991	0.25 ac	willow	
Upper Coffee	Coffeepot	Stoneover 4	Fert.	1991	0.75 ac	urea	
Upper Coffee	Coffeepot	Stoneover 5	Plant	1991	0.25 ac	willow	
Upper Coffee	Coffeepot	Stoneover 5	Fert.	1991	0.5 ac	urea	
Upper Coffee	Coffeepot Trib.	Stoneover 6	Plant	1991	0.25 ac	willow	
Upper Coffee	Coffeepot Trib.	Stoneover 6	Fert.	1991	0.5 ac	urea	
Larison Main	Larison Cr. Trib.	Lars TBV 7	fert.	1995	1 ac	urea	
Larison Main	Larison Cr. Trib.	Lars TBV 8	fert.	1995	2 ac	urea	
Larison Main	Larison Cr. Trib.	Zup Thin TBV 4	LWM place.	1992	7 ea	wood chunks	not cabled
Larison Main	Larison Cr. Trib.	Dinner Ridge 3	plant	1991	1 ac	willow	
Larison Main	Larison Cr. Trib.	Dinner Ridge 3	fert	1991	2 ac	urea	

Streamshed	Stream	Sale Name	Treat-ment	Year	Quantity	Species	Comments
Packard Main	Packard Cr.	Dinner Ridge 4	plant	1990	1 ac	willow	
Packard Main	Packard Cr.	Dinner Ridge 4	fert	1990	1 ac	urea	
Packard Main	Packard Cr.	Dinner Ridge 5	fert	1990	1 ac	urea	
Packard Main	Packard Cr.	Dinner Ridge 7	plant	1990	1 ac	willow	
Packard Main	Packard Cr.	Dinner Ridge 7	fert	1990	1 ac	urea	
Snow	Snow Creek	Whitewinds 5	plant	1993	1 ac	urea	

Oakridge Subwatershed

The existing condition of the streams in the Oakridge Subwatershed, except for Gray Creek, will need to be referenced to other streams of similar geomorphology and stream size in the watershed. This watershed, like that east of Hills Creek Reservoir, is composed of tuffs, breccia, colluvium, and residuum landtype complexes, which are highly erosive and susceptible to mass wasting.

Table . Stream surveys completed in Oakridge Subwatershed in the MFW Watershed.

Stream -shed	Streamshed Acres (CFS)	Elevation (FT)	Gradient (%)	Valley type Rosgen Level I	Stream class	Stream name	Survey Type Date
Gray	3759 (1)	3800- 2000- 1400- 1080-1040	2 mi 1.25 mi 2 mi 0.25 mi	8A 3A 10B 1C	III II II II	**Gray Creek**	OSGC 1964 Pre-GP 1988
Short-ridge	1304	3000- 1480- 1160- 1140	1.5 mi 0.8 mi 0.1 mi	8A 3A 1C	III II	**Shortridge Creek**	No survey
		2800- 1200- 1080- 1040	1 mi 0.2 mi 0.25 mi	8A 8.5A 1C	III II II	**Spot Creek**	No survey
Chilly Face	1635 (<0.1)	2400- 1360- 1080-1040	0.5 mi 0.5 mi 0.25 mi	8A 8.5A 1C	III III III	**Chilly Creek**	OSGC 1964

The landform of Gray Creek is very similar to Big Willow Creek, however, the mouths of Gray Creek and the other streams in the drainage, end in the flood plain of the Middle Fork of the Willamette in the lower alluvial valley as a Rosgen Channel Type C (Table). The gradient drops considerably and the meander pattern begins to widen. Historically, these stream reaches most likely functioned as overflow channels for the Willamette during storm events and as rearing areas for Spring Chinook.

Gray Creek is 6 ft in width, with boulder and rubble bottom type. Spawning gravel is negligible. Stream is of moderate value to native cutthroat trout, which are present.

The instability of this area is protrayed in a landslide near the culvert across from Gray Creek on Road 5852-333. The culvert at the time of survey did not provide for fish passage. According to the stream survey on Gray Creek, logs had fallen in the stream as a function of the thin soils, storm events and logging. The streambed had numerous debris jams and rock diversions. While some of the jams appeared stable and working as sediment traps, others maintained little to no holding capacity. **Few fish were noted in the stream, with numerous newts** (McCain, 1988).

Chilly Creek is 2 ft in width, with a bedrock substrate, very steep. The stream is considered to be of no value to game fish.

Completed Restoration

A small amount of planting has been completed in Gray's Creek. No documented monitoring was available.

Table . Restoration completed in the Oakridge Subwatershed if the MFW River.

Streamshed	Stream	Sale Name	Treatment	Year	Quantity	Species
Gray	Gray Cr. Trib.	Gray Creek 6	plant	1991	1.79 ac	willow
Gray	Gray Cr. Trib.	Gray Creek 7	plant	1991	2 ac	willow

Middle Fork of the Willamette

The existing condition for the **physical and chemical component of the Middle Fork of the Willamette** is described in Unthank and Sheehan (1994) and Lyons (1981). Stream surveys were completed in this basin in 1937, 38 and 94.

Table . Stream surveys completed in Lower MFW Watershed.

Stream -shed	Streamshed Acres (CFS)	Elevation (FT)*	Gradient (%)	Valley type Rosgen Level I	Stream class	Survey Type Date
MFW	168500 (183)	1000-2020	2.5	1C 6B	I II	US Bur of Fisheries 1937 USFWS 1938 USFS 1994

The existing physical characteristics are summarized in Table . The Middle Fork is generally a low gradient Rosgen C Channel, flowing through an alluvial valley. The bankfull width to depth ratio decreases slightly as the channel gradient increases downstream from 1 to 2 percent.

Table . Physical characteristics for Lower MFW Watershed.

Stream Location	BOF/ R6	Channel Entrench	Bed Sub-strate	Sinu-oisty	W/D Ratio (Ave Width Ft)	Temp F	Pools/ Mile	Resid Depth
Coal Creek	L/4	Moderate	CO/SA	1.1	17	54	4	4.1
Snake/Pine	K/3	Moderate	CO/SA	1.2	-	-	6	4.2
Gold/Buck	2	Moderate	CO/SA	1.2	14	-	4	4.2
Windfall/Res	J/1	Moderate	CO/CO	1.1	-	61	1	4.8

The riparian vegetation is dominated by small pole and small tree size alder and Douglas. Larger trees are only found along the lower reaches of the Middle Fork near the reservoir.

Table . Biological characteristics for Lower MFW Watershed.

Stream Name	Reach	Lg/Sm Wood/Mile	Brush/Mile	D Seral Stage % Inner Rip	Species
MFW	4	8	13	SP/ST/SS 36/55/9	CD/HA/ HW
	3	15	10	SP/ST 71/29	HA/CD
	2	12	14	SP/ST 42/50	HA/HA
	1	16	20	ST/LT 50/50	HC/HA

Legend
HA= Alder HB=Bigleaf HC=Cottonwood, ash, poplar
HD=Dogwood CD=Douglas Fir HW=Willow GF=Grass forb

Completed Restoration

Instream structures have been placed in the Middle Fork in the vicinity of the intersection with Rd. 2143 for approximately 1 mile in stream length.

Gravel bars were planted with 1000 conifer seedlings in the fall of 1994 in a dispersed area accessed from Rd. 2100425. Conifers were also planted on a gravelbar accessed by the Middlefork Trail upstream from the junction between Rd. 21 and Rd. 2127 (1100 seedlings). Species for both sites consisted of western hemlock, western redcedar, white pine, and a few Pacific yew. .

Hardwood layering (mostly willow and alder) of approximately 10 acres of gravelbars within the Middle Fork was completed the summer of 1994 using a youth crew. This work was done between the accesspoints of Rd. 2100151 and Rd. 2127.

G

Appendix G

Hydrology Documents

REFERENCE CONDITION - HYDRO

Maureen Campbell, Hydrologist

1995

Overview

The geology of the Western Cascades has determined the drainage network and water yield characteristics of the Watershed. This geologic character determines the rate at which water enters the groundwater and surface water systems. Modification of this interaction occurrs with a change in vegetation pattern.

Historically a change in vegetation occurred through natural fire and/or disease and bug infestation, all of which can result in reduced crown closure. Open areas with trees less than 35 years of age evapotranspire less water than do forests with full canopy closure, thus introducing more water into the soil. Open areas also accumulate greater quantities of snow than forests with full canopy closure. Snow accumulation and rain on snow events from warm precipitation fronts can cause rapid snow melt and high peak flows within the channel networks.

The historical range of hydrologically unrecovered forest land varies from 21% to 1%. The reduction of hydrologically unrecovered forest to 1% results from modern fire suppression that began in 1910. This is before Hills Creek Dam was constructed.

Table ___: Percent Hydrologically Unrecovered

Seral Stage	Years		
	1835-1855	1876-1915	1947
Stand Initiation Early Habitat	21%	17%	1%
Rock outcrops meadows unsuited	3%	4%	3%
Total Unrecovered	24%	20%	4%

Middle Fork Willamette River

The MFW River from Coal Creek to the Reservoir flows through a corridor defined by the local geology roughly a 1/4 mile wide. The MFW is an alluvial channel composed of sand, gravel and cobble-sized material. The average stream gradient is 2%. The 1946 air photos reveal a single thread channel alternating back and forth from single to double thread as it flows from one bend to the next. The active floodplain width roughly 2 to 5 times the wetted channel width. Islands of mature timber are present within the active channel. The riparian area was dominated by mature timber. Large woody material was hard to distinguish on these high-altitude photos.

Drainage Pattern

The Middle Fork Willamette River enters the Watershed from the south and flows north toward Hills Creek. The major streams that flow directly into the MFW River parallel each other and have a secondary dendritic drainage pattern. Stream density for the entire Watershed is 3.1 miles per square mile. Stream densities for the Subwatersheds range from 2.7 at the south end of the Watershed to 3.4 at the north end of the Watershed. Table____ provides information on area, miles of stream by Class, and drainage density. Note that the intermittent Class IV streams have been delineated from air photos rather than from topographic crenulations.

Table Subwatershed Area, Stream Class, and Stream Density.

5TH/6TH FIELD			SQUARE	STREAM CLASS				TOTAL	STREAM
	SUBWATERSHED	ACRES	MILES	I	II	III	IV	MILES	DENSITY
21-1	Oakridge	10,671	16.7	5.0	4.1	13.3	34.3	57	3.4
21-2 west	Hills Creek Reservoir	25,247	39.4	0.0	15.6	30.7	92.4	139	3.5
21-2 east	Hills Creek Reservoir	14,600	22.8	0.0	9.2	16.3	34.1	60	2.6
21-2 all	Hills Creek Reservoir	39,847	62.3	0.0	24.8	47.0	126.5	198	3.2
21-3 west	MFW/Little Pine	22,275	34.8	9.8	18.7	26.4	74.0	129	3.7
21-3 east	MFW/Little Pine	16,254	25.4	5.8	16.8	15.6	25.8	64	2.5
21-3 all	MFW/Little Pine	38,529	60.2	15.7	35.5	42.0	99.8	193	3.2
21-4 north	Coal Creek	1,584	2.5	0.9	1.4	2.1	2.9	7	3.0
21-4 south	Coal Creek	14,957	23.4	1.6	9.6	22.7	29.6	64	2.7
21-4 all	Coal Creek	16,542	25.8	2.5	11.1	24.8	32.5	71	2.7
	TOTAL 21	105,590	165.0	23	75	127	293	519	3.1

Longitudinal Profiles

Valerie Rogers, Hydrologic Technician

Longitudinal stream profiles for the east and west sides of the Watershed can be seen in figures _____ and ____. The profiles show relative position of the streams within the Watershed, and their topographic relief.

Figure . Longitudinal Profile East Side of MFW River and Reservoir.

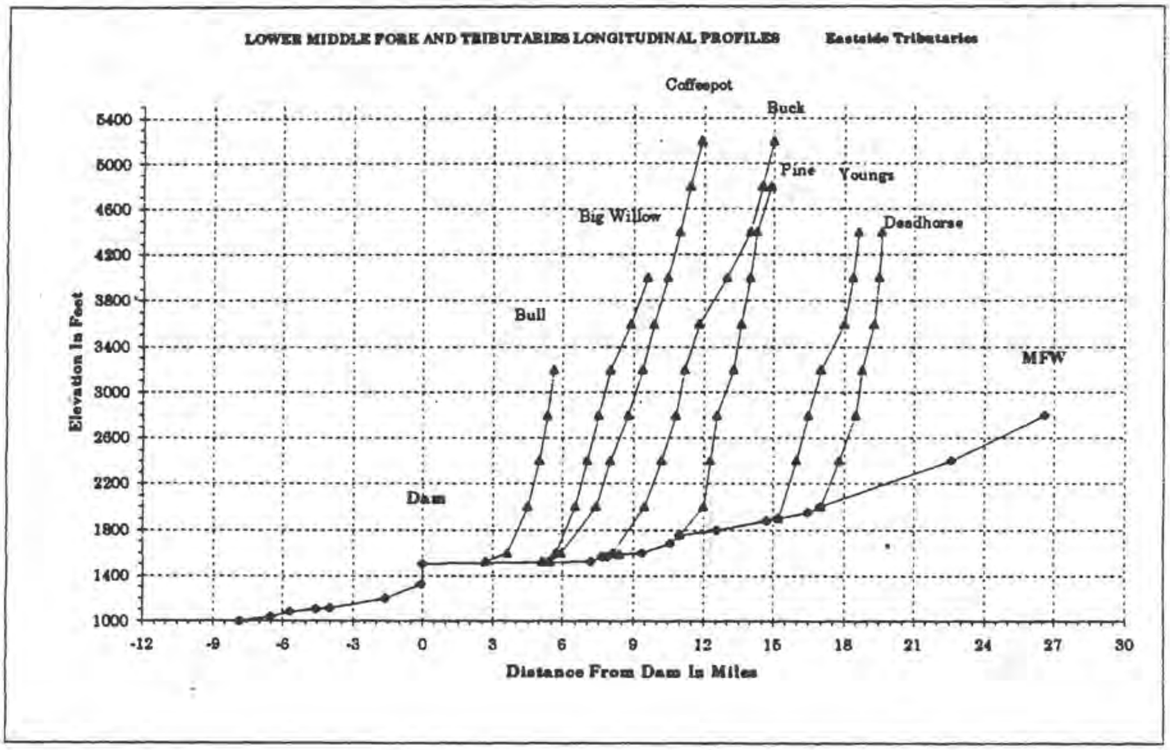
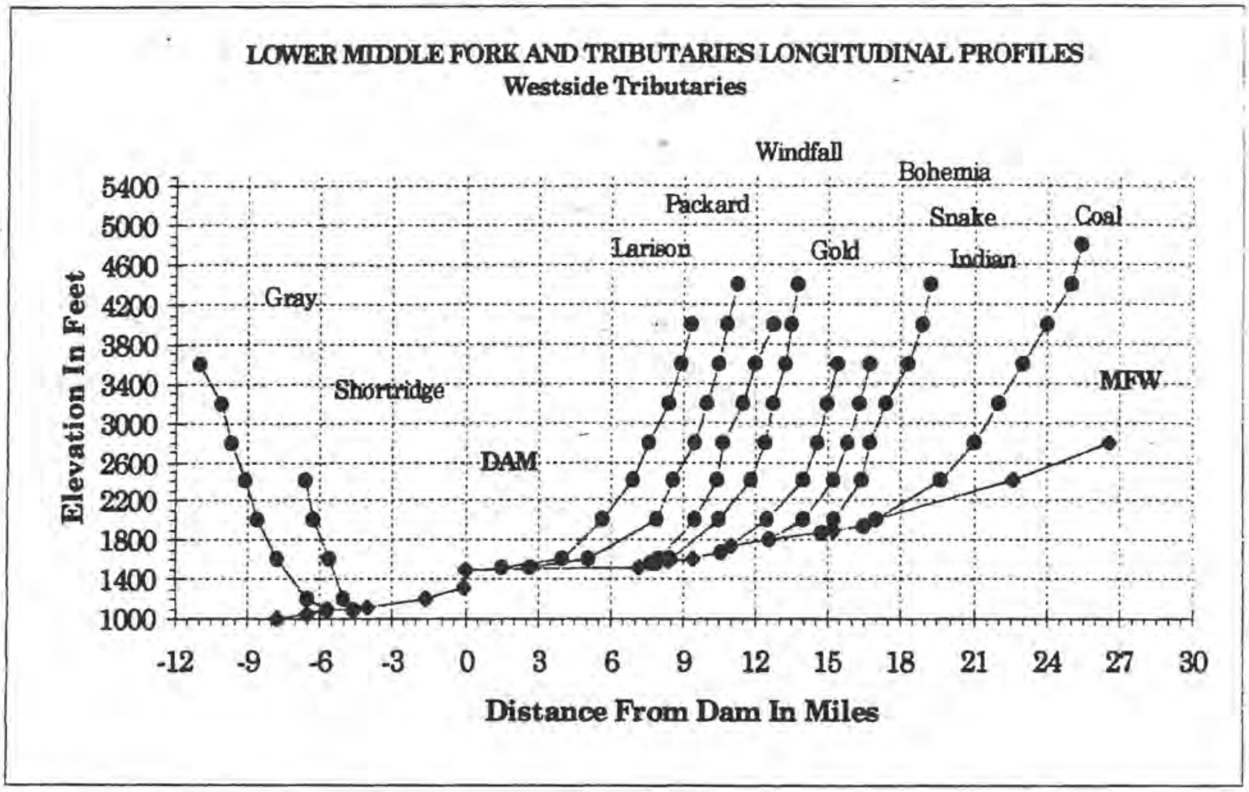


Figure . Longitudinal Profile West Side of MFW River and Reservoir.



Water Yield

Maureen Campbell, Hydrologist

Water Yield Class is an indicator of the rate at which water is transmitted through a particular soil profile to the stream system and into the groundwater. The water yield data is a character component determined for each SRI Landtype. The following definitions were taken from the Soil Resource Inventory GIS Data Dictionary, Willamette National Forest, 1994.

Water Yield Class I

Soils with a low runoff rate and a high water detention capacity, given that the soils are not saturated or frozen. Important in sustaining high base flow.

Assumption: 75% to Base Flow
25% to Storm Flow

Water Yield Class II

Soils with a moderate runoff rate and moderate water detention capacity. Water contributes to both peak flows and base flow.

Assumptions:	50% to Base Flow 50% to Storm Flow

Water Yield Class III

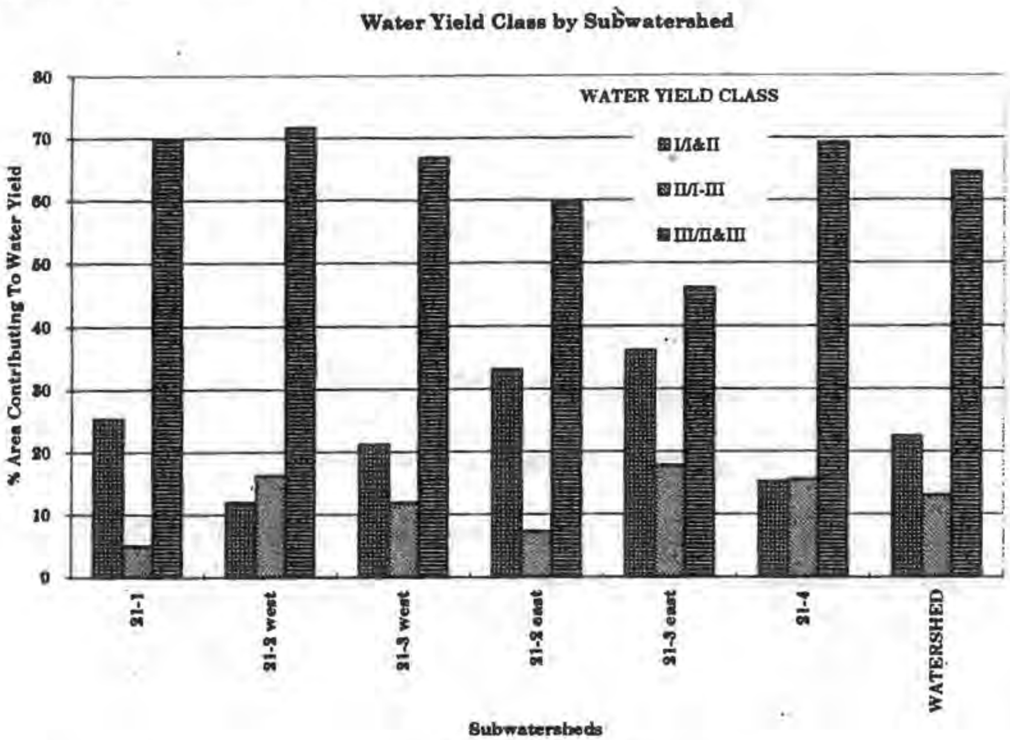
Soils with a high runoff rate and low water detention capacity. The storage capacity is low and easily exceeded with most of the water contributing to peak flow. Little water is yielded to sustain base flow.

Assumptions:	25% to Base Flow 75% to Storm Flow

Water Yield Character

The MFWDT Watershed is dominated by landtypes with a Class III water yield indicating that streams are flashy and respond quickly to storm events , and less water is detained in the soils as groundwater for contribution to summer low flow. Only 22% of the area is represented by landtypes that have a high water detention and low peak flow response to storms given that soils are neither saturated nor frozen. Fourteen percent of the area provides water equally to groundwater and to the stream following storms. The eastern half of Subwatersheds 21-2 and 21-3, Hills Creek Reservoir and Middle fork Willamette /Pine Creek Subwatersheds, show a greater percentage of the area covered by Landtypes with a Class I water yield, indicating Landtypes with a greater clay content and water storage capacity. Comparatively 33 and 36% on the east and 12 and 21% on the west side of the Subwatersheds.

Figure ___. Water yield Class



This reveals that streams on the west side such as Larison, Packard, Windfall, and Gold Creeks will show a potentially greater peak flow response to storm events as compared to Bull, Big Willow , Coffeepot and Buck Creeks on the east side of the Reservoir. Nonetheless, all of the Subwatersheds within this Watershed are dominated by streams that respond quickly to storm events.

Rain On Snow - Characterization

Valerie Rogers, Hydrologic Technician

Rain on snow events are common in the Western Oregon Cascades. These precipitation events bring warm air and rain into the mountains melting snowpacks quickly and delivering great amounts of water to the drainage network in a short period of time. Rain on snow events take place within the transitional snow zone (TSZ) which ranges in elevation from roughly 1500 to 4000 feet. The TSZ also varies in elevation relative to aspect. The upper boundary of the TSZ can be approximated by the True Fir/Doug Fir transition zone. Approximately 78% of the MFWDT Watershed is in the TSZ. The remaining area above 4000 feet generally maintains a seasonal snowpack.

This process is significant in that harvest units that are less than 30 years old accumulate greater quantities of snow than adjacent timbered lands.
Due to the high percentage of area within the TSZ, rapid flood peaks and high flows associated with rain on snow events are a dominant hydrologic process in the MFWDT Watershed. These storm flows in turn are an important factor affecting fluvial sediment transport rates as well as transport of large and small organic material. These higher flows also provide access to side channels which play an important role in providing diverse, high quality aquatic habitat to the local fauna.

Spring Season Water Yield

Maureen Campbell, Hydrologist

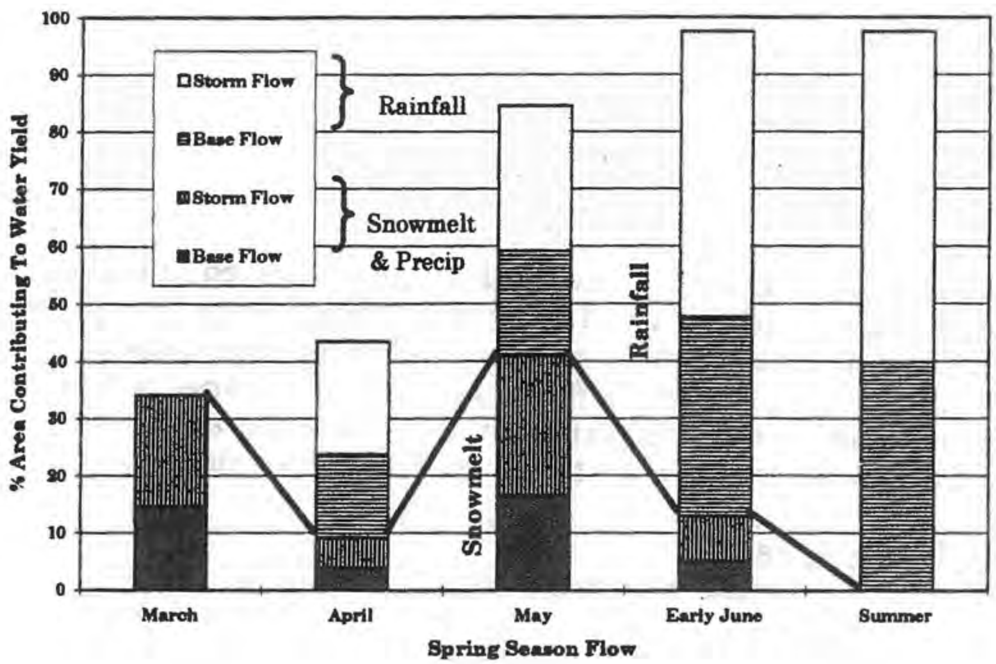
Based on aspect, elevation, water yield, and the expected timing of snow melt a flow regime was developed for the spring season. Assumptions were made on the percentage of water that would contribute to storm flow (peak flow) for a given water yield class. These values are shown below in Table_____. In general the timing assumption is that the snow pack will melt off earlier in the season on southerly aspects and at lower elevations first and higher elevations on northerly aspects last. Timing calculations are as follows: the drainage area of the water yield class multiplied by the percentage of water expected to contribute to storm flow and to base flow for a particular water yield class, given the aspect and elevation. The water yield analysis does not account for the quantity of precipitation, the status of groundwater storage, or vegetative condition. The influence of vegetation will be discussed under the chapter on Existing Conditions for Hydrologic Recovery.

Table . Assumptions for Snow Melt by Aspect and Elevation for Spring Season Flow

Aspect	Elevation	Snow Melt Off During
South Slope	X<4000 ft	March
South Slope	X>4000 ft	April
North Slope	X<4000 ft	April & May
North Slope	X>4000 ft	May & early June

Note: South Slopes include: west, southwest, south and east aspects.
North Slopes include: northwest, north, northeast, and east.

Middle Fork Willamette Downstream Tribs



Maureen Campbell, Hydrologist

ISSUE VM VEGETATION MANAGEMENT

Riparian Habitat

VM5

Riparian area vegetation has been altered within this Watershed by harvest activities, road building, and wildfire. Impact of the Shady Beach Fire on the riparian area is included within the harvest acres. Stream temperature, channel stability, and the potential for future large woody material recruitment is a product of the geology, vegetation and climate. These characteristics are further modified by management activity within the riparian corridor.

Stream Temperature

Stands that are within the riparian area, younger than 35 years in age, in general do not provide adequate shade for the stream environment especially for wider streams. On the other hand smaller streams may be shaded before this time depending on the local geomorphology and elevation. The alteration of site character by harvest, such as elevating the water table or intensifying a frost pocket, can retard the rate of regeneration. The impact of vegetation manipulation on water temperature is presented relative to the miles of perennial stream harvested within the last 35 years (see Table____).

Table____. Percent perennial stream harvested with max recorded stream temperature

Subwatershed	Stream	% Perennial Harvested	Max Water Temp (Fahrenheit)	Date
21-1	Gray	8.5		
21-1	Shortridge	0.0		
21-2 west	Larison	14.6		
21-2 west	Packard	56.2	77	1992
21-2 west	Stony	100		
21-2 west	Snow	14.5		
21-2 east	Modoc	20.8		
21-2 east	Bull	19.9	68	1994
21-2 east	Little Willow	0.0		
21-2 east	Big Willow	42.0	71	1994
21-2 east	Coffeepot	25.0	65	1994
21-3 west	Windfall	30.0	65	1992
21-3 west	Gold	26.6		
21-3 west	Bohemia	46.6	* 63	1993
21-3 west	Snake	28.6	* 64	1990
21-3 west	Spring Butte	46.9		
21-3 west	Indian	33.0		
21-3 east	Buck	23.9	76	1992
21-3 east	Estep	38.2		
21-3 east	Pine	26.6		
21-3 east	Youngs	16.7	64	1990
21-4 south	Coal	22.8	66	1993
21-4 north	Deadhorse	26.8		

Note: a) Stream miles harvested was hand measured from 1995 GIS map.
b) * indicates grab sample; otherwise water temperatures are from Max-Min thermometers.

Channel Stability

Vegetation manipulation of the channel bank and floodplain plays a significant role in maintaining the structural integrity of the channel and floodplain morphology. Harvest activity results in the loss of root strength that formerly held banks together creating banks vulnerable to erosion processes which are accelerated with storm events. Resultant influxes of sediment to the bedload can cause further erosion and deposition downstream, widening stream channels, elevating water temperatures, and deteriorating aquatic habitat. The impact of vegetation manipulation on channel stability is presented relative to the percent riparian buffer harvested for all stream classes within the last 35 years (see Table_____, Riparian Vegetation).

Large Woody Material Recruitment

Managed and unmanaged stands within the riparian area older than 55 years of age are assumed to begin providing both the down woody and the large woody material component to the riparian area, stream channel and floodplain. Trees 55 years of age are generally around 15 inches in diameter, and vary according to site conditions and tree species The following table shows the percent riparian area by Subwatershed less than 35 years of age and those greater than 55 years in age.

Table____. Riparian vegetation less than 35 years old and greater than 55 years old.

Subwatershed	% Riparian Area X < 35 years	% Riparian Area X > 55 years
21-1	8	72
21-2	22	50
21-3	33	46
21-4	33	64
Total 21	26	53

Note: a) 4% of each Subwatershed is roaded (roads have a 40 foot buffer and include all mapped in GIS).
b) riparian buffer calculations are inclusive of Class I-IV streams.
c) riparian buffer widths are based on the President's Plan.

Hydrologic Recovery

VM3

As a whole, 37% of the MFWDT Watershed has been harvested since 1960 and is vegetated by trees less than 35 years old; roughly the age where stands are considered hydrologically recovered as related to crown closure. Traditionally hydrologic recovery is based on a transient snow zone with an upper elevation of 4,000 feet, but because the Rigdon Ranger District is in a position of transition between the northern wet and colder forests and the southern warm and dryer forests, the transient snow zone likely extends to a higher elevation band and is inclusive of the higher ridge tops of this Watershed around 5,500 feet. Hydrologic recovery using stands less than 35 years of age at all elevations is presented in Table ___, Hydrologic Recovery by Subwatershed. Subwatersheds will then be further described relative to the east and west sides of the Reservoir and MFW River. These descriptions will include stream watershed hydrologic recovery to further reveal harvest activity.

Table___. Hydrologic Recovery by Subwatershed.

	Inside Riparian	Outside Riparian	Private	All Elev X<35 yrs	Total Acres	% X<35 yrs	% Hydrologic Recovery
21-2 east	762	3,839	0	4,601	14,600	32	68
21-1	**161**	**1,075**	**431**	**1,668**	**10,672**	**16**	**84**
21-2 west	717	2,564	9,240	12,521	25,247	50	50
21-2	**1,479**	**6,403**	**9,240**	**17,121**	**39,847**	**43**	**57**
21-3 west	1,435	4,271	4,121	9,827	22,275	44	56
21-3 east	1,012	4,346	0	5,358	16,254	33	67
21-3	**2,447**	**8,616**	**4,121**	**15,184**	**38,529**	**39**	**61**
21-4 north	111	312	0	423	1,584	27	73
21-4 south	728	3,689	0	4,417	14,958	30	70
21-4	**839**	**4,001**	**0**	**4,840**	**16,542**	**29**	**71**
21	**4,925**	**20,095**	**13,792**	**38,813**	**105,590**	**37**	**63**

Note: all private land is assumed to be less than 35 years old.

Table.____ Percent Area and Acres Harvested for above 4,000 feet.

Stands X<35 yrs	% 21-1	% 21-2	% 21-3	% 21-4	% Watershed	Total Acres
X>4000'/north	37	43	53	32	42	13,947
X>4000'/south	30	45	37	25	35	9,891
Total X>4000'	36	44	46	29	39	23,837
Total Ac X>4000'	356	5,233	9,587	8,661	23,837	

Subwatershed 21-1

- most hydrologically recovered Subwatershed.
- moderately high potential for rain on snow events occur.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-1	Gray	19	81
	Shortridge	21	79

Subwatershed 21-2 East

- moderately high potential for rain on snow events to impact the stream channel.
- east side of Reservoir slightly less flashy, more clays for suspended sediment, riparian vegetation better condition less channel/floodplain erosion.
- nearly half of the area above 4,000 feet within 21-2 has been harvested in the last 35 years.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-2 east	Modoc	90	10
	Bull	43	57
	Little Willow	24	76
	Big Willow	24	76
	Coffeepot	31	69

Subwatershed 21-2 West

- moderately high potential for rain on snow events to occur and impact the stream channel.
- west-side of Reservoir - flashier streams, some have little to know riparian vegetation, greater potential for elevated water temperatures and channel/floodplain erosion.
- nearly half of the area above 4,000 feet within 21-2 has been harvested in the last 35 years.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-2 west	Larison	33	67
	Packard	64	36
	Stony	88	12
	Snow	22	78

Subwatershed 21-3 East

- moderately high potential for rain on snow events to impact the stream channel.
- east side of Reservoir slightly less flashy, more clays for suspended sediment, riparian vegetation better condition less channel/floodplain erosion.
- nearly half of the area above 4,000 feet within 21-3 has been harvested in the last 35 years.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-3 east	Buck	36	64
	Estep	33	67
	Pine	32	68
	Youngs	30	70

Subwatershed 21-3 West

- moderately high potential for rain on snow events to impact the stream channel.
- west side of Reservoir - flashier streams, some areas have little riparian vegetation, greater potential for elevated water temperatures and channel/floodplain erosion.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-3 west	Windfall	28	72
	Gold	43	57
	Bohemia	39	61
	Snake	50	50
	Spring Butte	75	25
	Indian	49	51

Subwatershed 21-4

- most hydrologically unrecovered Subwatershed.
- moderately high potential for rain on snow events to impact the stream channel.
- majority of harvest within last 35 years.

	Stream	% X<35 yrs	% Hydrologic Recovery
21-4	Deadhorse	31	69
	Coal	29	71

Water yield remains the same as described in the Reference Condition. The majority of the MFWDT is composed of soils and geology that have a high runoff rate producing streams with a quick response to precipitation and snow melt events.

Issue TR Existing Transportation System

Increase In Drainage Density

TR3

Stream density and pattern determines the peak flow timing and duration within a channel and the system as a whole. Water yield is also an important factor determining the rate at which water is transported from the point of raindrop impact to the stream channel. Predominantly we have soils that transport water rapidly to the stream channel producing flashy flow responses to storm events and snow melt. Roading interrupts the subsurface and surface flow of water to the stream system, and channelizes the water in the ditches. These "pseudo" class IV streams effectively shorten the time it takes for water to reach the stream channel, further accentuating the flashy streamflow tendency. Within the Watershed, the road network effectively doubles the drainage density, thus decreasing the time it takes for the stream to respond to a storm event (see Table ____ for road and stream density values by Subwatershed). This causes greater peaks in flood flow, and consequentially a greater potential for floodplain and channel alteration.

Table____. Road and stream density.

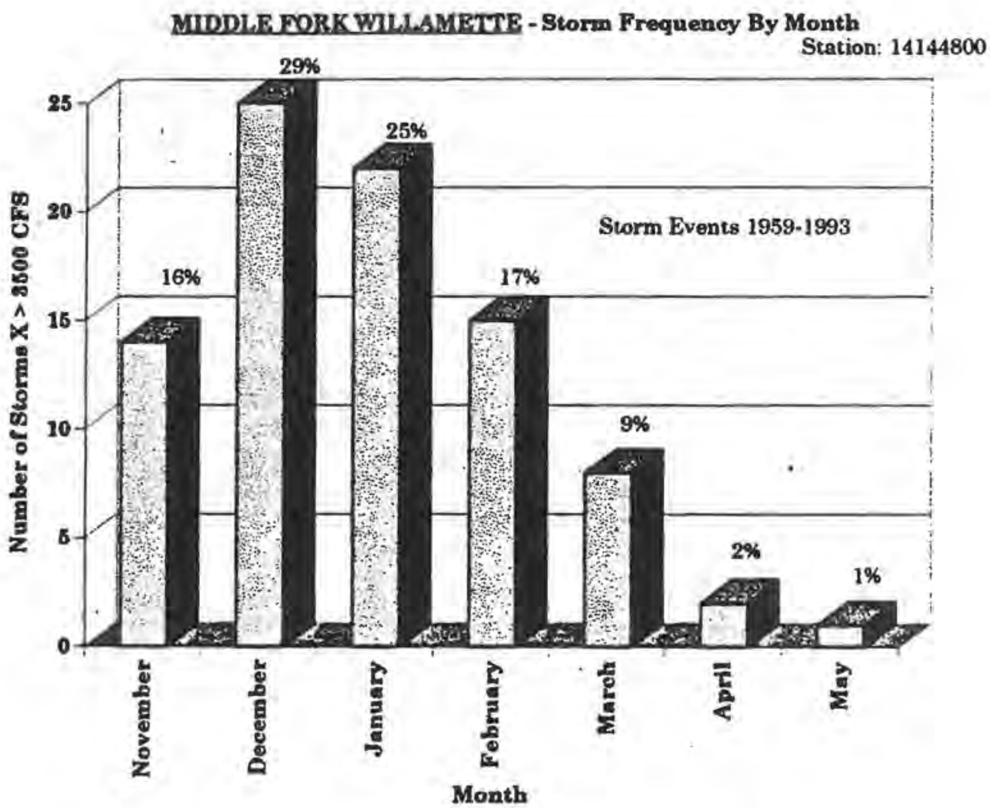
Subwatershed	Square Miles	Road Density	Stream Density	Road & Stream Density
21-1	16.7	3.3	3.4	6.7
21-2	62.3	3.6	3.2	6.8
21-3	60.2	3.5	3.2	6.7
21-4	25.8	3.0	2.7	5.7
Watershed Total	165	3.4	3.1	6.5

Streamflow

The MFW River above the Hills Creek Dam has one USGS Gauging Station which has been operational since 1959 recording both stream temperature and stream discharge. Station 14144800, named the "Middle Fork Willamette River Near Oakridge, OR", is located roughly 0.5 miles upstream from the Reservoir near Sand Prairie Campground. The drainage area of the station is 258 square miles and includes both the Upper Middle Fork Willamette Watershed and the MFWDT Watershed with the headwaters originating in the Diamond Peak Wilderness. Analysis of water years 1959 through 1993 provided the following insights and information.

Flood frequency by month reveals the number of streamflow peaks greater than 3,500 cubic feet per second (cfs) occurring within the watershed. The USGS has determined that 3,500 cfs represents a flood given the morphology of the channel. The period of record shows that more than half of the floods took place in December and January, and that roughly another one-third of the floods occurred in March and April as can be seen in Figure____. The largest of the floods occurred in December 1964 where precipitation initially fell as snow, then temperatures warmed and were followed by heavy precipitation, melting snow below 5,000 feet(Waananen, Harris, and Williams, 1971).

Figure___. Flood Frequency Greater Than 3,500 cfs on MFW, 14144800

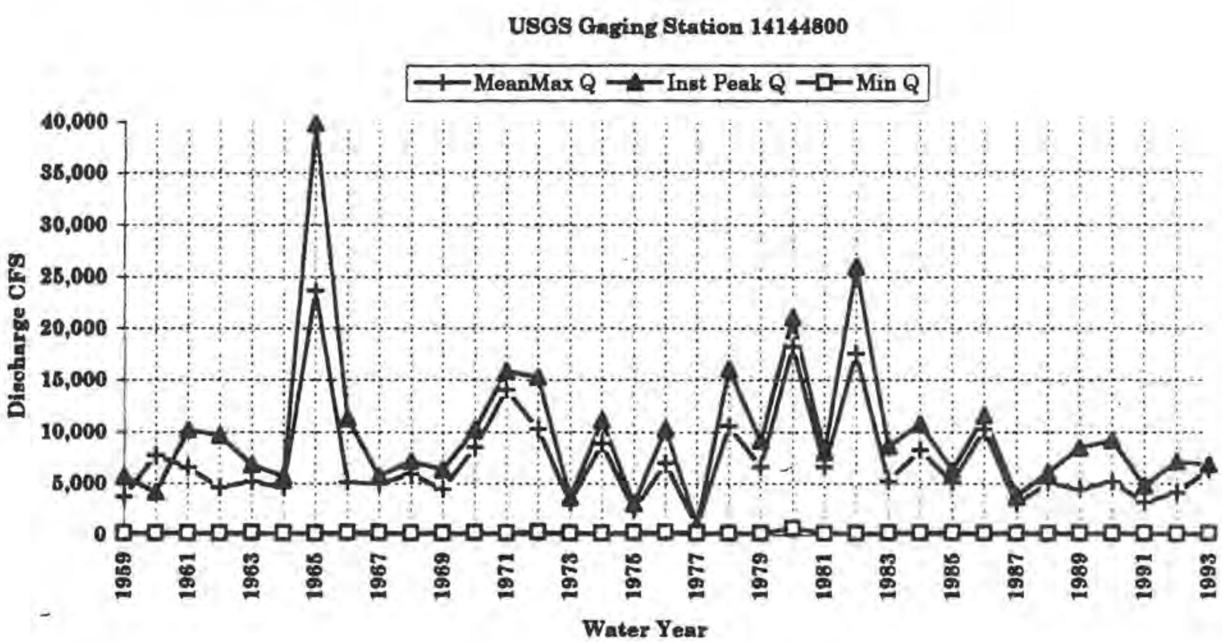


Instantaneous peakflows, mean daily maximum flows and minimum flows for the period of record are shown in Figure____. The maximum instantaneous peakflow for the period of record took place in water year 1965 on December 22, 1964 reaching an instantaneous peak flow of 39,800 cfs. The mean maximum daily discharge for that storm was 23,700 cfs. A recurrence interval (RI) was developed from the mean maximum annual flood events for the period of record using the Log-Pearson Type III Duration-Frequency Analysis. The RI for the <u>mean maximum flow</u> of the 1964 flood event is roughly 50 years (see Beilharz et al., 1991. <u>Instantaneous peak flow</u> recurrence intervals were developed for this gauging station, 14144800, by Harris et al. in 1979 and include the following values:

Instantaneous Peak Flow Recurrence Intervals, 14144800

Recurrence Interval	Discharge (cfs)
2 year	8,140
5 year	13,700
10 year	18,300
25 year	24,900
50 year	30,600
100 year	36,900

Figure___. Hydrograph for the Period of Record, Station 14144800



Other notable flood events occurring in the Willamette River Basin prior to this period of record include: 1861, where the flood event exceeded the 1964 flood in magnitude; 1890, where the flood was of slightly lesser magnitude than the 1964 event; in addition floods of a smaller magnitude took place in 1923, 1945, and 1955 (Waananen, Harris, and Williams, 1971).

Hydrologic Character

Within this watershed the hydrologic character of the geology and soil combine with the climate to create the following:

- the greatest quantity of total monthly flow, as seen for the averaged period of 1964-1993, occurs from December to May, peaking in December and January (see Figure____, Average Total Discharge by Month for 1964-1993, MFW River).
- the greatest frequency of flood events, larger than 3,500 cfs, occurs in December and January (see Figure___, Flood Frequency Greater than 3,500 cfs on the MFW). And although the frequency of flood events is on the decrease from February to May, the total discharge for those same months remains fairly high and constant (see Figure___, Average Total Discharge by Month for 1964-1993, MFW River).
- Higher flows in March and May are likely in response to snowmelt occurring below 4,000 feet, on the south slope and north slopes respectively. See both the Spring Season Flow Figure and Table and the Figure ___, on Average Total Discharge by Month for 1964-1993, MFW.
-

Figure____. Average Total Discharge by Month for 1964-1993, MFW River.

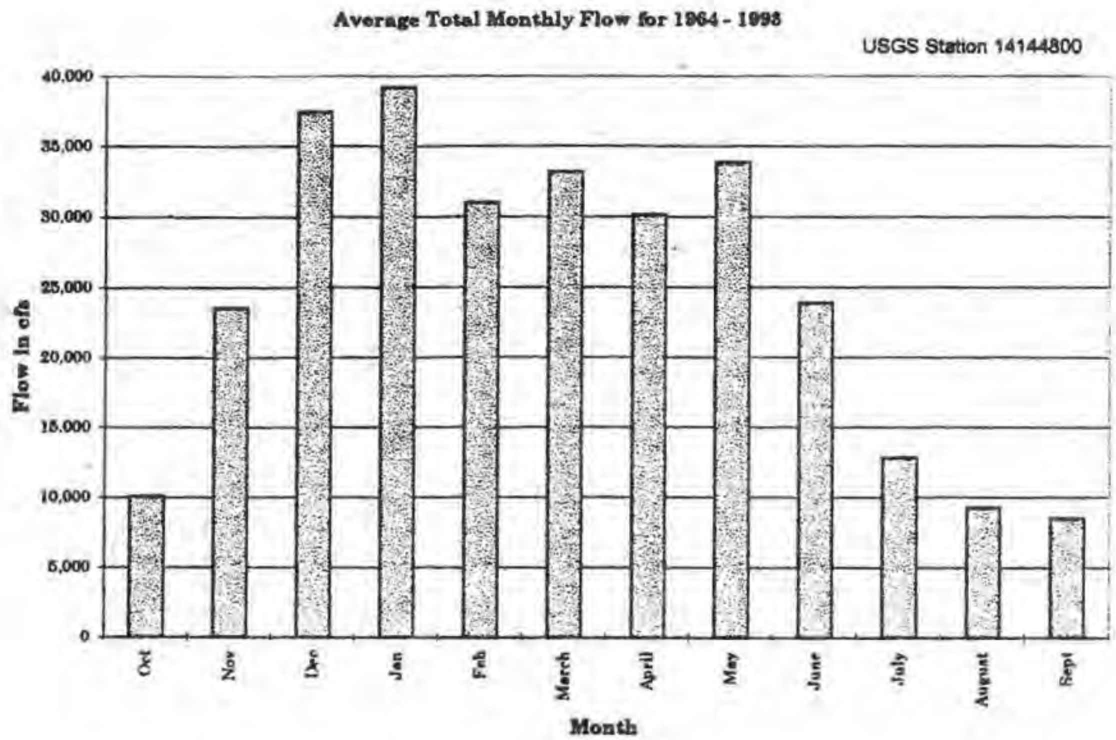
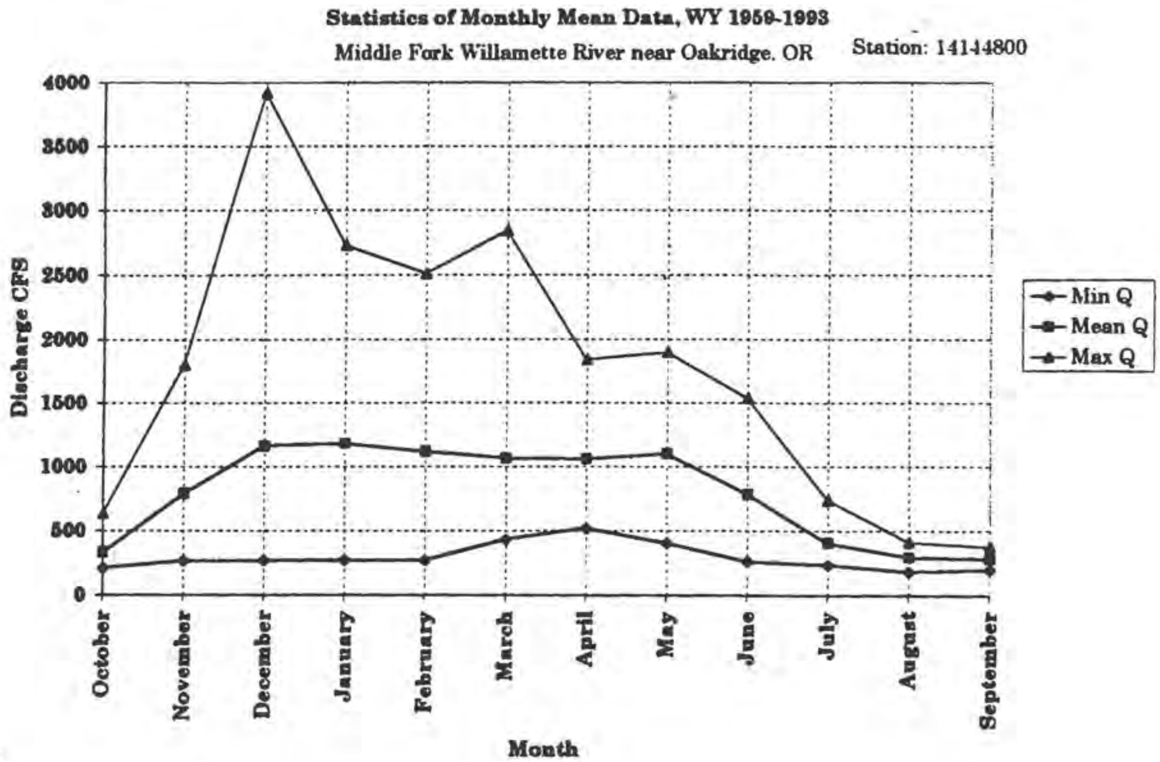


Figure____. Variance of Mean Discharge by Month for the period of record.



Temperature Regime

Valerie Rogers, Hydrologic Technician

Prior to timber management activities dominating the MFWDT Watershed, the MFW river was characterized by cool water temperatures year round. Temperature measurements taken during the 1937 US Bureau of Fisheries (USBF) survey reveal water temperatures ranging from 50 Fahrenheit (F) near Simpson Creek, immediately upstream of the Watershed boundary, to 58 F near Coffeepot Creek. Table ____ shows water temperature measurements, measurement time, and location of the readings by the USBF.

Table____. 1937 Water Temperatures MFW River

Location	Date	Time	Sky	Air Temp F	Water Temp F
MFW/Simpson	9/3	14:30	P.cloudy	67	50
MFW/Estep	9/2	16:10	Fair	68.5	56
MFW/Coffeepot	8/28	16:40	Fair	64	58
MFW/Modoc	8/31	17:00	Fair	62	57

The late afternoon/late summer timing of these measurements is past the usual peak summer temperatures which occurs from late July through mid August. Thus these values can be expected to be slightly lower than the maximum summer water temperature for 1937, but provide a good indication of the reference condition. In addition, some riparian harvest along the MFW may have occurred by 1937 influencing water temperatures and what we are considering to be the undisturbed condition.

It is likely the temperature of most tributaries was slightly cooler than the mainstem of the MFW due to the greater amount of canopy closure and the overall higher elevation of the tributaries. During the Bureau of Fisheries survey, temperatures were measured at the mouths of three tributaries spaced in the lower, middle, and upper sections of the Watershed (see Table___).

Table____. 1937/38 Water Temperatures in Tributaries of MFW River.

Location	Date	Time	Sky	Air Temp F	Water Temp F
Simpson Cr	9/12	na	na	70	52
Buck Cr	7/10	na	na	70	54
Hills Cr	9/11	14:30	Clear	70	57

These values average 54.3 F, one degree cooler than the mainstem at 55.25 F. The data suggest a general trend of increasing temperatures in the downstream direction for both the mainstem and tributaries.

MFW River Stream Temperatures 1959-1987

Natural disturbance processes such as fire, debris flows, windthrow, and disease have periodically altered the thermal regime in various parts of the drainage network, primarily through tree mortality. Temperature conditions in the Watershed overall however remained favorable for salmonids (~58) as evidenced by observations of "fair numbers" of rainbow, cutthroat, dolly varden (bull trout), and chinook reported in the 1937 USBF survey.

Temperature is a highly variable ecosystem element which can be characterized in many different ways. The following discussion of current temperature conditions is based primarily on a qualitative evaluation of available data.

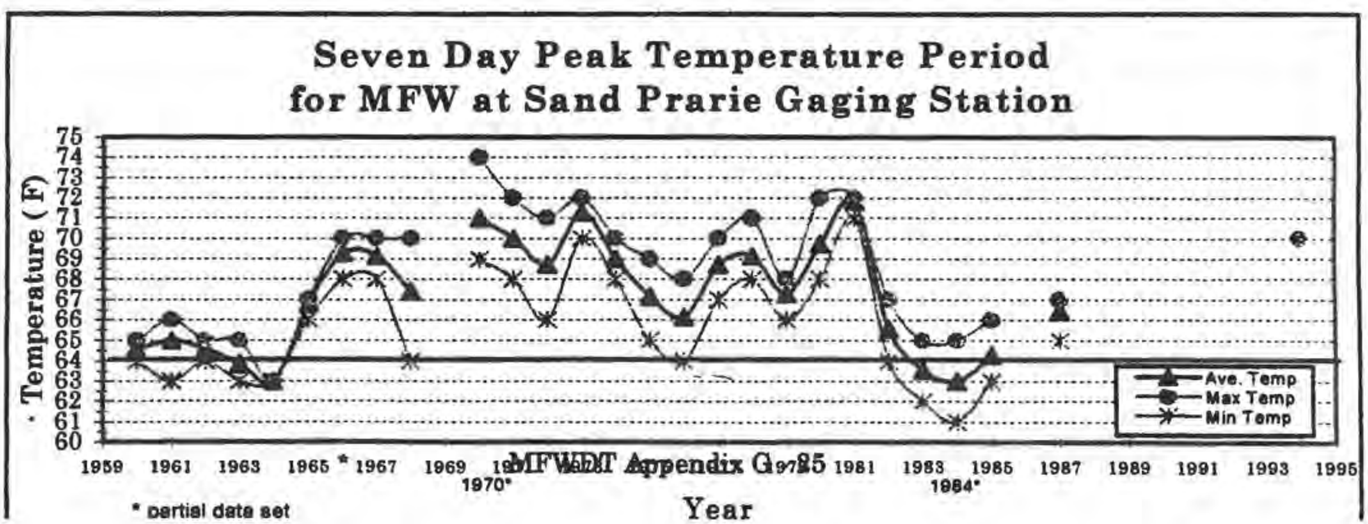
From an overall watershed perspective, temperature values in the mainstem MFW river are important to consider. Conditions in the mainstem reflect the integration of several factors which affect stream temperatures in the entire drainage network upstream of the sample location. These include broad scale factors such as elevation, air temperature, and seasonal solar radiation as well as fine scale factors such as flow, substrate, and canopy characteristics.

Data is available from a USGS gauging station located at Sand Prairie just above the upper extent of Hills Creek Lake. Temperature at this location is partially affected by temperatures in upstream tributaries outside the boundary of this watershed, and likewise is unaffected by temperatures in several downstream tributaries which drain directly into Hills Creek Lake. Daily max/min values have been recorded nearly continuously from 1960 to 1987. This period of record encompasses about half the period of intensive forest management.

Seven Day Peak Period

Figure_A_ displays the annual variation in the "seven day peak period", a temperature parameter of biological importance for cold water fish (DEQ 1994). The average, maximum, and minimum values for the peak period are shown for each year. The average values range from 63 degrees in 1964 to 72 degrees in 1980. The recommended maximum for the average value during the seven day peak period is 64 degrees. The data show only four years in which the average value has not exceeded this magnitude.

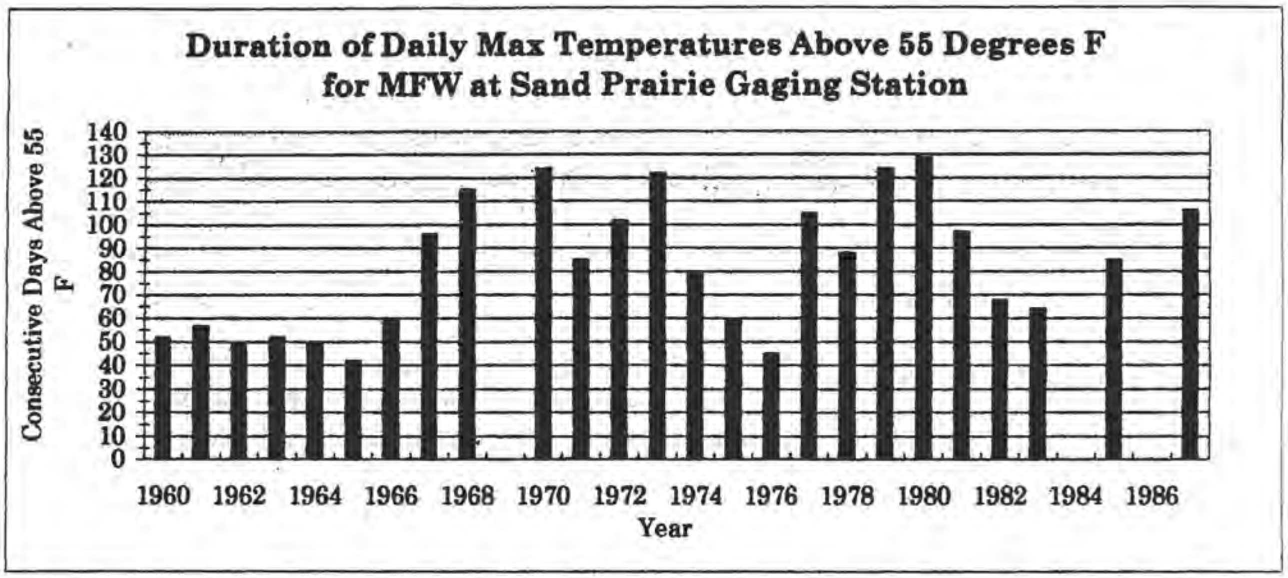
Figure_A._ Seven Day Peak Temperature Period for MFW at Sand Prairie Gauging Station.



Number of Days With Stream Temperatures above 55F

Another view of the temperature regime of the MFW at this location is shown in figure_B_. For Chinook salmon, 55 degree is at the upper boundary of the range of satisfactory conditions for adults and near the middle of the range for juveniles (DEQ 1994). The number of consecutive days in which maximum temperatures were above 55 degrees ranged from 42 in 1964 to 128 in 1980. Although not tied to a specific water quality requirement, this view of the data reveals a potential biological concern related to the duration of low level temperature stress.

Figure_B_ Duration of Daily Maximum Temperatures Above 55 Degrees F for MFW at Sand Prairie Gauging Station.

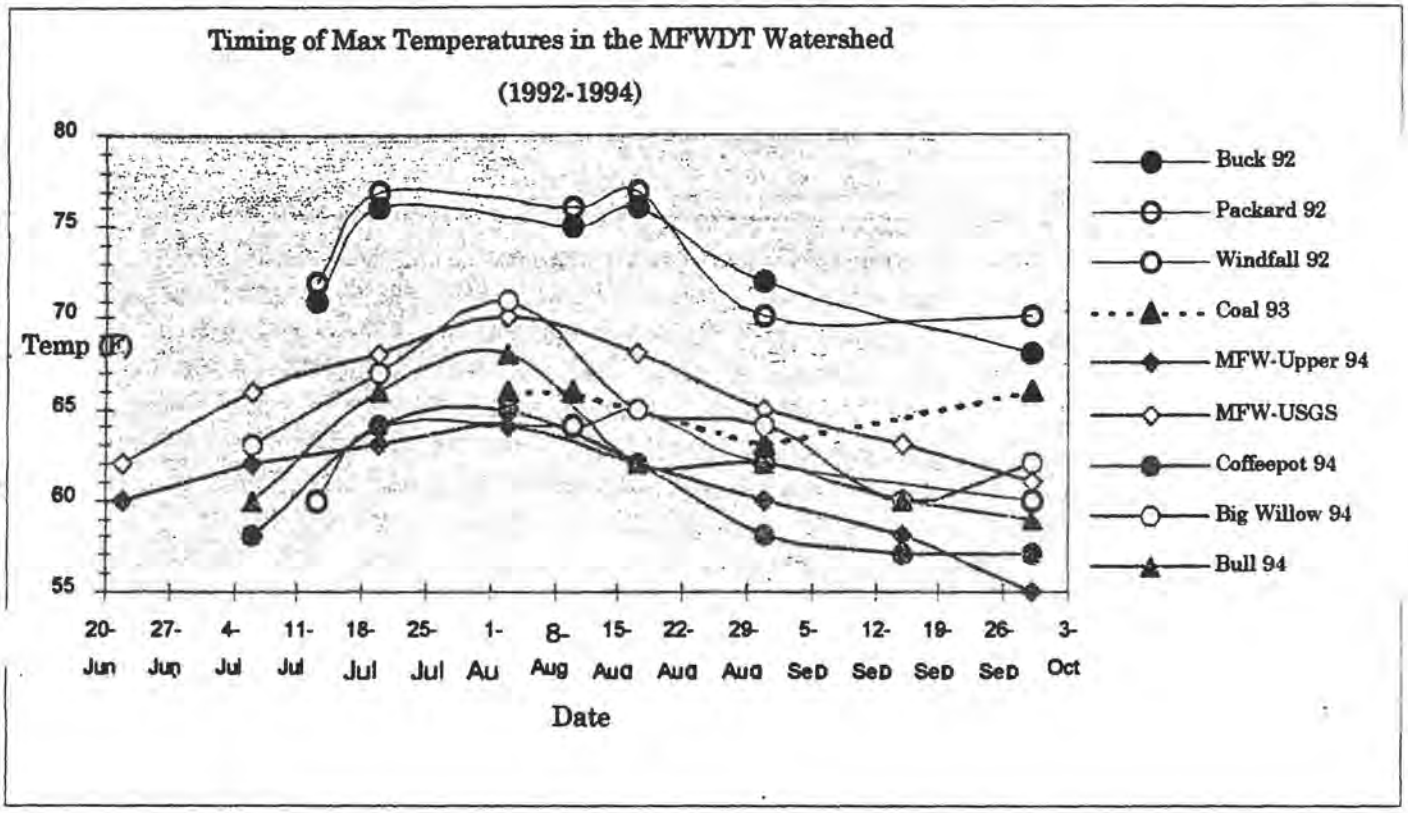


Together, figures _A_ & _B_ show some evidence of an overall increase after 1965 in both the magnitude and duration of seasonal high temperatures. The timing of these two measures however does not appear to be closely linked. For example, in 1979 the duration of daily maximum temperatures greater than 55 degrees was relatively long (124 days), while the magnitude of the average peak temperature was relatively low (67.5 degrees).

MFW River & Tributary Stream Temperatures 1992-1994

Additional data has recently been collected for several tributaries in the MFWDT watershed. Temperature was monitored with min/max thermometers placed near the mouth of each tributary. Two locations in the mainstem MFW were also monitored, including the original USGS gauging station site and a site near the upper watershed boundary. Figure _C_ presents a summary of the monitoring results. Although displayed collectively, direct comparison is valid only for locations sampled with the same interval in the same year. These groups are indicated by different linetypes in the figure.

Figure_C Timing of Max Temperatures in the MFWDT Watershed



Overall the data shows seasonal maximum temperatures tend to occur between late July and late August basin-wide. This timing is consistent with the 27 year period of record from the USGS gauging station and reflects the influence of regional climatic patterns. The type of data does not allow computation of the seven day average peak temperature, however it is reasonable to expect this standard is often exceeded throughout the watershed. The combined monitoring results show single maximum temperatures greater than or equal to 64 degrees have occurred in all locations and years for periods of up to eight weeks although not necessarily continuously.

Extremely high temperatures were recorded at two sites monitored in 1992. Maximum temperatures ranged from 76 to 68 degrees in Buck Creek and from 77 to 70 degrees in Packard Creek. During the latter six weeks of the season, different types of cooling trends developed in the two creeks as shown by the different slope of the lines in figure _C_. The pattern of maximum temperatures in Windfall Creek in 1992 was similar to Buck Creek but the range of values was much lower, between 65 and 60 degrees. This difference likely reflects differences in factors operating at a sub-basin scale.

Five other sites were monitored in 1994 including the USGS gauging station site. In the context of the entire period of record, the seasonal maximum temperature recorded at this site in 1994 is one of the higher values (see figure_A_ above). Thus the monitoring data from 1994 represent temperature conditions in a comparatively warm year. The range of values among these sites was less extreme than among the 1992 sites. This difference could be explained by the change in location or the change in year or a combination of these factors.

The widest range of maximum temperatures for a single location in 1994 occurred in Big Willow Creek. Maximum temperatures ranged from 60 to 71 degrees and a warming trend of 2 degrees occurred in the last two weeks of the season. A similar warming trend of 3 degrees occurred in Coal Creek during the last four weeks of the 1993 summer season. This trend did not occur at the other sites monitored in 1994. Between the two sites on the MFW river, the overall pattern of seasonal maximum temperatures is similar reflecting broad scale influences, but the range of values is different, reflecting fine scale influences. Between the two locations, the river is likely receiving inputs of relatively warm water from tributaries. The channel drops 400 feet in elevation and also increases in width and thus is less shaded.

Canopy Closure and Stream Temperature

The relationship between canopy closure and stream temperatures has been extensively studied and reported in the scientific literature (Brown and Krygier 1970, Beschta and Taylor 1988). Results have tended to show a positive correlation between reduced canopy closure and increased temperature. However, the magnitude of change can vary widely depending on site-specific characteristics. Table _1_ presents a sub-basin summary of the percentage of perennial stream miles directly impacted by harvest in the past 35 years along with recently recorded temperature data. Intermittent streams were not included because they are unlikely to contribute to seasonal maximum water temperatures since they generally do not flow above the surface during summer.

Table_1_ Percent perennial stream harvested with max recorded stream temperature.

Subwatershed	Stream	% Perennial Harvested	Max Water Temp (Fahrenheit)	Date
21-1	Gray	8.5		
21-1	Shortridge	0.0		
21-2 west	Larison	14.6		
21-2 west	Packard	56.2	77	1992
21-2 west	Stony	100		
21-2 west	Snow	14.5		
21-2 east	Modoc	20.8		
21-2 east	Bull	19.9	68	1994
21-2 east	Little Willow	0.0		
21-2 east	Big Willow	42.0	71	1994
21-2 east	Coffeepot	25.0	65	1994
21-3 west	Windfall	30.0	65	1992
21-3 west	Gold	26.6		
21-3 west	Bohemia	46.6	* 63	1993
21-3 west	Snake	28.6	* 64	1990
21-3 west	Spring Butte	46.9		
21-3 west	Indain	33.0		
21-3 east	Buck	23.9	76	1992
21-3 east	Estep	38.2		
21-3 east	Pine	26.6		
21-3 east	Youngs	16.7	64	1990
21-4 south	Coal	22.8	66	1993
21-4 north	Deadhorse	26.8		

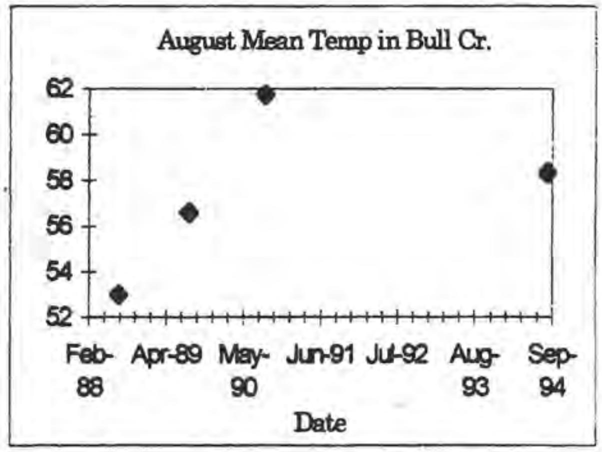
The available data seems to shows no consistent relationship between the two parameters. However, the data is inadequate to meaningfully assess the relationship as the maximum sample size for any year is three. The relationship also may be obscured and difficult to detect at this intermediate scale.

A review of available data for Bull Creek provides some indication of how temperature conditions change in a small tributary after a major disturbance (1988 Shady Beach fire and subsequent salvage logging). The August mean temperature in Bull Creek prior to disturbance was estimated to be 53 degrees. An increase of 1.5 degrees was predicted to occur after the fire and logging activity (Shady Beach Fire Recovery Project Final EIS 1989). Table_2_ and figure_2a_ show the August mean temperature for Bull Creek in 1989, 1990, and 1994. Although some samples are quite small, the data indicates August mean temperatures have increased as much as four times the predicted amount but may be decreasing. Bull Creek provides habitat for tailed frogs which are sensitive to temperatures above 66 degrees.

Table_2_ August Temperatures in Bull Cr.

Bull Creek Summary						
DATE	TIME	TEMP	MAX T	MIN T	MEAN	SAMPLE
1988					53	estimate
Aug-89	from hourly data				56.6	n = 120
8/6/90	1340	64				
8/13/90	1240	62				
8/20/90	1200	61				
8/27/90	1235	60			61.75	n = 4
8/4/94	945	58	68	55		
8/18/94	1120	56	62	55		
8/31/94	1105	55	62	54	58.333	n = 9

Figure _2a_ August Mean

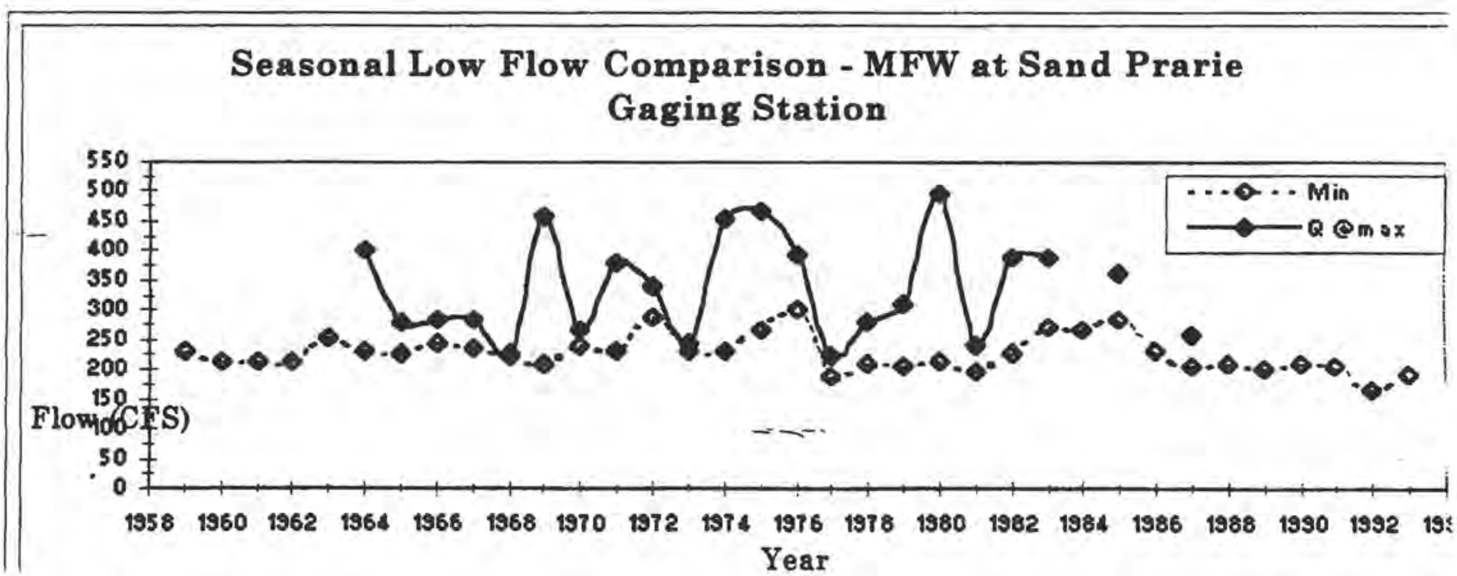


Temperatures in Bull Cr.

Temperature Interpretations

Seasonal variations in flow, air temperature, and solar radiation have a combined influence on summer stream temperatures. Suitable air temperature data was not readily available for this analysis. However an examination of seasonal low flows in conjunction with seasonal maximum temperatures was made. Figure _D_ compares the volume of discharge which occurred on the date of maximum temperature to the minimum discharge for the year.

Figure _D_ Seasonal Low Flow Comparison for MFW at Sand Prairie Gauging Station.



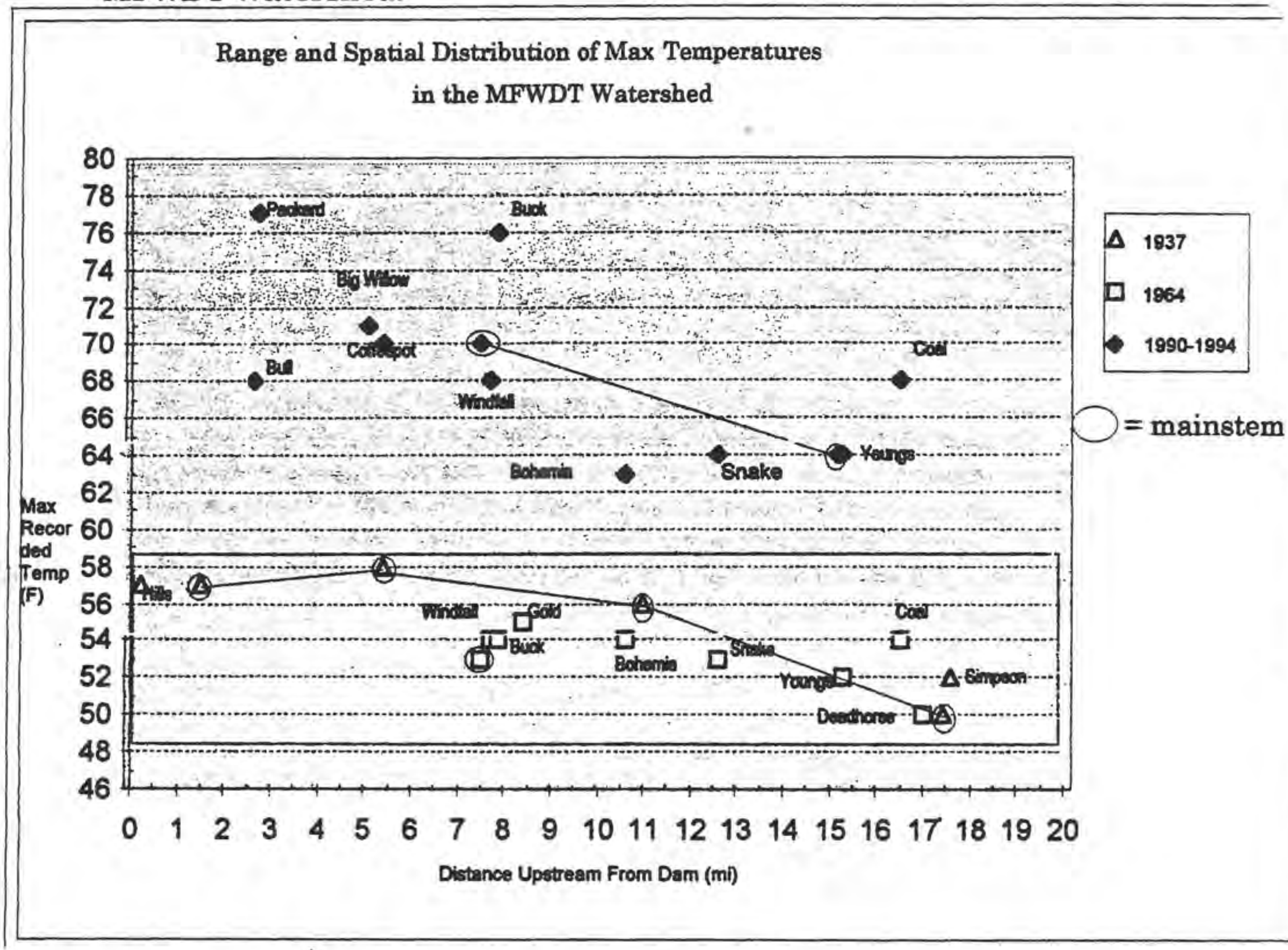
In some years, such as 1968, 70, 73, 77, and 81, the timing of seasonal low flows and seasonal maximum temperature was fairly concurrent. In other years such as 1964, 69, 74, and 80, the seasonal maximum temperature was attained when flow was approximately double the seasonal minimum. A review of Figure _A__ in the Current Conditions chapter reveals that in most of the years when low flow and high temperature occurred concurrently, the average seven day peak period temperature was relatively high. On the other hand, in 1980 when the timing of these two factors was not at all concurrent, the seven day average perk period temperature was not particularly low. Concurrent low flow may tend to increase peak temperatures, but higher flow may have a comparatively smaller effect on reducing peak temperatures, especially in a wider mainstem channel naturally exposed to solar radiation.

Yearly variation in weather patterns and corresponding fluctuations in stream temperature occur naturally. Likewise, both natural and human-related variation in characteristics such as canopy closure and substrate material occurs across the landscape and is reflected in different temperature conditions. Aside from the influence of long term climatic change however, the overall range of variability across a watershed tends to remain relatively stable through time, both with respect to the spread and to the center of the range.

Comparison and Extrapolation

Comparison and extrapolation of maximum stream temperatures from late summer/early fall stream temperatures was done using the 1990 to 1994 stream temperature data set. Figure _E_ was constructed from limited available data from three decades to portray the range of variability in temperature conditions of the MFWDT watershed. Data for 1990-1994 is the same as that found in Table _1_ and represents the maximum recorded temperature at a given location during that time period. It was necessary to aggregate the values in order to have a data set to reasonable size and to include as many of the same locations as possible from previous decades. Most of this data is from min/max thermometers and thus represents true maximum temperatures. Data from the other two decades is entirely grab samples. Only samples taken at a time of day and season as close as possible to the usual timing of seasonal maximum temperatures were included in the graph. Nevertheless these data points are almost certainly below the true seasonal maximum. They were collected during the first week of September when air temperatures were considerably lower than summer highs. (See appendix __ for relevant raw data). The shaded area of the graph which highlights the range of these values should therefore be adjusted upward, perhaps by approximately six degrees F as seen in the center of the graph. This would put the upper boundary of the range at 64 degrees which is generally consistent with the temperature tolerance of salmonids.

Figure_E_ Range and Spatial Distribution of Max Temperatures in the MFWDT Watershed.



With these considerations in mind, rough comparisons can be made. The upper end of the range from earlier decades slightly overlaps the lower end of the range in the 1990's. This suggests the center of the range has shifted upward significantly. The range of recorded temperatures is 14 degrees in the contemporary decade and 8 degrees in the earlier decades which suggests the amount of variability has increased. In terms of the spatial distribution of maximum temperatures, there is a slight general pattern of decreasing temperatures in the upstream direction in earlier decades for both the mainstem and tributaries. In the 1990's, the pattern is present for the mainstem but is scrambled for many tributaries.

Buck Creek shows the single most extreme change in maximum recorded temperature, an increase of 22 degrees. Stream temperatures are thought to reach a theoretical upper limit near the maximum average air temperature for a given region and elevation (MacDonald, Smart and Wissmar 1991). In the

Western Cascades, maximum average air temperatures at 2000 feet (the elevation at the mouth of Buck Creek) were found to be around 74 degrees. Thus the high value recorded in 1992 may be near the theoretical maximum at this location. In contrast, in 1937 the stream temperature in Buck Creek was 54 degrees when the air temperature was 70 degrees. This suggests there has been a substantial decline in the moderating influence of the riparian zone on the thermal regime of Buck Creek.

Life History Stages - Spring Chinook and Bull Trout

The following figures F and G present a view of the range of temperatures required during different life history stages for Spring Chinook salmon and Bull Trout along with a plot of daily min/max temperature recorded in 1973-1974 at the Sand Prairie gauging station. These years were chosen because they are the most recent two years without a temperature data gap. A review of figure A in the Current Conditions chapter shows these to be relatively though not uncommonly warm years. Life stage indicators were redrawn from originals created by Dave Buckanan (DEQ 1994).

Figure F Annual Temperature Regime of MFW at Sand Prairie with Temperature Requirements of Spring Chinook Life Stages

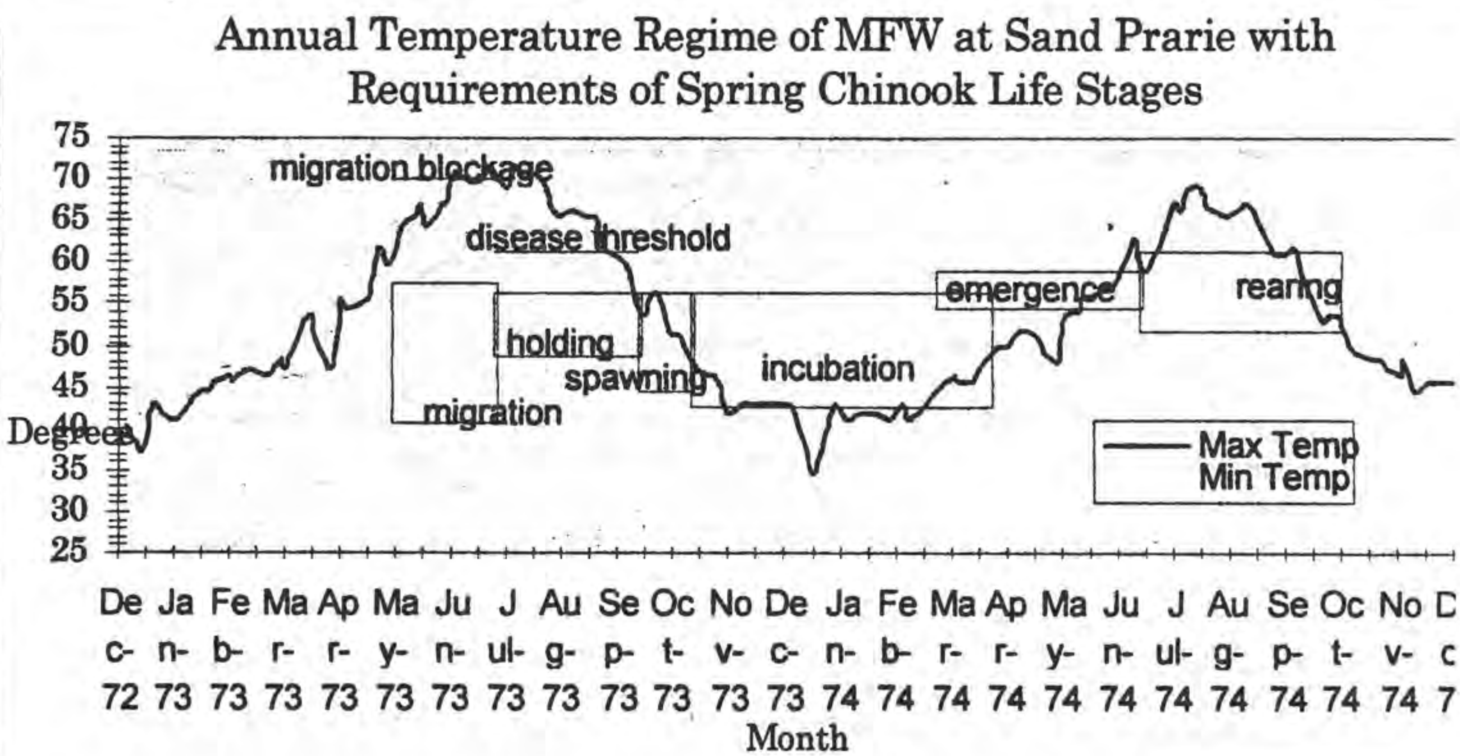
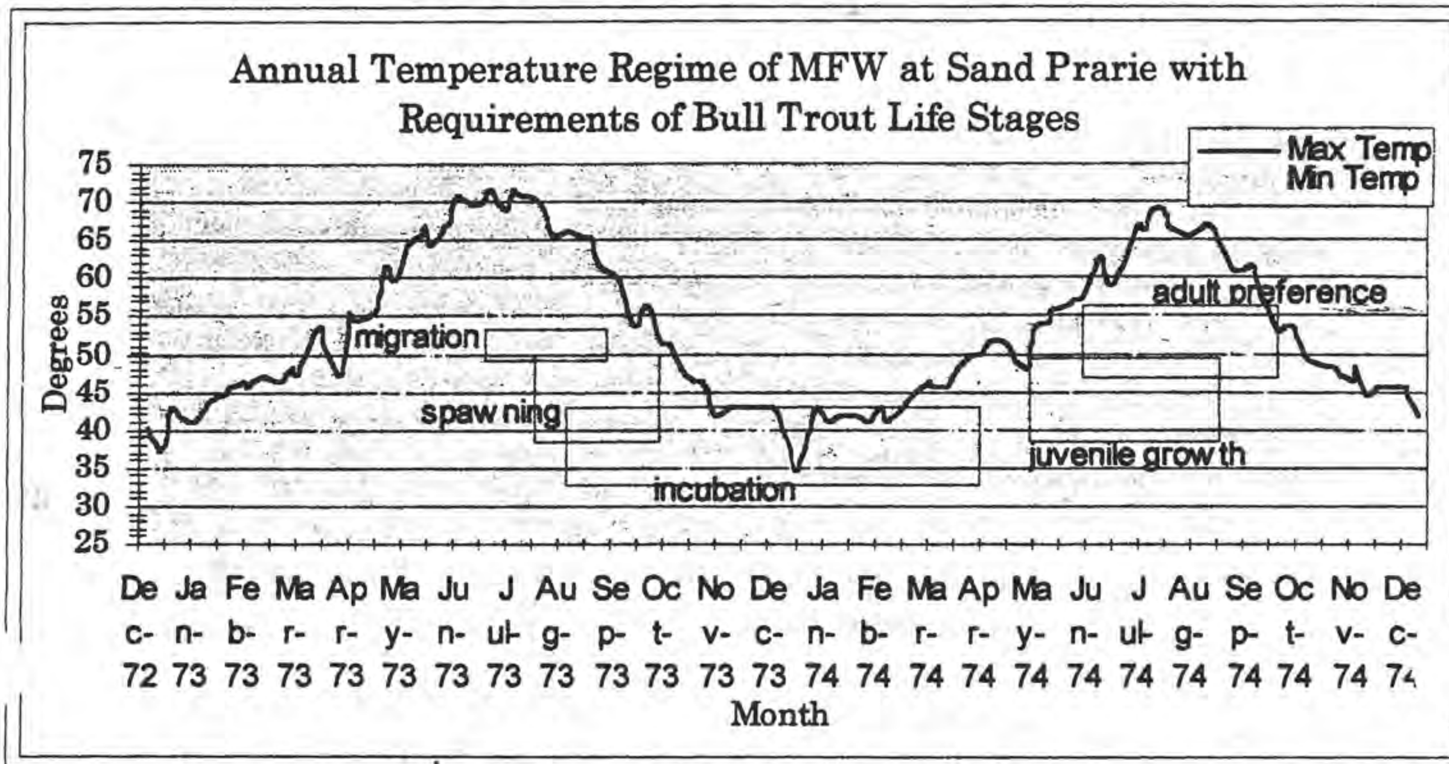


Figure G Annual Temperature Regime of MFW at Sand Prairie with Requirements of Bull Trout Life Stages



It is clear that summer maximum temperatures are well outside the suitable range for adult and juvenile summer life stages of both species. The situation is acute for adult Chinook salmon during the holding stage when even daily minimum temperatures approach the threshold at which common diseases become more virulent. The minimum temperatures are also above the suitable range for Bull Trout migration, spawning, and juvenile growth. In the case of Chinook, cooler than optimum temperatures also occur at other times of the year. This is perhaps not surprising since this part of the MFW was historically near the upper part of the species' range. However an estimated 750-1000 spawners were observed in this part of the river in September 1937 so temperature conditions were not entirely unsuitable.

Concepts of natural selection imply that the range of environmental conditions will not frequently be far outside the range of suitable conditions for species which have naturally adapted to that environment. Thus the range of biologically suitable conditions for naturally adapted organisms is a conservative approximation of the natural range of variability in environmental factors for a given place and time. This biological evidence of intolerable conditions for several life stages of two historically present species provides strong support for the claim that the temperature regime in this part of the MFW is outside the previous range of natural variability.

Temperature Conditions Conclusion

There is enough evidence of potentially frequent widespread occurrence of abnormally high summer temperatures to warrant concern, investigation, and corrective action. Vegetation manipulation is a likely causal factor, but available data is inadequate to determine the magnitude of its direct impact and interaction with other factors.

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MacDonald, L. H., Smart, A. W., and Wissmar, R. C. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. Environmental Protection Agency and Center for Streamside Studies. Seattle, Washington. EPA 910/9-91-001.

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DEQ Oregon Department of Environmental Quality 1994. Temperature Draft Issue Paper. 1992-1994 Water Quality Standards Review. Portland, Oregon.

H

Appendix H

Vegetation Documents

Appendix H1
Blowdown Patterns
in the Middle Fork Willamette Downstream Tributaries of the Willamette River

Jerry English, Forestry Technician

1995

Blowdown disturbance to timber stands predominantly comes from two types of windstorms. One is an East wind pattern. This occurs when a low pressure area develops near the Oregon coast, when there is a high pressure area located East of the crest of the Cascade Mountains. As the two systems try to equalize air pressure, the air moves from the East side to the area West of the Cascades. This air flow readily follows east to west water drainages, that have cut through the mountains. The velocity of this wind increases as it drops in elevation. The elevation drop is from approximately 5,000 feet at the crest to approximately 1,500 feet near Hills Creek Lake. Where there are no drainages, the air tends to flow westerly across the top of the landscape. As the air moves to the west, it slows down the closer it gets to the low pressure area. Therefore wind velocities are generally highest in the westerly oriented drainages and along the tallest ridges, in the areas nearest the crest of the Cascades. The Middle Fork Willamette Downstream Tributaries area is somewhat insulated from these wind patterns as Diamond Peak (8,744 feet), Groundhog Mountain., Logger Butte, and Warner Mountain. (all near 6,000 feet) are high enough to block most of the airflow from moving directly down to the Middle Fork in this analysis area. Only extreme weather patterns have high enough winds to affect the lower elevations of this area and cause extensive blowdown. The last time this occurred was on December 23, 1983. Most of the blowdown from all but the extremes of this type of wind pattern has been near the Groundhog Mountain., Logger Butte, and Warner Mountain. areas. Some blowdown from this wind pattern has occurred along the higher elevations of the Calapooya Divide on the west side of this analysis area. However the impact from this airflow pattern is not as high as it is further from the crest of the Cascades and the winds are not as strong. The high winds of the storm in 1983 blew down some patches of timber near twenty acres in size in the Young's Creek Drainage of this analysis area. Approximately 2,000 MBF of timber was salvaged from this area as a result of that storm.

The other type of windstorm that occurs is from winds circulating around low pressure systems moving inland from the Pacific Ocean. Wind velocities from this type of storm range from low to very high, depending on the strength of the system. As with the East wind pattern, wind velocities tend to be highest near the tops of the ridges. Wind direction is usually from the south or west, but can be from any direction. This can happen because the winds are always circulating around the center of the low pressure system. Wind direction depends on where your location is in relation to the center of the system. Winds from these systems generally are not as strong in the Middle Fork Willamette Downstream Tributaries as they are on the coast because the systems tend to lose energy as they leave the Pacific Ocean and move inland. In the area of the Middle Fork Willamette Downstream Tributaries the strongest winds usually come from the west or south because winds from other directions occur when the system has moved farther inland and lost some of its strength.

Some of the blowdown that occurs happens in very localized areas. The winds in this area are much more intense than in most areas of the general storm. This results in blowdown in a small area, whereas the winds over the rest of the forest were not strong enough to blow trees down. The winds in these storms also occasionally seem to swirl, blowing down trees in one area and then skipping over part of the forest to blow down trees in another location. This swirling action sometimes blows the trees down in directions different than the prevailing wind pattern, resulting in a crisscrossed jumble of trees.

Blowdown patterns from both of these windstorms usually occur along the edges of new openings. Most of the new openings in this analysis area are from timber cutting units. The trees in timber stands in this area grow up close together and their crowns tend to support each other, keeping the trees from getting bent over very much. One of the functions of the roots of a tree is to hold the tree upright. These root systems develop partly in response to the stresses put on the upper part of the tree, so the roots only develop to support the tree for the stresses it normally experiences. During timber harvest the trees left within the cutting unit and the trees along the edges of the cutting units lose the support of the adjacent trees. Until they can develop a larger and stronger root system in response to the increased wind stress, they are susceptible to being blown down during a windstorm event. It usually takes at least 5 years for a tree to become more windfirm.

Trees are susceptible to being blown down in two ways. One is when the root system is not capable of holding the tree upright from the force of the wind. Trees that have bigger crowns intercept more wind and have a higher chance of being blown down. Trees are also blown down when there is a weakness in the stem of the tree. During a windstorm the bole of a tree can break, with the root system still holding the lower portion of the tree below the break upright, while the upper portion falls to the ground. Most of the weaknesses in the trees in this analysis area are from various rotting fungi that weaken the wood in the bole of the tree, although there are a small number that attack the roots of the trees. Trees with smaller crowns, sound stems and root systems have a better chance of withstanding a windstorm.

Soil conditions also affect the ability of trees to withstand wind. In areas where the soil is shallow, a trees roots can not grow down to a sufficient depth to provide the support necessary to keep the tree upright. Soil moisture content also affects the strength of the root system. The higher the soil moisture the lower the root holding strength of the soil. Soil moisture is normally higher during the winter and spring, the moisture usually coming from the storms off the Pacific that also have high winds. There are also some wet soil areas that collect water and are not well drained, where soil moisture is high for most of the year.

Blowdown also occurs within undisturbed stands of timber. In the Middle Fork Willamette Downstream Tributaries analysis area this is usually isolated trees or very small patches of trees that are defective or located on shallow or wet soils. This type of blowdown is continuous and a natural part of the forest. No larger blowdown areas have been observed in the remaining undisturbed stands (reviews of 1990 photos of area).

The amount of blowdown a stand experiences during a strong wind ranges from only a few trees to almost all trees being blown down. A stand is seldom completely blown down. There are usually a few pockets of trees or scattered individual trees remaining standing, although these have usually suffered some damage to their crowns or boles from the falling of the adjacent trees. Most of the smaller trees and understory are crushed under the larger trees as they fall.

Some of the blowdown salvage sales by subdrainage

SUBDRAINAGE	SALE NAME	YEAR
21 1 Oakridge	Gray Cr. Salvage	1952
	Highway 58 Blowdown	1960's
21-2 Hills Creek Reservoir	Willow Creek Salvage	1952
	Bohemia Creek Salvage	1953
	Little Willow Cr 16A Salvage	1955
	High Noon BD	1968
	Umpqua BD	1968
	Slapdown	1976
	Twist	1977
	Little Rock Salvage	1978
	Bambi Salvage	1985
	Ash Salvage	1988
	Boulder Salvage	1993
	Pot Salvage	1993
	Spiral Salvage	1993
	Knoll Salvage	1994
21-3 Middle Fork Willamette/Little Pine	Buck Creek Salvage	1953
	Buck Cr 4A Salvage	1955
	Strip Salvage	1965
	Tea Creek Salvage	1966
	Umpqua BD	1968
	High Noon BD	1968
	Tally	1977
	Noon Tea	1977
	Flat	1979
	Joe Blow	1979
	Young's Creek Salvage	1984
	High Stew Salvage	1993
	Low Stew Salvage	1993
21-4 Coal Creek	Dumpty	1976
	Day Salvage	1981

Appendix H2
Harvest Treatments by Decade
Middle Fork Willamette Downstream Tributaries

Ginny Tennis, 1995

Decade	Clear-cut 110's Acres		Prep Cut 120's Acres		Shelterwood 130's Acres		Shelterw Remov Overst Remove 141,143 Acres		Selection Cut 150 Acres		Partial Removal 160 Acres		Salvage 230's Acres		Special Harvest 240's Acres	
	NRRA*	RRA*	NRRA	RRA	NRRA	RRA	NRRA	RRA	NRRA	RRA	NRRA	RRA	NRRA	RRA	NRRA	RRA
1930 -	20	5	0	0	0	0	0	0	0	0	161	128	8174	2883	15	0
1940-1949	34	1	0	0	0	0	0	0	0	0	0	0	50	8	0	0
1950-1959	1888	624	0	0	0	0	0	0	0	0	235	53	326	59	326	0
1960-1969	5177	1128	0	0	18	15	40	15	0	0	54	2	123	11	0	0
1970-1979	4460	1349	80	29	199	32	120	0	0	0	16	0	19	1	0	0
1980-1989	6453	1465	0	0	244	32	287	67	0	0	497	193	270	30	0	0
1990-1995	3405	315	0	0	111	13	54	0	0	7	665	150	15	25	0	0
Sub-total Acres	**21,437**	**4,887**	**80**	**29**	**572**	**92**	**501**	**82**	**0**	**7**	**1,628**	**526**	**8,977**	**3,017**	**341**	**0**
Total Acres	**26,324**		**109**		**664**		**583**		**7**		**2,154**		**11,994**		**341**	

NRRA - Non-Riparian Reserve Area
RRA - Riparian Reserve Area

The main portion of the harvest in the MFWDT Watershed started in the late 1940's. with the way the GIS year of origins have been put into the data base the early harvest does not show up until the 1950's.

Clearcutting in the lower elevation Douglas-fir forests was the preferred harvest system. Approximately 63% of the harvest acres were broadcast burned based on GIS data. The 1950's showed the first large harvest of 2512 acres. By the 1960's this had increased to a cut of 6305 acres. A slight decrease to 5809 acres occurred in the 1970's. The peak of harvest quantity was in the 1980's with 7918 acres of removal. From 1990 to present 3720 acres have been removed from the MFWDT. With the present riparian definitions, from the 1950's to 1995 the riparian impacts are shown in the 1970's and have decreased to 9% in the early 1990's.

Sixth field Subwatershed 21-3 was the major clear-cut harvest area from the 1950's until 1990 until a shift to Subwatershed 21-2 was made. Harvesting proceeded from the northern end of the Watershed along the original Road 23 and gradually expanded up the easily accessible areas first. Over a dozen units were harvested in the Willow Creek area in the late forties. Buck and Groundhog had heavy harvest in 1950's and this brought roads up to the eastern boundary of the MFWDT. In the 1950's, harvest started extending up Coffeepot Creek. Grays Creek had 4 units that were harvested in the early 1950's. The lower part of Coal Creek was harvested in the late 1950's and the upper reaches in the early 1960's.

Shelterwood harvesting was initiated in the 1960's with 33 acres treated. The largest number of acres was shown in the 1980's with 276 acres of shelterwood. Shelterwood removal and overstory removal started in the 1960's and peaked in the 1980's with 354 acres of removal. No shelterwood treatments were done in sixth field Subwatershed 21-1.

Partial removal was shown in the 1930's at 289 acres and has varied up to a high of 815 acres in 1990's.

Salvage has taken place but there is no verification on why the pre 1930 acreage is so high. A special harvest was done in the pre-1930's and 326 acres in the 1950's. What the special harvest treatment was is unknown.

Appendix H3
Matrix/LSR Current Conditions
Ginny Tennis, Forester
1995

In response to the timber issue the following information show acreage by GIS stand age, by Management Area Allocation, that may have commodity removal. Acreage do not include allocations closed to commodity removal.

The following chart depicts the terrestrial acres that may be utilized for PSQ. Acreage is given by Subwatershed and by an age range. This does not show the acres from other allocation that may have commodity removal following a catastrophic event. These acreage's will be further reduced by the 15 percent retention area associated with each harvest unit other than thinnings, suitability, buffers for TE&S Species or special habitat protection and any modifications in management along the proposed Wild and Scenic River Corridor and other resource protection needs as identified in the future. The scenic disturbance restrictions given to give a sense of the appropriateness of entering those allocations for commodity removal.

I. Matrix stand acres outside of Riparian areas and outside of 100 acre owl circles.

Land Management Plan Designation	Disturbance Restriction	Stand Age from GIS Year of Origin (Rounded Available Acres >1 ac) by years							Total Acres by LRMP
11a Scenic Modification Middleground	**<24% disturb =<4.5' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	0	0	0	0	0	0	0
Sixth field 21-2		164	380	137	683	254	6	310	1934
Sixth field 21-3		72	141	222	344	221	36	733	1769
Sixth field 21-4		0	11	0	15	0	0	0	26
Total Acres for MFWDT and Tributaries		**236**	**532**	**359**	**1042**	**475**	**42**	**1043**	**3729**
11c Scenic Partial Retention. Middle	**<20% disturb +<15-20' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	0	0	0	0	0	0	0
Sixth field 21-2		843	332	23	127	16	51	665	2057
Sixth field 21-3		74	153	50	38	86	35	439	875
Sixth field 21-4		0	26	0	16	2	69	46	159
Total Acres for MFWDT and Tributaries		**917**	**511**	**73**	**181**	**104**	**155**	**1150**	**3091**

Land Management Plan Designation	Disturbance Restriction	Stand Age from GIS Year of Origin (Rounded Available Acres >1 ac) by years							Total Acres by LRMP
11d Scenic Partial Retention. Foreground* * contains Proposed Wild And Scenic River Portion	**7% 1st 10 years of plan <14% disturbance=<10-15' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	0	0	0	0	0	0	0
Sixth field 21-2		0	0	0	0	0	0	79	79
Sixth field 21-3		33	84	77	58	268	52	894	1466
Sixth field 21-4		15	11	36	42	0	56	153	313
Total Acres for MFWDT and Tributaries		**48**	**95**	**113**	**100**	**268**	**108**	**1126**	**1858**
11e Scenic Retention Middleground	**7% 1st 10 years of plan <10% disturbance=<15-20' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	34	17	0	0	10	16	77
Sixth field 21-2		0	0	0	0	0	0	0	0
Sixth field 21-3		0	0	0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0	0	0
Total Acres for MFWDT and Tributaries		**0**	**34**	**17**	**0**	**0**	**10**	**16**	**77**
Land Management Plan Designation	**Disturbance Restriction**	**Stand Age from GIS Year of Origin (Rounded Available Acres >1 ac) by years**							**Total Acres by LRMP**
11f Scenic Retention Foreground	**5% 1st 10 years of plan <10% disturbance=<10-15' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	51	40	23	0	114	248	476
Sixth field 21-2		74	69	38	81	0	87	1206	1555
Sixth field 21-3		0	0	0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0	0	0
Total Acres for LMFW and Tributaries		**74**	**120**	**78**	**104**	**0**	**201**	**1454**	**2031**
14a General Forest Intensive Timber Mgt.	**Probable Sale Quantity programmed**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	**81-200**	**200+**	
Sixth field 21-1		0	0	0	0	0	0	0	0
Sixth field 21-2		404	683	585	1020	522	113	1609	4936
Sixth field 21-3		1015	2226	1667	2865	1187	317	6000	15277
Sixth field 21-4		41	318	312	237	164	265	180	1517
Total Acres for MFWDT and Tributaries		**1460**	**3227**	**2564**	**4122**	**1873**	**695**	**7789**	**21730**
matrix acre total by age		**2735**	**4519**	**3204**	**5549**	**2720**	**1211**	**12578**	**32516**
Percent of non Riparian Matrix by age		**8%**	**14%**	**10%**	**17%**	**8%**	**4%**	**39%**	

II. LSR LANDS FOR POTENTIAL COMMODITY REMOVAL

The following chart displays acres by age classes for some Land Management Allocation by sixth and fifth field watershed. This chart will allow the user to see potential acreage in various size classes in order to assess by sixth field Subwatershed where potential vegetation manipulation projects for habitat improvement or to meet other objectives can be done. Other acreage may be available in other allocations where no commodity removal is allowed.

Land Management Plan Designation	Disturbance Restriction	Stand Age from GIS Year of Origin (Rounded Available Acres >1 ac) by years					Total Acres by LRMP
11a Scenic Modification Middleground	**<24% disturb =<4.5' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	
Sixth field 21-1		106	129	76	409	149	869
Sixth field 21-2		2	56	0	53	0	111
Sixth field 21-3		0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0
Total Acres for MFWDT and Tributaries		**108**	**185**	**76**	**462**	**149**	**980**
11c Scenic Partial Retention Middleground	**<20% disturb +<15-20' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	
Sixth field 21-1		26	2	0	57	0	85
Sixth field 21-2		21	8	0	4	0	33
Sixth field 21-3		0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0
Total Acres for MFWDT and Tributaries		**47**	**10**	**0**	**61**	**0**	**118**
11f Scenic Retention Foreground	**5% 1st 10 years of plan <10% disturbance=<10-15' ht**	**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	
Sixth field 21-1		1	9	1	17	47	75
Sixth field 21-2		0	0	0	4	0	4
Sixth field 21-3		0	0	0	0	0	0
Sixth field 21-4		0	0	0	0	0	0
Total Acres for MFWDT and Tributaries		**1**	**9**	**1**	**21**	**47**	**79**
14a General Forest Intensive Timber Mgt.		**0-5**	**6-15**	**16-25**	**26-50**	**51-80**	
Sixth field 21-1		19	83	150	131	3	386
Sixth field 21-2		260	1026	512	359	337	2494
Sixth field 21-3		133	376	285	572	0	1366
Sixth field 21-4		522	946	595	748	0	2811
Total Acres for MFWDT and Tributaries		**934**	**2431**	**1542**	**1810**	**340**	**7057**

Appendix H4
Vegetation Description
MFWDT
Ginny Tennis
July 1995

The Willamette National forest has 5 major conifer series, Douglas-fir series, Grand fir series, mountain hemlock, Pacific silver fir series, and the western hemlock series. Classification is based on the Plant Association and Management guide for the Willamette National Forest, 1987.

A series is based on the physically largest tree specie(s) that would dominate at climax which are those species that would remain on site after a long disturbance free time period. The Lower Middlefork of the Willamette watershed has 4 of the 5 major conifer series within its boundaries. Mountain hemlock is fond as a minor component in stands at the highest elevations in the Lower Middlefork Willamette Watershed. Within each series the plant associations, or potential natural vegetation, is a group of species that can most effectively occupy sites with similar, moisture light and nutrient availability. The plant associations are recurring collections of groups of plant species which can grow and reproduce in competition over a long time period. Plant association is a group of species that could be climax. Climax forests rarely occur due to the longevity of the pioneer species, which are the first plants on any disturbed ground. Douglas-fir common to this area is a long lived pioneer species and may reach 1000 years old. Catastrophic fires or any other disturbance may not allow climax to be reached.

The series found in this watershed in the western 1/3 of Rigdon Ranger District sites occupy different areas of different environmental conditions. Delineations between different series tend to be blends of plants from adjacent series.

The following vegetation description, by series, is based on the Willamette National Forest Plant Association and Management Guide, personal observation, ecoplots, select tree data and silvicultural prescriptions from areas within the watershed.

Additional associations may be present but not documented on ecoplots.

DOUGLAS-FIR

The Douglas-fir series occurs on warm, relatively dry sites at lower elevations on south and west slopes. This is the driest environment capable of supporting a closed forest canopy. Incense cedar and grand fir are major climax species, but Douglas-fir dominates the canopy and regeneration layers. On the hot dry slopes at the lower elevations Douglas-fir will be the major climax species.

From ecoplot data vegetation on mature stands shows Douglas-fir is the primary component of the overstory, with a range of 20% to 95% cover. Incense cedar follows with minor to 40% cover and then ponderosa pine with minor to 20% cover. The stands with more ponderosa pine are located from Little pine openings to campers Flat along road 21 on the south and west slopes and on the lower end of Coal Creek. The ponderosa pine band follows along a lower precipitation band that goes up the Middlefork of the Willamette. Grand fir and white pine show up to 15 % cover. White pine is located on mid-upper elevation moist slopes as slopes east of Holland Meadows. Elevations on the ecoplots ranged from 1750 to 3150 feet in elevation.

The regeneration layer was nonexistent in 2 even-aged, fire regenerated stands with Douglas-fir as the only species in the canopy at an age of 100-130 years old. With multiple species in the canopy the regeneration layer consisted of Douglas-fir, incense cedar and minor amounts of western red cedar and Douglas-fir in the wettest areas.

The shrub layer includes vine maple, Oregon grape, salal, oceanspray, trailing snowberry, whipplevine and poison oak.

The herb, grass and fern layers tends to be light or under 10% cover and include species as twinflower, bluntleaf sandwort, fairybells, snowqueen, western starflower, pathfinder and strawberry.

Grasses include poas, bromes, and fescues.

Ferns include Sword fern, bracken fern and licorice fern.
Bigleaf maple was the most common hardwood with madrone and chinquapin present and alder on the streambanks.

Stand structures identified were even-aged single story, older remnant fire resistant Douglas-fir with an even-aged understory and stands that had 4 age classes on an 80 year fire disturbance regime.

Plant associations included are Douglas-fir/oceanspray/dwarf Oregon grape, Douglas-fir/oceanspray/grass, Douglas-fir-western hemlock/salal, Douglas-fir/oceanspray/whipple vine, Douglas-fir-western hemlock/dwarf Oregon grape and Douglas-fir/snowberry.

GRAND FIR SERIES

The Grand fir series tends to be on relatively well drained and dry slopes from 1800 to 4500 feet. Species in this series tend to a mix from the Douglas-fir, western hemlock and Pacific silver fir series. The grand fir series is between the drier Douglas fir series and the wetter western hemlock series. This description is based on stands from 160 - 300 years old.

Mature vegetation found on local ecoplot data includes an overstory of grand fir with 7-50% cover, Douglas-fir with 0-60% cover, with smaller quantities of incense cedar, Pacific silver fir, sugar pine, western red cedar and western hemlock. The regeneration is mainly grand fir from 5-20% with lesser amounts of sugar, white pine and western hemlock.

Bigleaf maple was present at lower elevations in minor amounts and may be a transitional stand to the western hemlock series. No other hardwoods are documented in these stands.

Shrub species present in the stands included Oregon grape, baldhip rose, trailing snowberry, vine maple, salal and oceanspray.

Typical herbs are vanilla leaf, three-leafed anemone, fairybells, starry solomonseal, and redwoods violet. The herb layer is very diverse.

Plant associations are grand fir/dwarf Oregon grape and Pacific silver fir-grand fir/false solomonseal

PACIFIC SILVER FIR SERIES

Pacific silver dominates the upper slopes above 4000 feet. Locations that have Pacific Silver fir include the Warner Mountain-Ground Hog area, Bulldog Prairie, Gertrude lake area and Steeple Rock. On slopes that are hotter and drier this series will be replaced by either Grand fir or Douglas-fir series. This description is based on stands from 130 years old to 600 years. Stands had from 2-5 age classes represented.

Overstory species included in this series include Douglas-fir with 10-80% cover, western hemlock with 5-45% cover, Pacific silver fir with 1-40% cover and noble fir with 1-40% cover. Associated species as mountain hemlock, Alaska yellow cedar, white pine , yew and western red cedar may be found in the stands. Hardwoods are not commonly found in this series.

Regeneration species include grand fir, western hemlock, white pine, yew and western red cedar.

Shrub species include rhododendron, vine maple, princes pine, dwarf bramble and big huckleberry, and Oregon grape.

Herbs include vanilla leaf, starry solomon seal, green pyrola, inside-out flower, ginger, queencup, fairybells, coolwort, montia, viola, beargrass.

Plant associations include Pacific silver fir-grand fir/false solomonseal, Pacific silver fir/coolwort foamflower, Pacific silver fir/rhododendron/dwarf Oregon grape, Pacific silver fir/rhododendron/beargrass, Pacific silver fir/dwarf Oregon grape, Pacific silver fir/vine maple/coolwort foamflower and Pacific silver fir big huckleberry/queencup beadlily.

WESTERN HEMLOCK SERIES

This series is located throughout the entire subdrainage from low to 4600 foot elevations. Douglas-fir is the predominant species in the western hemlock series. This description is based on information from stands ranging in age from 82-500 years old. Cohorts include western hemlock and western redcedar. Minor amounts of incense cedar, grand fir, sugar pine, white and ponderosa pine can be found in these associations. Bigleaf maple is the predominant hardwood with madrone and chinquapin found on west slopes.

Regeneration is mainly western hemlock and western red cedar. Drier sites have incense cedar and Douglas-fir regeneration.

The shrub layer is fairly well developed with vine maple, rhododendron, Oregon grape, princes pine and salal. The herb layer is diverse but with low covers of individual species as oxalis, twinflower, scoulers bluebell, montia and sword fern.

Plant associations found in this watershed for the western hemlock series include western hemlock/dwarf Oregon grape, western hemlock/dwarf Oregon grape/salal, western hemlock/dwarf Oregon grape/vanilla leaf, western hemlock/rhododendron-dwarf Oregon grape, western hemlock/rhododendron/twinflower, western hemlock/salal , western hemlock/rhododendron-salal, western hemlock/twinflower,

MOUNTAIN HEMLOCK SERIES

This series is located on the upper ridges above 4000 feet. The dominant tree species are mountain hemlock and silver fir and their regeneration. This is one of the harshest sites west of the Cascade crest. A short growing season, multiple frosts and high summer temperatures make for a difficult growing site.

Big huckleberry, princes pine, beargrass and dwarf bramble are common plants on the mountain hemlock/big huckleberry and beargrass sites.

Hemstrom, M.A., Logan, S.E. Pavlot, W. 1987. Plant Association Management Guide and associated plot data. USDA-Forest Service, Pacific Northwest Region. Eugene, Oregon

Appendix H5
MFWDT
Ginny Tennis, Forester
July 1995

INTERPRETIVE COMMENTS FOR GROUP #I - Western Hemlock/Douglas-fir Series

In this group the stand initiation and stem exclusion developmental stages has increased by timber harvest removal.

FACTORS PERTAINING TO TRENDS IN GROUP #I - Western Hemlock/Douglas-fir Series

Disturbance Events

The main disturbance events in the Western Hemlock/Douglas fir group has resulted from timber harvest activities over the past 50 years and man and lightening caused fires. This converted multicohort(unevenaged) stands and single cohort stands, found on dry site Douglas fir, to younger evenage stands or further developed the complexity with additional age classes added and the retention of overstory Douglas-fir and ponderosa pine.

Vegetative Succession.

The portion of the wetter western hemlock stands which have not had regeneration harvest activities currently have structures of multiple layers with a multiple species composition. On north slopes that have been burned an even-aged 100 year old western hemlock stands may be found under scattered Douglas-fir. The fire occurrence is variable but ecoplot data documents stands up to 500 years old with some underburning occurring in the stands.

The cool dry upper ridges or lower valley bottoms may have a grand fir climax. Fire occurrence based on existing stand ages is from 153-282 years. The stands have a mainly Douglas fir and grand fir overstory with white pine as a minor associate. Regeneration is limited to grand fir and western hemlock understory.

On the dry site Douglas fir there is a tendency to hold for many years in the stem exclusion stage even up to 150 years old and typically be of pure Douglas-fir. The exclusion of fire has contributed to the development of complex fuel bed as trees regenerate, creating a fuel ladder. The regeneration may cause a loss of tree vigor due to overstocking on moisture limited sites.
Fires have been noted to have 80-120 year regimes from ecoplot data. With a high periodicity in the past stands have developed with scattered large old

growth, Douglas-fir with younger old small sawlog size Douglas-fir and poles and saplings and seedlings underneath. Stand ages may be quite variable due to frequent, low intensity fires.

The dry site Douglas-fir contains ponderosa pine and sugar pine and rarely will have western hemlock in the stand. The dry site is approximately one third of the watershed running mainly on the east side of the watershed from Hills Creek to Coal Creek. The ponderosa band with its associated grasses is found from Little Pine Openings to the bottom of Coal Creek.

Disturbance processes and succession

Early harvest activities used single species planting at a close spacing tending to modify species composition, stand structure in relation to natural stands. Snag felling due to the hazards of logging and broadcast burning eliminated a future nutrient input source and a wildlife habitat component.

Natural stands with lower initial stocking tend to stay in the stand initiation stage longer and have a greater herb and shrub growth.(Oliver et al 1990) Diversity in managed stands tends to increase greatly as other species seed in from adjacent areas. In the past decade increased use of more species adapted to specific sites has been utilized to develop diversity. Animal damage from stocking loss due to gophers or mountain beaver or height growth loss or form damage does allow stands to stay in the stem initiation stage longer. Removal of competing vegetation may allow faster development into the stem exclusion stage.

With the presence of the large number of trees per acre in the managed stands the available space is soon utilized and the stands may stagnate or slow in growth of height and diameter. Thinning or removal of trees allowed increased growth on the remaining trees and allow some ingrowth of shrub and herbs dependent on the amount of stocking removal. Stands that were not precommercially thinned or are overstocked natural stands from fire may stay in the stem exclusion stage for a much greater time frame. On the hot dry Douglas-fir and ponderosa pine sites grass is a severe competitor for the moisture available.

Fire occurrence causing tree mortality, or insects, disease and other damage mechanisms caused openings to develop and allowed ingrowth of trees. A 1993 survey of insect damage done by the USDA Forest Service in Cooperation with the Oregon Department of Forestry identified in this watershed identified 1) 10 sites of Douglas-fir bark beetle up the bottom of the Middlefork of the Willamette, Packard Creek and Coal Creek. Douglas-fir bark beetle occurs in endemic levels in downed, weakened, or diseased trees as occurs in small blowdown pockets or fires or disease center. Green trees are not preferred but will be attacked if populations are high. Small trees are not large enough for breeding purposes and down trees in full sunlight are not utilized since the phloem dries out prior to completion of the bark beetle breeding cycle. 2) 1 site of the mountain pine beetle south of Estep Creek in a ponderosa pine stand. The mountain pine beetle dendroctonus ponderosae, will attack both sugar and ponderosa pine. It is associated with stress trees brought on by overstocking or mistletoe infections. A 1994 Survey mapped an infection center of Oregon Pine Ips southeast of Little Pine Openings and western pine beetle in the lower section of Dry creek.

Four common root diseases found in Oregon include Laminated Root rot, Phellinus weirii, Armillaria root disease, armillaria obscura, annosus root disease, and black stain root disease. Laminated root rot infection centers are normally less than one acre in size. Black stain is found in plantations along roads or in soil compaction areas and in overstocked stands and results ingrowth loss and tree killing. Most infections of these common rots are small scattered areas but to act as a disturbance mechanism allowing light in due to trees blowing down due to loss of root strength or bole integrity or trees dying in an upright position.

Westside Douglas-fir is severely damaged by laminated root rot and black stain root disease and is moderately damaged by armillaria up to age 25 and then susceptibility decreases. Western redcedar tends to be less susceptible to root diseases except for armillaria.

Ponderosa pine is moderately damaged by armillaria centered around infected stumps and annosus which is spread by spores in the wind and infects through fresh stumps and infects other trees by root contact.

Incense cedar is seldom damaged by the common root diseases.
Sugar pine and white pine are moderately damaged by armillaria.

Grand fir can be severely damaged by laminated, armillaria and annosus. Pacific silver fir is severely damaged by annosus root disease and moderately affected by laminated root rot and armillaria.

White pine blister rust will cause individual tree mortality and create small openings.

Small openings in Douglas-fir stands are created from small areas of harsh sites or where one plant species is inhibited from growing near or beneath another by allelopathic chemicals. Rhododendron may inhibit the growth of Douglas-fir and allow white pine to be introduced in the openings.

The openings allow understory reinitiation of Douglas-fir due to the increased light as well as retention of brush and hardwoods.

Control of fire has allowed the less fire resistant young trees as Douglas-fir and grand fir to remain in these stands especially on the driest sites.

The oldgrowth stage may show varied layers of mixed age and species stand with scattered large residual Douglas-fir. On the sites where moisture is more prevalent multiple canopy structures tend to be the ingrowth of shade tolerant species as western hemlock and grand fir as individuals and less well defined fire layers as fires tend to less frequent but more a stand replacement event due to the build up of woody material on the forest floor.
GROUP 2 Pacific Silver Fir/Mountain Hemlock/Grand fir Series

The makeup of this group from GIS data by major species is 80% Noble fir, 10% mountain hemlock, 5% white pine, 4 % silver fir and 1% Alaska yellow-cedar.

FACTORS PERTAINING TO TRENDS IN GROUP 2-Mountain Hemlock/Silver Fir

Disturbance Events

The main disturbance event in the Pacific silver group has resulted from timber harvest activities over the past 45 years. Conversion of older multicohort(unevenaged) stands to young evenage stands has been the largest change in the subdrainage. Early units had no riparian areas buffered and early attempts at tree retention were inadequate leaving a 1 or two tree deep protection area which won't provide suitable shade immediately after harvest. Minor blowdown has taken place on unit boundaries as in the head of Deadwood Creek and increase large woody material on unit edges. Small stand replacement fires are infrequent but have occurred within the last 100 years and break up the typically large areas of older stands. Soil movement will delay stand development along Coal Creek and tend to make some stands stay in the stem initiation stage longer.

Vegetative Succession.

The majority of the silver fir stands which have not had regeneration harvest activities currently have multi-layered structures with 2-5 age classes present in stands. At lower elevations Douglas-fir and western hemlock are the most common associates. At upper elevations mountain hemlock and Alaska yellow-cedar tend to be codominant.

The younger stands tend to have fewer layers. The Steeple Rock area has stands of Douglas-fir, Silver and western redcedar that are fire originated in 1861. West of Juniper Mountain 2 stands of a large component of western hemlock and Douglas-fir in the overstory with the silver fir have years of origin of 1459 and around 1643. Along Coal Creek a stand with 40 percent silver fir in the overstory with 64" in diameter Douglas - fir was fire originated over 500 years ago. From these stand ages the fire-return interval can be estimated at 120 to over 500 years. Silver fir forests are characterized of infrequent fires of high severity and may occur under unusual conditions of summer drought and east winds.(Agee,1993).

The Lower Middle fork stands are primarily not at climax due to presence of large quantities of seral species as Douglas-fir, western hemlock, noble fir and minor amounts of white pine. A minor climax of mountain hemlock has occurred at the highest elevations as Balm Mountain. Droughty areas will retain a higher proportion of Douglas-fir stocking.

Disturbance processes and succession

Early harvest activities used single species planting at a close spacing. Broadcast burning and PUM and YUM yarding removed down woody from the site. Snags were removed for logging safety and by broadcast burning. This tended to modify species composition, stand structure and different from natural stands. Natural stands with lower initial stocking tend to stay in the stand initiation stage longer and have a greater herb and shrub growth.(Oliver et al 1990) Diversity in managed stands tends to increase greatly as other species seed in from adjacent areas. In the past decade increased use of more species adapted to specific sites has been utilized to develop diversity.

Animal damage from stocking loss due to gophers or mountain beaver or height growth loss or form damage does allow stands to stay in the stem initiation stage longer. Removal of competing vegetation may allow faster development into the stem exclusion stage but on harsh sites it should be retain to provide site shade for seedling germination and protection from frost. On the harsh higher elevations desired stocking levels may be hard to achieve and stands may never close as in the high elevation True fir mountain hemlock zones.

Some recent managed stands in Coal Creek have spotty, low stock with heavy brush competition. These stands will tend to be clumpy, mixed with open grown trees. Stocking problems are associated with poor burns, duff and rock inclusions and seedling establishment under droughty conditions. These stands will take much longer to reach and may never reach the stem exclusion stage or require density management. Adjacent to these stands are older managed stands with large number of vigorous trees per acre and no brush problems. This vigorous growth will soon occupy available space is soon utilized and the stands may stagnate or slow in growth of height and diameter. Thinning or removal of trees allowed increased growth on the remaining trees and allow some ingrowth of shrub and herbs dependent on the amount of stocking removal. Stands that were not precommercially thinned or are overstocked natural stands from fire stay in the stem exclusion stage for a much greater time frame and the trees may stay small in diameter and become spindly with small crowns.

As the stands age, disturbance as disease, windthrow and small fires allow openings to develop in the stands. A 1993 survey of insect damage done by the USDA Forest Service in Cooperation with the Oregon Department of Forestry identified four sites of the true fir engraver in the Dome Rock and upper Coal Creek area. Small openings are created with the death of the trees.

Four common root diseases found in Oregon, that develop small openings in stands include Laminated Root rot, Phellinus weirii, Armillaria root disease, armillaria obscura, annosus root disease, and black stain root disease. Laminated root rot infection centers are normally less than one acre in size. Black stain is found in plantations along roads or in soil compaction areas and in overstocked stands and results ingrowth loss and tree killing. Most infections of these common rots are small scattered areas but to act as a disturbance mechanism allowing light in due to trees blowing down due to loss of root strength or bole integrity or trees dying in an upright position.

Westside Douglas-fir is severely damaged by laminated root rot and black stain root disease and is moderately damaged by armillaria up to age 25 and then susceptibility decreases. White pine is moderately damaged by armillaria. Pacific silver fir is severely damaged by annosus root disease and moderately affected by laminated root rot and armillaria.

With the openings coming in a transition from stem exclusion to understory reinitiation takes place.

In this Understory reinitiation phase the more shade tolerant species come in and start development of understory layers of different age trees. As the trees mature the seral species die out and a mature stand is developed and climax species, silver fir may become predominant on the site. With Douglas-fir being so long lived and fire interrupting succession climax of silver fir is not often seen. This is the late successional or old growth stage where trees start dying out due to age. The older high elevation portion of these stands has a high snag component in the mountain hemlock zone.

EXISTING LONG TERM MONITORING

Two Shady Beach Fire Recovery Monitoring Plots are located in the LMFW and Tributaries watershed. Ecology Reconnaissance plot #6399 from 1982 is located in T.22 S., R. 3 E., Section 13 and is a PSME/HODI/WHMO association. MOM Inventory plot #5012, from 1988 is located in T.22 S., R. 3 E., Section 1 and is a PSME/TSHE/BENE
plant association. The 50-100 monitoring is for a long-term study of fire effects on the plant associations. Monitoring consists of a cross-section of the 1988 burned areas that will provide a photo and quantitatively measured record of change from permanent points. Monitoring is designed to examine the following:

1. Native species performance based on fire intensities and plant association
2. Interim species performance(exotics introduced to stabilize the site.
3. Time frames required for healing to pre-fire successional status.
4 Documentation of vegetative recovery on salvage logged versus unlogged sites.

Installation was done in 1988. Monitoring schedules vary and can be found in the District file

Appendix H6
Vegetation Manipulation Issue VM6
Ginny Tennis, July 1995

Management activities and fire have set the stage for what is available for timber, special forest products or what is needed for vegetation management to meet the objectives of the Willamette National Forest Land and Resource Management and the Northwest Forest Plan.
Harvest takes a mature stand back into a stand initiation phase. Other disturbances include insect and disease, floods, wind and mass movement. Appendices 1 & 4 describes the past blowdown projects and some stand processes.

A chart showing the treatment acres by decade starting from the 1930's for the Lower Middle Fork of the Willamette and Tributaries is found in Appendix 2.

THE VEGETATION CURRENT CONDITION FOR THE MIDDLE FORK WILLAMETTE DOWNSTREAM TRIBUTARIES AND TRIBUTARIES
IN ACRES

Seral Stage	Acres
Stem Initiation Early Habitat	34,046
Stem Exclusion Pole, Small Timber	14,708
Understory Reinitiation Mature Timber	6,512
Mature, Old-growth Timber	44,003
Unsuited Non-forest**	1,759
Meadows	1,128
Water	3,017
City	930
Other*	3,897
Total	110,000

**Change due to private land conversion
*Roads, Administrative and Special Use areas

The current seral condition for forested lands including private is 31% in stem initiation, 13% in stem exclusion, 6% in understory reinitiation and 40% in mature/old growth. Of the 110,000 acre watershed over 90% is forested. Private lands are mainly in the stem initiation stage, with only a few in stem exclusion due to harvest activities.

The Forest Service forested lands are 21% in stand initiation, 11% in stem exclusion, 6% in Understory Reinitiation and 40% in the mature/Old Growth Stage. Appendix ***** is the vegetation description by series.

Clearcutting in the Douglas-fir forests was the preferred harvest system with over 26,000 acres harvested since 1940. The 1950's showed the first large harvest of 2512 acres. By the 1960's this had increased to a cut of 6305 acres. A slight decrease to 5809 acres occurred in the 1970's. The peak of harvest quantity was in the 1980's with 7918 acres of removal. From 1990 to present 3720 acres have been removed from the Lower Middle Fork of the Willamette.

The major clear-cut harvest area from the 1950's to 1990 was sixth field watershed 21-3 and then a shift was made to sixth field 21-2.
Harvesting proceeded from the northern end of the watershed along the original road 23 and gradually up the easily accessible areas first. Over a dozen units were harvested in the Willow Creek area in the late forties. Buck and Groundhog had heavy harvest in 1950's and this brought roads up to the eastern boundary of the LMFW. In the 1950s harvest started extending up Coffeepot Creek and into lower Coal Creek.

Shelterwood harvesting has been done on a small portion of the watershed.

Harvesting removed down woody material from streams and units in early harvests. Snags were all removed also in early sales. Present management leaves 15% green tree retention areas in removal areas except thinnings to provide micro-site, structure, future large woody material and snags. Early reforestation tended to plant a single species on a set spacing. Planting was done at heavy enough level to assist in meeting stocking level guidelines and unless stock was poor, weather or handling was too severe plantation survival was good leaving some overstocked stands.

The discussion of vegetation manipulation and commodity availability is organized by the by Record of Decision Designations. I. Matrix Lands II. Late Successional Reserves and Managed Late Successional Reserves and III. Riparian areas.

I. MATRIX LANDS

The Desired Future Condition for Matrix land is to increase diversity and ecological function while providing timber and other commodity production while maintaining moderate levels of old-growth components as snags, logs, and relatively large green trees.

The Current Condition of the Matrix lands on allocations that provide for timber production and associated riparian lands is:

CURRENT MATRIX CONDITION	Stand Age (Terrestrial Acres, >1 acre)							Total
	0-5 yrs	**6-15 yrs**	**16-25 yrs**	**26-50 yrs**	**51-80 yrs**	**81-200yrs**	**200+yrs**	**Acres**
Non-Riparian Matrix Acres	2735	4519	3204	5549	2720	1211	12578	32516
Associated Riparian Acres	452	1092	918	1327	427	104	766	5086

INTERPRETATION FOR MATRIX

The change from the overall watershed reference, to current condition shows harvest of stands in the Understory Reinitiation and Mature/Oldgrowth stages and those and a large increase in the stem initiation stage and an increase in the stem exclusion stage. A higher percentage of these stands are in stem exclusion than shown in the numbers. This is the result of coding in the GIS year or Origin being delayed due to early natural reforestation.
Due to high reforestation success, at a close planting spacing, stand density management will be required to produce large trees and maintain health and vigor of stands. Without treatment stands will stagnate at an early age and tree diameter growth will be slowed.

Non-riparian matrix acres in stands 80 years or older by six field watershed are: 1)sixth field 21-3,8506 acres, 2)sixth field 21-2, 4126 acres, 3) sixth field 21-4769 acres and 4)21-1 388 acres. The 13789 matrix acres may be reduced 2000 acres by Special Habitats and buffers and reduced by 532 acres in Slinky, Stonepot, Boulderdash and Weeping Projects and a further reduction from 15% green tree retention. The available matrix acres for PSQ are 9569 and are primarily in sixth field watersheds 21-3 and 21-2. See Appendix ****** Matrix Current Condition for watershed detail.

Matrix acres in stands between 26-50 years are assumed to be managed stands near commercial thinning age or if not precommercial thinned and overstocked may be suitable for post and poles. Acres in this age class by sixth field watershed are: 1) sixth field 21-3, 3305 acres, 2) sixth field 21-2, 1911 acres, 3) sixth field 21-4, 310 acres and 4) sixth field 21-1, 23 acres for a total of approximately 5549 acres. Volume removal may also be appropriate in stands 50-80 years old. Stand Density management and pruning are needed to increase product quality, size and tree vigor.

With many acres in younger age classes reforestation activities will be done including replants, release and animal damage control.

RECOMMENDATIONS FOR MATRIX

*The majority of the acres available for PSQ will come from sixth field 21-3, and 21-2. To maintain diversity, harvest will maintain the early successional stage. Harvest will occur in a range of habitat types and prescriptions from commercial thinning to regeneration harvest on matrix lands. Marking prescriptions should reflect diverse species, forms and conditions of vegetation. Windfirm boundaries between LSR and matrix lands are desirable and can be facilitated with "feathering" of harvest boundaries.

Commercial thinning and post and pole opportunities are found mainly in watersheds 21-3 and 21-2. Exams to the regional standards should be done to facilitate project scheduling and facilitate data entry into GIS for all stands.

Vegetation management activities may be appropriate on all acreage shown above and may be needed and done in non-harvest allocations to meet specific objectives.

Opportunities for treatments to enhance function or to meet commodity productions include but are not limited to:
1) develop snags for structural diversity and future nutrient input for large woody debris

2) stand density management to meet objectives of diversity in species composition and stocking, structure and promote health vigor and size or meet other objectives and commodity needs.

3) pruning to increase product quality and improve tree vigor or to meet other objectives

4) vegetation treatments to reduce risk of fire, insects, disease or animal damage.

5) release or removal of vegetation to promote vigor, tree size, stocking protection, or forest user safety

6) reforestation for establishment, stocking level maintenance, stand diversity development or to meet other objectives. Cone and other vegetative collections may be utilized.

7) use of prescribed fire and fuel management to promote, health and vigor of vegetation, fuels reduction or meet other objectives as
habitat maintenance.

8) Roads restoration may be planted with a variety of vegetation, native collections may be utilized

9) Fertilization to promote, healthy and vigorous vegetation on all lands

10) Removal of special forest products will be done under current direction

11) Salvage and harvest will provide commodities from allocations where appropriate.

II. Late Successional Lands and Managed Late successional lands

Desired Future Condition for LSR,s or unmapped Late Successional areas, is the development and protection of late successional and old growth characteristics including: 1)Multi-species and multi-layered assemblages of trees of variable spacing 2)Moderate-to-high accumulations of large logs and snags, 3)Moderate-to-high canopy closures, 4)Moderate-to-high numbers of trees with physical imperfections as cavities, broken tops, large deformed limbs and lean 5)Moderate to high accumulations of fungi, lichens and bryophytes 6)Gap development from minor disturbances is allowed to continue.

Development of these characteristics in Late-Successional Reserves should focus on stands, under 80 years of age, that have been regenerated following timber harvest or stands that have been thinned. Treatments should be done in any stands that are prone to insect, fire, wind or fire disturbances, to prevent large-scale disturbances.

The following chart displays a summary of acres by age classes for the LSR Lands. The LSR Current Condition chart with individual watershed acres is found in Appendix ****. The summary shows some of the potential acreage where potential vegetation manipulation projects for habitat improvement can be done and commodity removal may be a result of the treatment. Treatments may be done in other allocations and LSRS.

CURRENT LSR CONDITION	Stand Age (Terrestrial Acres, >1 acre)				
	0-5 yrs	**6-15 yrs**	**16-25 yrs**	**26-50 yrs**	**51-80 □**
Non-Riparian Lsr Acres	1090	2635	1619	2354	536
Associated Riparian Acres	175	631	509	555	49
Total	1265	3266	2128	2909	585

INTERPRETATION FOR LATE SUCCESSIONAL RESERVE

The change from the overall watershed reference to current condition shows a harvest of stands in the Understory Reinitiation and Mature/Oldgrowth stages and those and a large increase in the stem initiation stage and an increase in the stem exclusion stage.
Over 24 % of the Late Sucessional Reserve for scenic and previously general forest allocations is under 80 years of age. About 4531 acres are in age classes 0-15 years and may be suitable for release and precommercial thinning. A portion of these may have already been treated. About 5622 acres are in age classes 16-80 and may be suitable for post and pole or commercial thinning. Some small acreage in special habitats might have vegetation treatment opportunities.

RECOMMENDATION FOR LATE SUCCESSIONAL RESERVE

Consider implementing precommercial thinning program on the 3266 acres in the 6-15 years of age. This will minimize the loss of tree vigor due to

overstocking and maintain full crowns and improve diameter and height growth. The increased vigor will reduce the risk of insect and disease
problems. Delaying the precommercial thinning will cause a loss of crown size and cause the trees to be of small diameter and increase the
post treatment fuel loadings and residual stand damage. The tall spindly trees may break under heavy snow loads. The desired future condition should be designed in at the precommercial thinning stage in order to not preclude options. The decline in health and vigor due to overstocking and
and poor crowns is not recaptured and will slow the development of large diameter trees. In riparian areas design the precommercial thinning based on desired future condition for the individual stream reach or riparian habitat. This is an opportunity to develop the species composition and set the stage for desired tree diameters for down woody material through the use of stocking level control.

An assessment of approximately 5307 acres of managed stands in the 16-50 year age class and approximately 585 acres in the 51-80 year age class should be done to identify habitat conditions and design vegetation manipulation projects to meet wildlife or other objectives.

Vegetation management along the reservoir should promote the health of stands, minimize fire hazards, and provide for the habitat needs of T and E species like nest sites and promote visual diversity for the recreationist and maintain roadside safety.

Verification and update of the GIS data is necessary to provide an accurate picture of stand conditions in the LSR.

Treatments are limited to those that are beneficial to and maintain late-successional forest conditions, forest health, user safety and reduce risk in all stands include but are not limited to:

1) development of snags

2) development of coarse woody debris, by snags development and tree felling

3) stand density management to produce large trees, develop structure, modify species composition, provide gaps and modify spacing or meet other objectives.

4) reduce risk from fire, insects, diseases or other environmental variables

5) release advanced regeneration of conifers, hardwoods or other plants

6) underplanting and modifying understory vegetation to begin development of multistory stands or retain desired stocking level

7) reforestation for establishment or other treatments for stocking level maintenance, stand diversity or to meet other objectives such as hydrologic recovery.

8) Roads may be restored to a natural state within LSR's and may be planted with a variety of vegetation and may use native collections.

9) Fertilization to promote, health vigor and vegetation establishment.

10) Seedling protection projects as animal control

11) Removal of snags and logs to reduce hazards and use for salvage where appropriate or provide restoration materials

12) special forest products may be collected under the current direction guidelines

III. Riparian Reserve Areas

Past management and natural processes have changed the condition of the riparian areas by increasing the quantity of stand initiation and stem exclusion
exclusion stages while reducing the understory and old growth stages. Snags and down woody material were removed during harvest.

The Desired Future Condition for Riparian Reserves is to sustain a physically complex and stable riparian and wetland vegetation in Riparian reserves along with restoring large conifers. Activities to facilitate this or that may be appropriate under current direction include:

1)Release young conifers in riparian areas from overtopping hardwoods.

2)Plant unstable areas as landslides.

3)Stand density management or pruning to encourage development of large conifers or modify species composition

4)Reforesting shrub and hardwood dominated stands with conifers or vice versa

5)Collection of vegetation or reproductive materials to facilitate site conversions or rehabilitation reforestation or revegetation projects or restoration projects.

6)Removal of salvage or other vegetative material to meet the Desired Future Condition or provide for user safety and commodities that are appropriate

Prescribed widths of the Riparian Reserves may be modified and be given a prescribed width based on slope distance or multiple of a site tree potential after a site specific analysis is conducted and described and the rational for the boundaries is presented through the appropriate NEPA process. Programmed timber harvest is prohibited.

I

Appendix I

Heritage Resources

Heritage Resources
Jane Agar, Archeologist
1995

With a diversity of resources ranging from abundant fish, small mammals, big game and prolific vegetation the Middle Fork Willamette Downstream Tributaries (MFWDT) and its tributaries have provided choice human habitat for at least 6,000 years. Ethnographic evidence from low elevation sites suitable for year round use, to aboriginal trails providing travel routes accessing a multitude of diverse upland resources remain throughout this watershed today.

Beginning at least 1,500 years ago, Kalapuyans occupied the Upper Willamette Valley and its tributaries, including the LMFW. The Kalapuyans' settlement patterns and subsistence activities reflected a seasonal round that moved from valley floor to hillside. In his typology of Upper Willamette Valley and tributary sites, White (1975) suggests the Kalapuyans occupied the valley edges, in conjunction with the Douglas fir ecotone, during the late spring and summer to engage in diversified hunting, tool manufacturing, and hide preparation. Given what is known about the fluctuation in elevation of the floral community over time (Delting 1968) the locations of these sites in the sub-basins of the Western Cascades may fluctuate just as drastically, since food resources tend to be more lucrative in the ecotone.

The Southern Molalla migrated into the Upper Willamette, pushing out the Kalapuyans after AD 1600 (Swanton 1968). Ethnographic literature dealing with the Molalla is elusive to non-existent. Consequently, little is known about their culture, but it is reasonable to presume their subsistence style was similar to other groups in the Western Cascades.

During the early 1800's Euroamericans began moving into the Willamette Valley. By mid-century settlements were developing along the LMFW. The horse, acquired at white contact, enabled the Klamath Indians to travel over the Calapooya Divide via Staley Ridge and down the Middle Fork. Over the centuries, Indian groups developed a well-defined trail system they used until after Euroamerican settlement in the area. Some of the trails included the Staley Ridge Trail and the trail that later became the Oregon Central Military Wagon Road.

By 1855, most of the Indians who had survived the influx of disease brought in with the white settlements, were relocated to reservations at both Grand Ronde and Warm Springs.

Early Euroamerican settlers in the upper reaches of the Willamette found life difficult. They learned to utilize the resources available to them in an environment where their communication with the outside world was primarily limited to the dry season. In order to survive, settlers would bell their cattle and summer them on the Calapooya Divide. To gain access to the Divide, they widened Indian trails for the herds of livestock.

Records indicate that several cabins existed in the area of Oakridge. A locally famous inhabitant of one of these cabins was Stephen Rigdon. Unique to 19th century transportation histories are the log books he kept. This Willamette Valley farmer went each year from 1871 to 1896 to the meadows near the western base of the Cascades near Emigrant Pass to graze his cattle and maintained a way-station for travelers frequenting the Oregon Central Military Wagon Road (OCMWR).

The OCMWR is the most completely documented route of 19th century travel in Oregon. The documentation for this road includes: log books from travelers from 1871 to 1896, the diary of the road surveyor, contemporary newspaper accounts about the construction of the road in 1865-66, and hundreds of pages of testimony relating to litigation about the road in the years 1889-91.

Initial interest in this route was sparked when in the spring of 1852 residents of the upper Willamette Valley explored the Middle Fork to try to find a route over the Cascades. During the summer of 1853 more then 1500 people with between 250 and 300 wagons used this Free Emigrant Route to cross the upper Willamette Valley (Menefee and Tiller 1977). Through the late 1850's and early 1860's gold miners, occasional emigrants, and others who needed to cross the Cascades passed over the lands along the LMFW.

The OCMWR was the result of several factors. It was built because of the increasing commitment in the 1860's of the federal government to improvements in transportation in the Trans-Mississippi West . It was also a result of the growing interest of inhabitants of the upper Willamette Valley in the development of the resources of central Oregon, especially in the lush meadowlands surrounding water resources in those areas. Settlers transferred their shareholder land grants into farmsteads. Some built hunting lodges initiating utilization of the area for recreational purposes (Jensen 1970). The road was to become a major route of emigration for the second generation of Oregon pioneers, those who engaged in eastward bound migration from the Willamette and Umpqua Valleys into the central and southeastern parts of the state after 1868.

By the 1870's, interest in the economic potential of the timber available in the Cascades resulted in utilization of the Middle Fork River to drive logs to mills in the Eugene area (Mason 1973). Log driving reached its peak between 1890 and

1910. As supplies became exhausted the loggers moved upstream to such places as Fall Creek, Winberry Creek and the North Fork of the Middle Fork. Contract loggers such as Jasper Hills figured prominently in the activities. By 1912, the river drives had been replaced by the advent of the logging railroad and the lack of available timber near the driving streams.

In 1893, the Cascade Range Forest Reserve was established under the auspices of the U.S. Department of the Interior. The Reserve covered a large portion of the Cascade Range. Initially it was a closed area, but by 1897 the land was reopened to settlers, miners, stockmen and lumbermen for their use. In order to enforce the regulations of the U.S. Department of the Interior and later the Department of Agriculture in 1905, forest rangers were hired to patrol the area. Rangers working in the area of the MFWDT engaged in activities that included patrolling, acting a s game warden, surveying, erecting cabins, trail building, timber marking, log scaling, locating sites for mills and hotels, fire fighting, and being a deputy U.S. Marshal.

During the early 1900's the Cascade Range National Forest underwent several administrative changes. In 1908, the U.S. Forest Service created the contemporary Umpqua National Forest in the Cascade Mountains from the Cascade Reserve. The forest included lands south of the Middle Fork Willamette River and north of the Rogue-Umpqua Divide. In 1911, lands north of the Calapooya Divide were placed under the jurisdiction of the Cascade (now Willamette) National Forest that later included the Oakridge Ranger District and in 1947, the Rigdon Ranger District. The 1911 land administrative land exchange between the Umpqua and Willamette National Forests moved the Forests' common boundary to its current position along the crest of the Calapooya Divide.

Twentieth century development of the Upper Willamette was expedited by the advent of the railroad, the contemporary road system, and the logging truck. In an effort to control forest fires, several lookout towers were built including those at Hills Peak (1923), Bearbones (1934), and Balm Mtn. (1934). Presumably the Civilian Conservation Corps were utilized by the U.S. Forest Service since records indicate their presence in the forest from 1933 to 1942. Telephone access was provided the towers such as the line laid from Johnson Meadows to Bearbones in 1930. The towers were utilized for several years, eventually being replaced by aerial patrols, radio communication, and a complex National Forest road system.

A study of this area in the 19th and early 20th centuries is a study of resource developments, trends and making this all happen - people. With the exception of the archaeological record, investigator's know little about the Indians as individuals prior to white contact. The literature of the 19th and early 20th centuries, however, refers to personalities such as Charlie Tufti and John Chuck who were Indians who homesteaded on the Middle Fork of the Willamette River (Jensen 1970). Mountain stockmen and trappers, including William D. Bradley (Bradley Lake, Flat and Trail) and Elijah Bristow (Bristow Prairie), opened up the area. Forest rangers, such as W.F. Staley (Staley Creek and Ridge), also left their mark.

J

Appendix J

Wildlife Documents

Ken Kestner
Wildlife Biologist
July 1995

ISSUE: VEGETATION MANIPULATION□

VM1: HABITAT/WILDLIFE DIVERSITY

REFERENCE

Wildlife species are tied to habitat types suitable for the species to live and reproduce. Some species are generalists as deer and bears and utilize multiple types of habitats. At the other extreme, some species are specialists and tightly tied to one type of habitat, as pikas are with tallus rock. Most species in the watershed are between the generalists and specialists, in utilizing several, but not many, habitat types, as early and mid seral forest, or mid and late seral forest, or aquatic and riparian forest, either early and mid seral riparian or mid and late riparian forest habitats.

Likewise, some species, as the northern spotted owl, survives best in large acreages of interior late seral forests of the mid to lower western hemlock/Douglas-fir zone, while the black-backed woodpecker favors a mosaic of late seral mountain hemlock and true firs, found at the higher elevations.

Guilds of species utilizing the similar habitats are numerous and can be viewed in a separate document for the Forest and west Cascades. The analysis for this watershed takes the approach of addressing the various habitats, instead of listing off wildlife and plant species. Maintaining respresentations of the habitats is the primary tool for maintaining the species, if one further recognize that habitat includes size, disteribution and microclimate, also.

Initial discussion arranges the timber series/timber types as dominate habitat types; the western hemlock/Douglas-fir habitat type, which includes the dry-site Douglas-fir with pines, and the mountain hemlock/true fir habitat type, which lumps the "white woods" because of similiar habitat features and use. The riverine hardwood habitat and the "special habitats" are recognizably smaller in percentage of the watershed, but are considered as dominate habitats with the conifer habitats due their obvious habitat structural difference and their importance in species richness.

Within the conifer habitat types, subsets of seral habitats are addressed, due the change in suitability for different wildlife and plant species. These subsets are the early seral habitats (stand reinitiation), the pole-small timber seral habitat (stem exclusion), and the mature/old growth seral habitat, which includes timber that's >21" dbh.

The guilds of wildlife species developed thus far fit the dominate habitat types and subset of seral habitats mentioned above. Of the conifer habitat types, there are further defined subsets of habitats types, or habitat characteristics. These are not portrayed in the guilds developed thus far, but are of difference habitat characteristics that determine habitat suitability for many wildlife and plants species.

These further defined habitat types, or habitat characteristics, are represented as open forest habitat, utilized by species as goshawks, great horned owls, flamuated owls and chipping sparrows, mixed hardwood/conifer habitat, utilized by black-headed grosbeaks and black-throated gray warbler, and pure conifer habitat, utilized by western tanagers, Hermit's warblers and Townsend's warbler.

Maintaining habitat types, or characteristics, that a given site in the watershed would provide is one of the better methods of providing for and maintaining species viability and distribution, as directed by the NFMA. An old Arkansas axiom says: "If the habitats are provided, including adequate size and distribution, the species will come, if they can get there (a connecivity function).".

FOUR DOMINATE HABITAT TYPES

WESTERN HEMLOCK/DOUGLAS-FIR HABITAT:

Western hemlock/Douglas-fir forests comprised the largest habitat type. This habitat type then consisted of a larger subset of habitats, as early seral forest habitats, pole-size and small timber habitats, mature and old growth habitats, ponderosa pine/douglas-fir habitats, pure conifer habitats and mixed hardwood/conifer habitats.

The ponderosa pine/Douglas-fir habitat was notably different in species composition and habitat structure from the remaining habitats making up the dominate western hemlock/Douglas-fir habitat type. Douglas-fir and ponderosa pine habitat existed in the low elevation along the eastern side of the river and in the lower portion of Coal Creek. The pines were more prevelant in the Youngs Creek - Deadhorse Creek area. Sugar pine was also intermixed with the Douglas-fir habitats and was more common in the Buck Creek to Estep Creek area.

MOUNTAIN HEMLOCK AND TRUE FIR HABITAT:

Mountain hemlock and the true firs comprised about 5% of the watershed, as provided by stand description. However, this percentage may be underrated with Pacific silver fir/Douglas-fir stands being described as Douglas-fir stands.

Mountain hemlock and Noble fir/ Pacific silver fir habitats existed at the higher elevations along the Calapooyia Ridge, notably in upper Coal Creek, and at the higher elevations from Warner Mountain area to Groundhog Mountain area. Grand fir was distributed in relation to the Western hemlock/Douglas-fir habitats, but gained its own habitat type in upper Gold Creek where a small stand of old growth grand fir exists.

The major ridgelines extending westward from the main Cascades Crest provided disjuncted and stringers of these mountain hemlock and true fir habitat types into the watershed, adding diversity and range of wildlife species, as the black-backed woodpecker, pine marten and great gray owls.

HARDWOOD HABITAT:

Riparian hardwood habitats formed the edges of the river and many class II streams and along many Class IIIs streams after fire events and until conifers closed canopy over the hardwoods. Hardwood trees were a component of the conifer forest habitats in the mid to lower elevations. Small stands of white oaks (<2 acres) existed, as at present Packard Campground, and scattering of individual oaks are believed to have been more common than currently.

SPECIAL HABITATS:

Special habitats comprise habitats as seeps, springs, caves, meadows, rock outcrops, bogs, marshes, small lakes and ponds. Special habitats varies in size from ~25-acre meadow with surrounding forest to a small spring on a forested hillside. Though special habitats comprise only 1%-2% of the watershed acreages, they provide a higher species richness than the general forest habitats and contribute to the overall biodiversity across the landscape. Many species, particularly plant species, are specifically dependent of special habitats for their micro-site needs.

Special habitats of the same type, as wet meadows, were commonly very diverse from each other in their botanical composition and structure, thus influencing the types and richness of insect and larger wildlife species that utilized the special habitats. Examples would be dry non-forested tallus slopes that often have currant bushes around the edges, which are depended on by hummingbirds, as pikas depended on the cavities amongst rocks for cover and denning. Wet non-forested tallus slopes often had Sitka alder or other brushy vegetation around the edges, which provided a constant brush habitat, whereas the brush habitats of the general forest came and went with fires and regeneration of conifers. Forested, old tallus slopes are essential habitat for wildlife as the Dunn's salamander. These shaded and litter covered tallus slopes provide a cool and moist environment essential for egg mass maturation and for the adults to survived the periods of dry and hot weather above ground.

PROCESSES AFFECTING HABITAT TYPES:

The frequencies and intensities of fires were the dominate factors affecting habitat diversity. Over the centuries most of the watershed experienced fire at varying frequencies and to varying intensities.

Before the mid-1850 series of fires, approximately 95%-97% of the forested habitats are thought to have gained a mature/old growth habitat conditions during a period of low intensity fires.

Then, a series of large, intense fires occurred during the mid-1800's, converting thousands of forest acres to early seral forest habitats. Another low intensity period occurred while the early seral forest habitats grew into pole-size and small timber habitats. Around the turn of the century, another series of large, intense fires occurred, again converting thousands of forest acres to early seral forest habitats. This scenario presented a forest landscape with a mixture of early seral habitats, pole-size and small timber forest habitats, and mature/old growth forest habitats.

The intense stand replacement fires of the mid-1800's created large blocks of early seral forest habitats in the upper Packard Creek drainage and the upper Coal Creek drainage and created extensive mosaic pattern in the Larison Ridge area.

Of the mid-1800's fires on the east side of the river, acreages of stand replacement fires creating early seral forest habitats in the western hemlock/Douglas-fir habitats were smaller; 1000 acres and generally of a few hundred acres or less. The larger of these were across the middle reaches of Bull Creek, Willow Creek and Coffepot Creek, in the lower Youngs Creek to Deadhorse Creek and across to lower Coal Creek area, in the lower to middle Coal Creek area, the middle Coal Creek area. The majority of the fire acres east of the river, especially southern aspects, should have appeared as open forest habitats, with hardwoods, brush and grasses.

The true fir zones of Upper Coal Creek and the Warner Mountain to Groundhog Mountain incurred stand replacement fires, and resulting early seral habitat, a short period before 1835 (170 to 200 years ago) and are considered part of the mid-1800's fires.

The Youngs Creek, Deadhorse Creek, lower Coal Creek area of Douglas-fir/Ponderosa pine, and the upper Coal Creek Pacific silver fir/Douglas-fir area retained a higher percentage of green, residual overstory trees, providing an early seral habitat with sparse overstory trees.

The series of fires around the turn of the century created early seral forest habitats in more of a mosaic pattern, verse large blocks, and also were concentrated heavily in the Larison and Pavckard area, with fewer small patches of early seral habitats created across the remaining watershed.

Fire frequency often determined fuel loading, as accumulations of dead wood, and often determined fuel ladders, as understory limbs which could carry a fire into the overstory canopies. Levels of fuel loading and fuel ladders also typified the habitat that many forest wildlife responded to. The fuel loading and fuel ladders also determined the habitat types that resulted from a fire, as an early seral habitat of grasses, forbs and brush dominated from a stand replacement fire, or open woodland habitat, or multi-canopy forest.

Early seral habitats were developed in small patches, complex mosaic patterns, and large acreage blocks. Small patches and mosaic patterns of early seral habitats often provided a high degree of fragmentation and edge habitats. However, large areas of early seral habitat created by stand replacement fires would have provided a greater species richness, or number of wildlife species, associated with early seral habitat (Bunnell, F. 1995). Such large areas generally have a greater diversity of habitat sites within them, as small patches or strips of unburned sites and greater number of microhabitat sites with varying aspects, moisture regimes and plant associations.

As the areas of stand replacement fires regenerated predominately with conifers, two scenarios of habitat structure and composition commonly occurred, depending on sites. One scenario is where hardwood trees weren't a component of the site, and the regeneration developed as mostly pure conifers. The second scenario is where hardwood trees were a component, sometimes densely so, and the regeneration developed as mix hardwood/conifer habitat.

Areas of frequent underburning should have shown a low concentration of large logs and snags, as old ones were consumed and a few new ones recruited. These areas typically had more open understory, with minor lower canopy structure. Such habitats of frequent underburning commonly existed on southern aspects. These areas also normally had a corresponding low concentration and fluctuation in wildlife species associated with the habitat components of large logs, snags and dense understory canopies, while having a higher concentration of wildlife species associated with open forest habitat.

Areas of very infrequent fires, as in several hundred years, should have shown high concentrations of large logs and snags and corresponding high concentration of wildlife species associated with large logs and snags and with multiple canopy structures. These areas also tend to experience very intense fires when fires did occur.

With the stand replacement fires, most of the watershed still remained in mature and old growth forest habitats. Though much of these forested habitats periodically underburned, the large residual green trees still provided a forested environment.

Brush and hardwood trees were important components in the habitat diversity and determined the habitat suitability for many wildlife species. Brush-associated wildlife, as brush rabbits, benefitted by stand replacement fires, as Ceanothus, vine maple and other brush tended to dominate the burn areas until the regenerated conifers overtopped and suppressed the brush. In parts of the watershed, as the ponderosa pine areas, grasses predominated and provided an open timber/grass habitat favored by species as the flamuated owl, XXXX.

Hardwood trees, as big-leaf maple, cottonwood, red alder, white oak, madrone and chinkapin, provided a mix hardwood/conifer forest habitat, favored by wildlife such as the white-breasted nuthatch, Bohemian waxwing, and silver gray squirrel. Hardwood trees provide invaluable food sources in the form of seeds, catkins, and insects that feed on the leaves. Big-leaf maples, oaks, cottonwoods and red alders with defect are favored by some cavity nesters, as the downy woodpecker.

Several of these hardwood tree species tend to resprout after fires and gain an initial height advantage over the young conifers. Unlike many of the brush species, the hardwood trees tended to persist longer into the age of the second growth conifer, resisting shade suppression until the conifers developed a mature forest.

The hardwood riparian forest of the larger, low gradient river and streams usually were affected by flood events more dramatically than by fires. The hardwood riparian areas on steeper gradient streams had a greater variance in effects from fires.

The main processes affecting special habitats were slope instability, flood events, and fire. Slope instability often formed the hillside bogs and small lakes, as Windfall Lake. "Slump" ponds, as found in Bull Creek drainage, were created by a hillside movements and became essential reproductive sites for red-legged frogs, a Sensitive species, Northwesten salamanders, and often western pond turtles, another Sensitive species. Flood events in the lower gradient streams also made and eliminated flood channel ponds or quiet waters, that benefitted the species above as well as beavers and otters.

Fire was the main factor in maintaining meadow areas, and meadows often fluctuated in size as a result of fires and the absent of fires. During periods of no fires, conifers encroached into meadows, slowly narrowing the meadows size. Periodical fire tended to burn out the encroaching trees, restoring the meadows' size. Frequency and intensity of fires determined the effectiveness of abating the encroachment of trees.

Within the Matrix, there's a potential for about 2,100 acres of small, unmapped special habitats and surrounding forested buffer zones.

In the early 1900's, emphasis on fire suppression precluded large acreages of early seral forest habitats from occurring by stand replacement fires. The sizes of natural fires were effectively reduced to small acreages, and early seral forest habitats quickly grew into pole-size habitat, and then into small timber habitat.

Forest habitats that were characterized as having low levels of logs and snags and open understory began to change, with incremental increases in down logs, snags, and young understory trees filling in the open forest floor. These changes in habitat characteristics would beneficiallyly influence the suitability for some wildlife species, as the spotted owl, the pileated woodpecker, and the pine marten. The loss of open forest habitats would decrease habitat suitability for other species, as the flamulated owl and the northern goshawk.

CURRENT

The western hemlock/Douglas-fir, Mountain hemlock/true fir, hardwood riparian, and special habitats are still dominate habitat types on the landscape, with the addition of the Hills Creek Lake reservoir.

The acreages of seral habitats, or subset habitats of the forest-type habitats have changed substantially. The 34,046 acres of early seral habitat have increased 9100% from the 370 acres in the 1940's. Compared with the 18,447 acres at the turn of the century and the 23,000 acres around the mid-1850's, the changes are 84% increase and 48% increase, respectively.

The 14,708 acres of pole/small timber seral habitats increased by 27% from the 11,568 acres in the 1940's. Compared with the 19,550 acres at the turn of the century and the 1,000 acres around the mid-1850's, the changes are 25% decrease and 137% increase, respectively.

Meanwhile, the 50,515 acres of the mature/old growth habitats have decreased about 46% from the 93,993 acres in the 1940's. Compared with the 67,581 acres at the turn of the century and the 82,328 acres around the mid-1850's, the changes are 25% decrease and 39% decrease, respectively.

The distribution pattern of these habitat seral stages, namely the early seral and the pole/small timber seral, and related edge conditions, have changed substantially, due the distribution practices of timber harvest. The change in distribution pattern can be visualize with the HVEG map compared with today's harvest pattern.

The seral pattern of the private land has some resemblence to reference, or natural, condition with larger block-acreages of similarly aged habitat. The early and pole/small timber habitats on private land and the smaller managed plantations on NFS land are low or deficit in habitat components, as large logs, snags, and patchiness of residual trees.

Currently, the dominate habitat type is still mature and old growth forest habitats, although reduced in acreage and with a very different pattern and habitat structure across the landscape, resulting predominately from fire suppression and timber management practices, as harvest, regeneration, and stand improvement techniques.

Timber harvesting in the 1950's started the resurgence of early seral habitat, and steadily increased until the present, with the highest rate of early seral habitats being created during the 1970's and 1980's. On the National Forest System lands, the early seral habitat by timber harvest was distributed across the forested landscape in small harvest patches. The private lands started with small patch openings (30-50 acres in size), and ended up with large blocks consisting of early seral and pole-size habitats. The impoundment of Hills Creek Lake (~2240 acres) also reduced the forest and riparian habitats.

CONCLUSIONS

A gradual loss of the open mature/old growth forest habitats, as the mix of densely structured mature/old growth forest, open structured mature/old growth forest, and gradient between, shift toward the former with fire suppression.

A loss of large acreage-blocks of similar aged forest habitats, whether of early, mid or late seral, as result of patch-distribution of forest management in the Matrix. The LSR 0222 will trend toward large acreage-blocks of late seral forest habitats.

A loss in acreage of mature and old growth ponderosa pine/Douglas-fir forest habitats, with projected program of timber harvest.

A loss in non-forested habitats, as meadows, with conifer encroachments resulting from fire suppression.

A reduction in hardwood components in mid-seral mixed hardwood/conifer forest habitats, namely managed plantations, due pass emphasises on treatments favoring "crop tree" production.

A reduction in early and mid-seral forest structure, due pass emphasises on density stocking and even spacing of crop trees, and removal of competing trees.

TREND

An overall downward trend in habitat diversity exists for the watershed, due several reasons.

RECOMMENDATIONS:

Assess, develop and implement strategies to maintain representations of open forest habitats, where fire historically provided such, with priority emphasis to the ponderosa pine/Douglas-fir area.

Develop management strategies to provide large blocks of similar aged forest habitats, with priority emphasis to the ponderosa pine/Douglas-fir habitats.

Assess and develop management strategies in the ponderosa pine/Douglas-fir habitats to maintain functions of mature/old growth habitat. Such assessment would consider how the scenic allocations, the Green Tree Retention and Wildlife Tree (Snags) prescriptions meet those mature/old growth functions.

Assess and implement strategies to enhance and regain non-forested habitats, as meadows, with uses of silvilcuture and fire treatments.

During precommercial and commercial thinnings, apply silvicuture prescriptions which promote or maintain hardwood trees.

Diversify, or vary, stocking densities during reforestation, precommercial thinnings and commercial thinnings toward representations of sites' natural tendencies. Strategies would include maintaining small openings that are difficult to reforest, vary spacing during reforestation, vary spacing during precommercial and commercial thinnings, which include no-thin areas, maintain diversity of tree species during thinnings, and maintain some defective trees during thinnings.

VM2 INTERIOR HABITAT

REFERENCE

After the stand replacement fires of 1850 and prior, there were very large blocks of mature and old growth interior forest habitats. Much of these habitats likely had small, early seral opening resulting from previous underburn fires, but on the landscape, these blocks of mature and old growth habitats functioned as contiguous forests. The large blocks of interior mature and old growth forests existing around 1850 were interpreted from the Historic Vegetation Map for the watershed.

Estimated 13,440 acres, Dinner Ridge, most of Larison Creek, lower Packard, lower Windfall Creek
Estimated 19,200 acres, Gold Creek south to lower Coal Creek
Estimated 10,880 acres, Buck Creek to Youngs Creek
Estimated 2,560 acres, Modoc Cr.-Bull Cr. area.
Much of the remaining mature/old growth habitats were in interior habitats ranging in sizes between 2,000 acres and 100 acres.

Areas as the Youngs Creek periodically burned. The sparseness of residual overstory canopy might have resulted in this area being characterized more of an open woodland, instead of intereior forest habitat.

Besides these large blocks of interior habitat, numerous smaller blocks of interior forest habitats were distributed across the landscape..

The turn of the century stand replacement fires were well distributed across the watershed, with the greatest acreage concentration occurring from Larison Creek drainage northward over Larison Ridge and down toward the river, across from the City of Oakridge. These turn of the century fires were highly mosaic in pattern in the Larison area and the Windfall Creek-lower Packard Creek area. Across the remaining watershed, these fires were in more of a patch pattern.

With the regeneration of the <1850 stand replacement fires still too young to serve as mature/old growth habitat, the turn of the century fires substantially reduced acreage sizes of interior mature/old growth habitats. Large blocks of interior mature/old gerowth habitats remaining were:

Lower Packard Cr. drainage:	estimated 7,600 acres
Upper Dinner Ridge/Larison Cr. area:	estimated. 1,280 acres
Mid. Larison Cr. area:	estimated. 1,920 acres
Lower Pine Cr. to Youngs Cr. area	estimated. 4,500 acres
Indian Cr.- lower Coal Cr. area:	estimated. 7,040 acres
Upper Bohemia Cr.- Spr. Butte Cr. area:	estimated. 8,960 acres
Upper Buck Cr area:	estimated. 2,300 acres
Cone Cr. area:	estimated. 2,200 acres

Numerous interior habitat blocks, ranging in sizes of 1000 acres and less, were distributed across the watershed.

CURRENT

With the advent of timber harvesting and continuing to the present, the remaining areas of large blocks of interior forest habitats are substantially smaller and are on NFS lands.

North slope of Larison Ridge:	est. 3,200 acres (~5 sq.mi); in LSR 0222
Upper Gray Creek drainage:	est. 1,600 acres (~2.5 sq.mi); in LSR 0222
Mid-Lower Larison Creek drainage:	est. 3,200 acres (~5 sq.mi); in LSR 0222
Upper Packard Creek drainage:	est. 2,560 acres (~4 sq.mi); in LSR 0222
Upper Bohemia Creek drainage:	est. 1,280 acres (~2 sq.mi); in LSR 0222
Lower Buck Creek drainage:	est. 1,280 acres (~2 sq.mi); in MATRIX
Upper Gold Creek drainage:	est. 1,088 acres (~1.7 sq.mi); in MATRIX
Mid Coal Creek drainage:	est. 2,560 acres (~4 sq.mi); in LSR 0222

The mid Coal creek interior habitat extends in a long lineal fashion in the mid and upper reach of of the drainage and along the upper, west aspect slopes of Dome Rock Ridge. About 60% of this 2,560 acres is the west slopes below Dome Rock and is characterized with mature second growth from the <1850 fires and stringers of old growth in the draws, and with a high number of rocky and shallow dry meadows. This 2,560 acres block is contiguous with about 1,600 acres of interior habitat on the east slope of Dome Rock Ridge in the adjoining watershed.

The mid and upper reaches of Windfall Creek drainage (Matrix) has an unfragmented 1,280 acres block of forested habitat, which is composed of mature second growth and old growth, and with several hundred acres of small timber habitat about 100 years old. Windfall T.S is planned to thin and to regenerate harvest the younger timber. The lower reach of Windfall Creek drainage has about 640 acres of mature second growth/old growth intermix habitat.

Distributed across the rest of the watershed (LSR and Matrix), there are blocks of interior habitat ranging in size of about 640 acres to 100 acres.

CONCLUSION

Acreages of interior mature/old growth forest habitats is substantially reduced from reference conditions, due the timber harvest and the past practice of distributing harvest units across the landscape. With the smaller acreages of remaining mature/old growth forest stands providing interior, the higher ratio of edge to stand acres further reduce the interior habitat acreages remaining.

INTERIOR HABITAT TREND

For the next five to six decades, until managed stands in the LSR grow into mature forest habitats, the trend will be a continuing loss of interior mature and old growth forest habitats, resulting from program of timber harvest in the Matrix lands.

RECOMMENDATIONS FOR INTERIOR HABITATS

1) For the Matrix lands, assess the remaining stands of interior habitats for attributes of quality and landscape distribution, and develop a strategy for prioritizing and around those to extent feasible, considering other resources needs.

2) As part of the above strategy, assess how large block-acreages of managed stands can be managed to provide some attributes of interior forest habitats.

3) For the LSR acres, promote the reduction in fragmentation and the increase of interior forest habitat with silvicultural treatments in the managed units, which might include both precommercial and commercial thinnings.

LSR 0222, REFERENCE

The area of the watershed which is now a part of a designated Late Successional Reserve (LSR-0222) have been mostly of mature and old growth forest, with the same distribution of western hemlock/Douglas-fir habitat types and Mountain hemlock and Noble fir/Pacific silver fir habitats.

The areas of Packard Creek and Larison Creek drainages had large stand replacement fires. Where the fires around the turn of the century overlapped and reburned some acres of the previous mid-1850's fires, a very low level of large woody material (logs) and snags exists.

LSR 0222, CURRENT:

Three portions of LSR 0222 within the watershed amount to 41,525 acres, or only 8% of the full LSR 0222 (504,688 ac.) that extends to the north, west and south of the watershed.

LSR 0222 extends into the watershed in three areas. The current forest habitat condition of the three areas and of the total LSR are:

ACRES	Early Seral (<1"-~5"dbh)	Pole & Sm. Tbr. (~5"-~21" dbh)	Mature/Old Growth (~21"+ dbh)
1) 22,148 ac.	3,441 ac.(16%)	3,052 ac.(14%)	15,655 ac.(70%)
2) 5,980 ac.	1,595 ac.(27%)	1,235 ac.(21%)	3,149 ac.(52%)
3) 13,477 ac.	2,746 ac.(20%)	1,201 ac.(10%)	9,450 ac.(70%)
4) 41,525 ac.	7,782 ac.(19%)	5,488 ac.(13%)	28,254 ac.(68%)

LOCATIONS AND SPECIFICS ON THE THREE AREAS OF LSR 0222 WITHIN THE WATERSHED:

1) GRAY CREEK, LARISON CREEK, PACKARD CREEK PORTION: About 22,148 acres in the northwest corner of the watershed, including Gray Creek drainage, Larison Ridge, Larison Creek drainage, and upper Packard Creek drainage. The acres are in the 6th field GRAY subwatershed (8,981 acres) and 6th field LAKE subwatershed (13,167 acres).

Limited amount of timber harvest started in the 1950's and steadily increased over the next four decades. Currently, the forest habitats consist of:

Early seral habitat (<5" dbh):	3,441 acres (~16%)
Pole-size habitat (5"- 9"):	1,465 acres (~ 7%)
Small timber habitat (9"-21" dbh):	1,587 acres (~ 7%)
Mature / old growth habitat (21"+ dbh):	15,655 acres (~70%)

The 1,465 acres of small timber habitat are the results of the fires around the turn of the century, and the average size would in the 18" to 21" dbh range.

The early and pole-size habitat resulted from timber harvest, and the vast majority of these acres exists within the Larison Creek and the Packard Creek drainages.

Ten known spotted owl activity centers, one of which has <40% suitable habitat within its home range. This one site is believed to be of owls which were displaced into the LSR from the timber harvesting of the adjacent private in the Packard Creek drainage. The north slope of Larison Ridge have not been fully surveyed, and habitat exists for at least two additional spotted owl activity centers. Three separate response locations of competitive, non-native Barred owls are known on the north slopes of Larison Ridge.

2) UPPER GOLD CREEK, UPPER BOHEMIA CREEK, MID SNAKE CREEK AREA: About 5,980 acres in the upper Gold Creek drainage, upper Bohemia Creek drainage, and part of Snake Creek drainage. These acres are within the 6th field 21 3 GOLD.

This LSR area didn't have stand replacement fires indicated from our historic vegetation map, although there are some second growth stringers evident within the LSR area in the headwaters of Bohemia Creek.

Early seral habitat created by timber harvesting started during the 1960's in the Snake Creek drainage, followed by harvest in upper Bohemia Creek in the 1970's, then distributed across this LSR area during the 1980's and early 1990's.

Currently, the forest habitats consist of:

Early seral habitat:	1,595 acres (~27%)
Pole-size habitat:	42 acres (<1%)
Small timber habitat:	1,193 acres (~20%)
Mature & old growth habitat:	3,149 acres (~52%)

The early and pole-size habitats are from timber harvesting. An estimated 340 acres of the small timber habitat might be of the first harvests in Snake Creek in the 1950's. The remaining 853 acres of small timber habitat should be of fire-history second growth not recorded on the historic vegetation map, and the average diameter should be in the 18" to 21" dbh range.

Five spotted owl activities exists within this LSR portion, one of which is of a Resident Single owl. This LSR portion have had extensive spotted owl surveys, and additional owls are not likely. One great gray owl response is recorded along Calapooyia Ridge area just south of Johnson Meadows.

About 1300 acres of this LSR portion forms an extension, through checker board private lands, toward the river corridor. Of the five activity centers, activitiy centers of two spotted owl pairs and the Resident Single exist within this 1300 acres extension. With harvested private lands and partially harvested NFS land on three sides of the LSR extension, suitable habitat exists for one owl home range.

An important function of this 1300 acres extension provides dispersal connectivity in this area for late successional species, from the larger body of the LSR toward the river corridor. Of the 640-acre square mile that forms the end of this extension and closes to the river corridor, an estimated 220 acres is of mature/old growth habitat; the remaining a mixture of early seral and pole-size habitats. Silvicultural treatments can be designed to enhance the future dispersal function of this 1300 acres with manipulation of the managed plantations within the 1300 acres and in NFS plantations along the river corridor. Private land (480 acres) blocks a contiguous connection with the river corridor.

3) About 13,397 acres in the middle and upper Coal Creek drainage and a small area of Indian Creek drainage. These acres are in 6th field COAL.

Since the late 1850's, there has been only a few, small scattered areas of early seral habitat created by the fires at the turn of the century; an estimated 640 acres of small scattered openings in the mid Coal Creek area and an estimated 340 acres of stringertype openings in the Deadhorse Creek drainage.

Early seral habitat created by timber harvesting started in the 1960's and continued until 1994. Currently, the forest habitats consists of:

Early seral habitat:	2,746 acres (~20%)
Pole-size habitat:	11 acres (<1%)
Small timber habitat:	1,190 acres (~ 9%)
Mature / old growth habitat:	9,450 acres (~70%)

Of the 1,190 acres of small timber habitat, about 980 acres would be from the fires at the turn of the century. The remaining estimated 210 acres would either of early harvests in 1960's on good growing siters or of slow growing second growth from the <1850 fires and located on the harsh sites of Dome Rock Ridge.

Five spotted owl activity centers are known in this LSR area, one of which is a resident single. Two barred owl locations are also known. A pair of great gray owls are known in the Loletta Lakes area.

TRENDS FOR LSR 0222:

1) Decrease in fragmentation (managed harvest units) during the next three decades, as the early seral habitats grow into pole-size/small timber habitat.

2) Increase in fire hazard, due fire suppression and accumulation of fuels in natural stands.

RECOMMENDATIONS:

1) Proceed with developing the eight (8) LSR assessments relating to this watershed portion, which would contribute to the overall LSR 0222 assessment and management plan.

2) Silviculturally treat managed units, which are <80 years of age, to promote growth and structural diversity leading to late successional forest habitat characteristics, including riparian and upslope terrestrial areas. Priority of managed units would be those which likely existed as late successional habitats over many centuries.

Dense, young forest habitats have likely occurred within the LSR, and an assessment is needed to identify need for retaining some managed units in such habitat characteristic.

3) Develop a Travel Access Management Plan for the LSR, to balance need for fire suppression access priorities and need to reduce risks of human caused fires and damage to other late successional resources, as aquatics.

VM3 CONNECTIVITY

REFERENCE

Connectivity is used herein to mean suitable habitat for wildlife and plant to move across the landscape for functions as foraging, dispersal of offsprings, genetic interchange between populations, recolonizing areas as habitats change and become suitable for a given species, and expansion and retraction in population distribution or range.

Connectivity is also addressed in terms of mature and old growth forest habitats, and associated wildlife species, as those habitats have been the dominate, long-term habitats on the landscape. Except for special habitats, as meadows, early seral forest habitats were relatively short-term (15-25 years) at any given location. Wildlife and plant species that are generalists in habitats or can tranverse long distances rapidly, as elk and many birds, have a less concern for connectivity.

Species which are limited to a few habitat types and of slow mobility have the higher concern for habitat connectivity. Many of the species of slow mobility need a distribution of their populations established across the landscape to function as connectivity.

Habitat for connectivity wasn't always contiguous or continuous across the landscape, nor in place at all times. Fire often disrupted connectivity of forested habitats for periods of time. The frequency and magnitude of fragmentation to connectivity affects different species differently, as between the long distance, mobile species and the short distance, less mobile species.

Different wildlife species utilized the landscape differently for foraging and dispersal. Upland wildlife, as deer, elk and wolves, would tend to utilize the upland forest and ridgelines, especially where the riparian areas were deeply incised and travel more difficult. Riparian associated species, as salamanders, naturally followed riparian areas until a need to transverse upland terrestrial habitat to gain access to another drainage and riparian.

PROCESSES AFFECTING CONNECTIVITY:

The large blocks of interior habitat existing after the turn of the century fires were still interconnected with mature and old growth forest habitats distributed across or around the areas of early seral habitats. The interconnections ensured dispersal and genetic interchange over time. In most situations, the mature and old growth habitats that served as interconnections among the large interior habitat blocks were themselves of adequate size and depth to serve as interior forest habitats.

Several riparian areas and associated low saddle ridges serving as dispersal connectivity into adjacent major watersheds were notably affected by these stand replacement fires at the turn of the century.

1) Coal Creek mid and upper reaches.
2) Buck Creek's upper-most reach.
3) Big Willow Creek mid-reach and the upper-most reach.
4) Packard Creek upper-middle reach.

Riparian habitats have played an important role for dispersal and genetic interchange for many wildlife species, particularly the riparian associated species, as frogs and salamanders, turtles, marsh voles and minks. The larger, more mobile wildlife are capable of overland travel, though great distances of unsuitable dispersal habitat might become an impedence.

The smaller, less mobile wildlife, as salamanders, have a greater dependency on suitable riparian habitats for dispersal and genetic interchange. Connectivity between major drainages occurred by two routes. One route is down drainage to a confluence, then travelling up the adjoining drainage. The second route were overland, crossing ridgelines usually at low saddles where terrestrial habitats were suitable for dispersal. For the less mobile species and the time to transverse the passage, suitable habitat often required cover from predators, a forage base, and especially for amphibians, suitable microclimate.

The overland route was likely important for species that were associated with Class III and IV streams, seeps and similar riparian habitats higher on the slopes. Overland would commonly be a shorter distance and more favorable to survival than dispersing down one drainage and up another.

All ridgelines between riparian drainages offered opportunity for interdrainage dispersal and connectivity. Some of the major drainages with low saddle ridges for overland connectivity to adjoining watersheds were:

1) Coal Creek drainage leading into Boulder Canyon of the Umpqua River system.
2) Indian Creek drainage leading into the Steamboat Creek drainage of the Umpqua River system.
3) Buck Creek drainage leading into Groundhog Creek drainage of the Hills Creek watershed.
4) Big Willow Creek drainage leading into the Landes Creek drainage of the Hills Creek watershed.
5) Windfall Creek drainage leading into the Brice Creek drainage of the South Fork of the Middle Fork of the Willamette River.
6) Packard Creek and Larison Creek drainages leading into the Layng Creek drainage of the South Fork of the Middle Fork of the Willamette River.

Fire periodically affected the riparian areas and the terrestrial routes over ridges. Fires commonly performed an underburn in the lower gradient riparian areas, retaining the larger overstory which hastened recovery. Where stand replacement fires occurred in the overland dispersal routes and steep gradient riparians, the suitability for dispersal would be reduced. The dead timber that later would fall hastened the recovery toward suitable dispersal habitat by providing a large quantity of logs in addition to the young regeneration. The amount of large logs promoted the suitability for cover, forage and microclimate.

Across the landscape, overland dispersal occurred over both the steep gradient and the gentler gradient terrain. The gentler gradient terrain likely served a greater number of species. Dispersal across steeper gradient terrain was likely an essential factor for species as the tailed frog, that inhabited steep gradient streams.

CURRENT

Across the landscape of the watershed, connectivity for upslope terrestrial and riparian associated wildlife species is highly fragmented, but negoiable by most wildlife species. The large blocks of managed private lands and the Hills Creek Lake form the greatest barriers for most upslope terrestrial and riparian wildlife species that travel on land, as opposed by air.

The connectivity of riparian habitats are affected worse than the upslope terrestrial habitats, as a result of past timber harvests across riparian areas. The upslope terrestrial connectivity is highly fragmented and in some areas blocked for some smaller species, as the red tree vole, but for the landscape, most areas are negoiable for dispersal and foraging by wildlife.

From the 1950' until today, the reservoir and timber harvesting have had the greates impacts on the connectivity processes of foraging, dispersal and the resulting processes of species' range expansion, colonization and genetic interchange.

Of the major connectivity corridors, riparian and upslope terrestrial, the current conditions are:

1) Coal Creek drainage: Riparian connectivity substantially affected, mostly by older harvest units now in pole-size habitats.
   Upslope terrestrial connecitivity is stiil reasonable good.
2) Buck Creek drainage: Riparian connecitivity and ridge saddle substantially affected by older managed units now in pole-size habitats.
   Upslope terrestrial connecivity substantially affected on the north side of the drainage. The mid-lower reach of the drainage's south side is in very good condition.
3) Big Willow Creek drainage: Riparian and upslope terrestrial connectivity substantially affected by older and recent timber harvests. Landscape connectivity across drainages curtailed by Hills Creek Lake.
4) Packard Creek drainage: Riparian and upslope terrestrial connecivity very good on the NFS lands in upper reach; mid and lower reaches curtailed by managed private lands and by Hills Creek Lake.
5) Windfall Creek drainage: Riparian and upslope terrestrial connectivity very good condition on drainmage's north side; affected on south side, mostly with older units of pole-size habitats.
6) Larison Creek drainage: Riparian and upslope connectivity moderately affected in upper reach; very good in mid and lower reaches. Landscape connecivity, particularly for riparian, is curtailed by Hills Creek Lake.
7) Indian Creek drainage: Riparian and upslope terrestrial connecivity substantially affected by older and recent harvest activities, including private lands.
8) Youngs Creek drainage: Riparian and upslope terrestrial connecivity moderately affected by older and recent harvest activities.

CONCLUSIONS

The Hills Creek Lake is a major break in connectivity for the river corridor. Species, as birds and larger mammals, can transverse around the lake. Smaller terrestrial species, as riparian-associated voles and salamanders, are essentially blocked. The large block of private property in the Packard Creek drainage basically augments the effect of the lake.

The connectivity of the remaining watershed is highly fragmented, both in the riparian reserves and upslope terrestrial areas. For most species, the fragmentation can be negoiated around, either presently or as managed units recover to a forested environment.

TRENDS

On landscape level, considering all drainages within the watershed, the riparian connectivity will slowly inprove with ingrowth of regenerated harvest units within the riparian areas.

In the Matrix lands, the inter-riparian connections across ridges between adjoining drainages, within and outside the watershed, will continue a downward trend with program harvest. In the LSR lands, these inter-riparian connections across ridges will have an upward trend with ingrowth of regenerated harvest units.

In the Matrix lands, the upslope terrestrial connectivity will continue a downward trend with program harvest to a level relying on existing non-harvest, forested habitats, as the Green Tree Retention clumps, forested lands unsuited for timber management, and the 100-ac LSRs. Standards and Guides for the foreground scenic allocations will moderate the downward trends on those Matrix lands.

The LSR lands will have a slow upward trend for upslope terrestrial connectivity with ingrowth of regenerating harvest units.

Connectivity between the large LSR in the watershed and the large LSR 0221 in the adjacent Hills Creek drainage will have a downward trend in the Matrix for the upslope terrestrial connecivity and the ridgeline terrestrial connections between riparian areas, while the trend for the connectivity of riparian areas slowly increases. The downward trends will occur at a faster rate than the upward trend, due the program harvest rate verse the regeneration ingrowth toward mature/old growth conditions, including accumulation of large logs and snags, in the riparian areas.

RECOMMENDATIONS

1) In riparian areas affected by past harvests, apply silvicultural treatments to enhance growth and structural diversity resembling mature and old growth characteristics.

2) Maintain the prescribed riparian widths of the mainstem of the major drainages and selected tributaries within the Matrix lands. The RIDGELINE INTERCONNECTION MAP displays the drainages and tributaries considered for non-reduction of riparian reserve widths, and also displays the ridgeline interconnection areas that should be considered for overland connectivity, as per

the next recommendation; the Class IV riparian reserves tying these connections together are recommended for retention of prescribed widths. Site specific analysis can modify to wider or narroer widths.

3) In areas of ridgeline interconnections between riparian areas of different drainages, promote characteristics of mature/old growth habitats. Placement of large woody material (logs) in deficit areas within managed units would facilitate connecivity. For final harvests in these interconnection areas, design the retention of large woody material (logs), Green Tree Retentions, and Wildlife Trees to facilitate connecivity.

4) For connectivity between LSR 0222 and LSR 0221, design a connectivity strategy for the two routes of Windfall Creek/Buck Creek drainages and Coal Creek/Youngs Creek-Deadhorse Creek drainages, including riparian and upslope terrestrial habitats. Such strategy should consider silvicutural treatments in existing managed stands to promote growth and structural diversity, consider identifying and deferring harvest of some natural stands presently serving connectivity, consider areas for longer harvest rotations, particularly the ridgeline interconnection areas, and consider identifying areas for select harvest verse regentation harvests.

VM4: SITE PRODUCTIVITY

REFERENCE

Site productivity herein refers to ecological site productivity relating to large woody material (logs) and snags on the landscape.

Large logs and snags provide recycled nutrients and habitat for various nitrogen fixing bacteria, decay fungi, insects, salamanders, birds and mammals. Important factors for large logs and snags are the better moisture conditions and ability to last longer in the enviroment.

Mycorrhiza-forming fungi and their symbotic association with vascular plants have been well documented in recent years. Large logs serve several important functions during the dispersal of hypogeous mycorrhiza-forming fungi, which produce their fruiting bodies below ground. The logs serve as home sites and travel lanes, as well as supplying cover for small mammals that are the primary dispensers of these fungi. Also, the decomposed logs provide suitable sites for re-establishment of colonies of hypogeous fungi.

PROCESSES DETERMINING LARGE WOODY MATERIAL (LOGS) AND SNAGS:

Natural fires, wind, insects and disease were the main factors determining levels of logs and snags on the landscape. Whereas wind, insects and disease normally affected small areas of the watershed and generally always produced higher levels of logs and snags, fire periodically affected thousands of acreages and with contrasting results on the levels of logs and snags; low levels in areas of frequent stand replacement fires and high levels in areas of infrequent stand replacement fires.

Where fire was very infrequent, a gradual increase of large logs and snags was likely evident. Where frequent unburning occurred, the levels were likely low. In areas of stand replacement fires, the levels of large logs and snags were very high for many decades and then incurred a low level until the forest matured and supplied a recruitment of large logs and snags. In areas of frequent stand replacement fires, levels of large logs and snags were likely very low.

Roughly 60% to 70% of the watershed was of mature and old growth forest habitats and provided some levels of large logs and snags. The frequency and locations of underburning isn't known. The stand replacement fires of the mid-1850's and the turn of the century fires provided high levels of large logs and snags. Where the two fire series overlapped in the Larison and Packard drainages, the levels were low.

Starting with the fire suppression emphasis in the early 1900's, the levels of large logs and snags would likely have shown gradual increase.

CURRENT

Ecological site productivity, as pertains to LWM, is contrasting on the landscape. In natural forest habitat stands, where fire and salvage have been precluded, the sites have a gradual increase in LWM. In managed plantations, the sites are low or deficit in LWM for ecological productivity.

As a general rule, large woody material was commonly left on clearcut harvest units between the 1940's and 1970, due the low merchantable value during that period. About 23,000 acres of NFS lands would be of this condition and would be of the managed plantations that are 25 years of age and older. Private forest lands should be on similar conditions.

Starting in the mid-1970's and until the late 1980's, PUMing and YUMing of LWM from harvest units's left little to no LWM in harvest units. Similar conditions would hold for the majority of the private forest lands. The NFS acres would be about 37,700 acres for this period.

Also, during the late 1970's and mid-1980's, roadside salvaging tended to remove merchantable logs and snags from several hundred feet along both sides of the roads on NFS lands. Roadside salvagings differ from the old clearcut scenario of this period, in that options remain for recruitment of LWM in the short term.

For the clearcuts lands of the 1970's and early 1980's, recruitment of LWM would be long term on NFS lands, maybe a century and longer. On private lands, LWM might not be recruited, due more intensive management.

Ecological site productivity is still well distributed on the NFS lands, due mainly to the distribution pattern of the 1970 to mid-1980 clearcuts while retaining unmanaged forest stands across the landscape. These 30-40 acres clearcuts, generally, have surroundings of natural forest stands, which can influence and hasten the ecological functions within these older harvest units, as their regeneration grows into a young forest environment.

CONCLUSION

Most of the managed units have reduced ecological site productivity, as a result of past removal of LWM and snags. For the watershed as a whole, ecological site productivity is functional in the remaining natural stands. These natural stands are well distributed across the watershed's as leave strips and unentered blocks on the NFS lands. The acres harvested during the 1940's and 1950's have a fair quantity of LWM, while the acres harvested after the early 1960's and until around 1989 have relatively minor quantity of LWM and snags.

Of the private lands, the checkerboard holding south of the large Packard area have a higher percentage of 1940 - 1950's harvest units, with the higher quantity of LWM (cull logs) left on site. The large block of private holding in the Packard Creek area had a high percentage of the acres harvested after the early 1960's, resulting in a relatively minor quantity of LWM left on site. No or extremely few snags were left on the private lands.

TRENDS:

1) Slight upward trend in site ecological productivity for the watershed, as the NFS's LSR lands, as the older managed units within the LSR grows toward maturity and are inflenced by the surrounding mature forest environments.

2) Probable static trend in NFS's Matrix lands. For ecological site productivity relating to LWM, the continuing program of harvest will be offset with the S&G for LWM and contribution of falldown of trees from the Wildlife and Green Tree Retention left during harvests.

RECOMMENDATIONS:

1) Of areas deficit in LWM, as due past management practices, identify and prioritize those areas of landscape importance, as connectivity corridors, (riparian and upslope terrestrial) and refugias, and program to re-establish the sites' ecological productivity as relates to LWM. One mean of re-establishing a site's ecological productivity, pertaining to LWM, is delivery of LWM to the site. A long-term mean is silvicultural treatments to enhance large diameter trees as future recruitment to LWM.

VM4 RIPARIAN HABITAT

REFERENCE

Riparian areas of the river, streams and wetlands provide some of the most important habitat for wildlife and plant species. Many of the wildlife species that either feed or reproduce in the aquatic area of the riparian are directly dependent on the adjoining riparian habitats. Harlequin ducks (Sensitive species) and water dippers are good examples of reproducing in the riparian habitat and feeding in the aquatic environment. Red-legged frogs (Sensitive species) and northwestern salamanders are examples of the reverse scenario.

Riparian areas also serve a landscape function of connectivity, for dispersal and genetic interchange of riparian associated species.

PROCESSES AFFECTING RIPARIAN HABITATS:

Fires, floods and, to lesser extent, debris slides and deep-seated mass movements were the factors affecting riparian habitats. Debris slides usually affected only the aquatic fringes of the riparian areas, were of small occurrences and area within the watershed, and generally added to the complexity of the riparian area at spot locations where log jams came to rest.

Deep-seated mass movements occasionally created "slump" ponds and wetlands, with resulting riparian habitats around them. Floods had little effect, overall, to the upland riparian habitats. In the lower gradient river system, floods tended to cause changes in channel alignment, resulting in some loss of forested riparian habitat while the abandoned channel alignment revegetated. Floods also maintain a complex of side channels, many of which provided ideal conditions beavers to dam and create wetlands serving as habitat for many wetland associated wildlife and plant species.

Fires probably had the greatest effects to riparian habitat, and conditions as slope gradient, aspects, weather, fuel loading and weather were variables. The steep gradient slopes showed higher incidences of stand replacement fires, affecting riparian habitats associated with Class IV and some Class III streams. The lower gradient riparian habitats associated with Class I and II streams usually incurred a light underburn, if affected at all.

Riparian habitats associated with Class III and some Class II streams were affected differently by fire. A few, as mid Windfall and mid Big Willow experienced intense stand replacement fires in the mid-1850's, resulting in high accumulation of snags and logs, and early seral riparian forest habitat. A few riparian areas, as various reaches in mid and upper Packard experienced moderate intensity fires, resulting in sparse riparian overstory forest. Most, however, experienced underburns with low intensity closer to the streams and low to moderate intensity farther from the streams. Fuel loading, winds, and/or size of fires that create their own weather conditions were likely cause for the higher intensity fires in these reaches of riparian habitat.

CURRENT:

TABLE 25: PERCENTAGE RIPARIAN VEGETATION provides a quantification of riparian habitats in natural, relatively unmanaged condition and of riparian habitats that have been substantially altered, mostly by past harvest activities.

From the TABLE, the 53% that is >55 years of age (1940 and older) is assumed to be natural riparian areas, providing most or all riparian habitat components, as LWM, snags, multi-aged forest; multi-aged forest being of mature or old growth habitat characteristics.

The 26% that is less than 35 years of age and the unshown 21% between ages 35 and 55 years are assumed to be riparian areas that have altered, mostly by timber harvest and to a lesser extent by roads.

For the 26% that transpired since 1960, a good portion is assumed to be deficit in the riparian habitat components mentioned above. During this period, the clearcut practice and the chip market provided the incentive to remove all merchatable material, including cull logs. Starting around mid-1980's, riparian reserves started being prescribed for timber sales being planned at that time. The riparian widths provided after the mid-1980's to present were smaller than presently prescribed by the Forest Plan, as amended by the NW Forest Plan.

During the years between 1940 and early 1960's, the riparian habitats were harvested of timber, as after the early 1960's, although cull logs were often left, providing some level of LWM within the riparian areas.

In addition to the traditional harvest units, salvage of LWM and snags commonly occurred in riparian areas that are within several hundred feet of roads.

CONCLUSION:

About 53% of the watershed's riparian habitats provides full width and habitat components of LWM, snags and multi-aged forest. These riparian habitats are providing habitat for riparian-associated species. The riparian function of connectivity, however, is disrupted by fragmentation resulting from past harvest practices and the Hills Creek Lake. All major drainages within the watershed have had some level of riparian habitat harvested of timber.

The 21% of riparian habitat, between ages 35 and 55 years, would be of small timber riparian habitat, with some level of LWM, and providing habitat and dispersal for many of the terrestrial riparian-associated species.

Much of the 26% riparian areas harvested since the early 1960's are of early seral and pole-size habitat, with none to minimal LWM. These areas are of the greater concern for future recovery of riparian habitat and connectivity, as LWM is a critical habitat component for some species, as the red-backed vole.

TRENDS:

From present, riparian habitat from the past harvest activities will gradually recover, with the growth of the regenerated trees. To recover to a functioning mature/old growth riparian system, including connectivity, the scope of time is beyond this analysis.

If the managed units within the riparian areas are left to natural progression, the density of tree stocking in most units would substantially slow the recovery of the riparian habitats. As these stands move into a small timber riparian habitat, the heavy stocking density would promote an even-aged stand with small canopies and disproportionate height to bole diameter during an extended time period of stem exclusion. These stands would also be highly subject to windthrow, especially when future timber harvests occur adjacent to them.

RECOMMENDATIONS:

1) Provide LWM into riparian reserves that are deficit of LWM, as due to past removal by harvest or other practices. Providing LWM would aid the suitablity of riparian habitat for many of the terrestrial species while the regenerated forest grows toward maturity.

While the riparian connectivity is fragamented across the landscape, as result of past dispersal of harvest units, emphasis for retoring LWM into deficit areas of the riparian reserves would be for prioritizing those riparian reserves systems that interconnect Late Successional Reserves. The riparian reserves are considered one of the main landscape characters to provide connectivity between LSRs.

2) Where trees within riparian reserves need to be felled, as for road, or are naturally felled, as by wind, the function as LWM should be first assessed as site specific needs. A critical point for assessment is the health of the riparian reserve within the drainage of concern. Where the riparian habitats have been heavily fragmented within a drainage, or small segments of functioning riparian habitat has been isolated, as between managed units, the quantity of LWM needed might be higher than 'assumed' natural occurrence or the standard & guide of 240 lineal feet prescribed for harvest units.

The function of a higher quantity would be to sustain riparian-associated species in the small isolated riparian habitats. Opportunity also exists to distribute such felled trees into deficit areas to aid recovery of connectivity for terrestrial species, as voles and amphibians.

ISSUE: FIRE SUPPRESSION

NF2 HOW HAS HABITAT DIVERSITY CHANGED WITH FIRE SUPPRESSION

REFERENCE

The frequencies and intensities of fires were the dominate factors affecting habitat diversity. Over the centuries most of the watershed experienced fire at varying frequencies and to varying intensities. Large fires are thought to have been cyclic over the centuries, relating to long periods of moderate climate resulting in low to moderate fire intensities creating small openings and underburn conditions. As fuel loading and weather patterns changed, conditions evolved for intense large fires, resulting in large fires with high acreages of forest habitats being converted to early seral forest habitats. A range between those two extremes was likely the norm.

Fire frequency often determined fuel loading, as accumulations of dead wood, and often determined fuel ladders, as understory limbs which could carry a fire into the overstory canopies. Levels of fuel loading and fuel ladders also typified the habitat that many forest wildlife responded to. The fuel loading and fuel ladders also determined the habitat types that resulted from a fire, as an early seral habitat of grasses, forbs and brush dominated from a stand replacement fire, or open woodland habitat, or multi-canopy forest.

Early seral habitats were developed in small patches, complex mosaic patterns, and large acreage blocks. Small patches and mosaic patterns of early seral habitats often provided a high degree of fragmentation and edge habitats. However, large areas of early seral habitat created by stand replacement fires would have provided a greater species richness, or number of wildlife species, associated with early seral habitat (Bunnell, F. 1995). Such large areas generally have a greater diversity of habitat sites within them, as small patches or strips of unburned sites and greater number of microhabitat sites with varying aspects, moisture regimes and plant associations.

As the areas of stand replacement fires regenerated predominately with conifers, two scenarios of habitat structure and composition commonly occurred, depending on sites. One scenario is where hardwood trees weren't a component of the site, and the regeneration developed as mostly pure conifers. The second scenario is where hardwood trees were a component, sometimes densely so, and the regeneration developed as mix hardwood/conifer habitat.

Areas of frequent underburning should have shown a low concentration of large logs and snags, as old ones were consumed and a few new ones recruited. These areas typically had more open understory, with minor lower canopy structure. Such habitats of frequent underburning commonly existed on southern aspects. These areas also normally had a corresponding low concentration and fluctuation in wildlife species associated with the habitat components of large logs, snags and dense understory canopies, while having a higher concentration of wildlife species associated with open forest habitat.

Areas of very infrequent fires, as in several hundred years, should have shown high concentrations of large logs and snags and corresponding high concentration of wildlife species associated with large logs and snags and with multiple canopy structures. These areas also tend to experience very intense fires when fires did occur.

With the stand replacement fires, most of the watershed still remained in mature and old growth forest habitats. Though much of these forested habitats periodically underburned, the large residual green trees still provided a forested environment.

Brush and hardwood trees upslope from the riparian areas were important components in the habitat diversity and determined the habitat suitability for many wildlife species. Brush occurred in several habitat forms. In areas of Ceanothus, a fire dependent species, the density of Ceanothus regrowth was related to the intensity of the fire. Ceanothus brush 'fields' occurred after high intensity stand replacement fires. These brush habitats tended to dominate the sites for decades by suppressing the regeneration of the conifers. A low intensity underburn would have formed an open forest habitat with a low density of Ceanothus brush forming the habitat structure on the forest's floor.

Other brush habitats, as vine maple, ocean spray, etc., varied in brush densities, dependent on sites. The diversity of brush species at a site added diversity to the habitat structure and wildlife species which utilized them.

Hardwood trees, as big-leaf maple, cottonwood, red alder, white oak, madrone and chinkapin, provided a mix hardwood/conifer forest habitat across the landscape, commonly on the warmer sites. Several of these hardwood tree species tend to resprout after fires and gain an initial height advantage over the young conifers. Unlike many of the brush species, the hardwood trees tended to persist longer into the age of the second growth conifer, resisting shade suppression until the conifers developed a mature forest.

Hardwood trees provide invaluable food sources in the form of seeds, catkins, and insects that feed on the leaves. Big-leaf maples, oaks, cottonwoods and red alders with defect are favored by some cavity nesters, as the downy woodpecker.

The hardwood riparian forest of the larger, low gradient river and streams usually were affected by flood events more dramatically than by fires. The hardwood riparian areas on steeper gradient streams had a greater variance in effects from fires.

The main processes affecting special habitats were fire, slope instability and flood events. Slope instability often formed the hillside bogs and small lakes, as Windfall Lake. "Slump" ponds, as found in Bull Creek drainage, were created by a hillside movements and became essential reproductive sites for red-legged frogs, a Sensitive species, Northwesten salamanders, and often western pond turtles, another Sensitive species. Flood events in the lower gradient streams also made and eliminated flood channel ponds or quiet waters, that benefitted the species above as well as beavers and otters.

Fire was the main factor in maintaining meadow areas, and meadows often fluctuated in size as a result of fires and the absent of fires. During periods of no fires, conifers encroached into meadows, slowly narrowing the meadows size. Periodical fire tended to burn out the encroaching trees, restoring the meadows' size. Frequency and intensity of fires determined the effectiveness of abating the encroachment of trees.

CURRENT

In the early 1900's, emphasis on fire suppression precluded large acreages of early seral forest habitats from occurring by stand replacement fires. The sizes of natural fires were effectively reduced to small acreages, and early seral forest habitats quickly grew into pole-size habitat, and then into small timber habitat.

Forest habitats that were characterized as having low levels of logs and snags and open understory began to change, with incremental increases in down logs, snags, and young understory trees filling in the open forest floor. These changes in habitat characteristics would beneficially influence the suitability for some wildlife species, as the spotted owl, the pileated woodpecker, and the pine marten. The loss of open forest habitats would decrease habitat suitability for other species, as the northern goshawk, and the flamulated owl in the ponderosa pine areas.

Additionally, the mature and old growth pines appear to be showing increased pine beetle infestations, due likely to increased competition from understory Douglass-fir during the recent drought years.

Fire exclusion has permitted the gradual reduction in open forest habitats and gradual reduction in the adundance and structure of hardwood trees in the mix hardwood/conifer forest habitats, due continued suppression by succession.

Special habitats, especially non-forested habitats as meadows, have lost acreages in size. Some natural meadows have become full forested by encroaching conifers, as the 9d Special Habitat designated in lower Coal Creek that had been an oak/meadow complex (T.24 S.,R.3.,Sec.14, SE).

CONCLUSIONS

A gradual loss of the open mature/old growth forest habitats, as the mix of densely structured mature/old growth forest, open structured mature/old growth forest, and gradient between, shift toward the former with fire suppression.

A reduction in hardwood components in mature/old growth forest habitats by continued shade suppression

Increase in high intensity fire hazard of remaining mature/old growth forest habitats, with increasing levels of ground and ladder fuels.

A loss in non-forested habitats, as meadows, with conifer encroachments resulting from fire suppression.

TREND

An overall downward trend in habitat diversity exists for the watershed, due several reasons.

RECOMMENDATIONS

Assess, develop and implement strategies to maintain representations of open forest habitats, where fire historically provided such, with priority emphasis to the ponderosa pine/Douglas-fir area.

Assess and implement strategies to enhance and regain non-forested habitats, as meadows, with uses of silvilcuture and fire treatments.

NF3 FIRE SUPPRESSION & WILDLIFE THREATENED, ENDANGERED & SENSITIVE SPECIES

REFERENCE

Of the wildlife species currently listed as Threatened, Endangered or Sensitive, the ones that would have inhabited this watershed in the 1940's and prior and would have their habitats affected by fire and fire suppression are the American peregrine falcon (Endangered), the northern spotted owl (Threatened), and the northern red-legged frog, Pacific fisher, and wolverine, which are listed as Sensitive. The northern bald eagle (Threatened) likely did not inhabit the watershed for nesting, but likely was an infrequent forager of the watershed, especially during their non-nesting seasons.

AMERICAN PEREGRINE FALCON:

For the peregrine falcon, the series of fires around the 1850's and the turn of the century created various habitat conditions in the western hemlock/Douglas-fir dominate habitat zone and in the mountain hemlock/true fir dominate habitat zone, as well as keeping meadow areas open. The diversed array of habitat conditions provided for a diverse array of bird prey for the falcons, as: yellow warblers in the river hardwood habitats; savannah sparrows in the meadows; MacGillivaray's warblers in the early seral fire-created brush fields; black-throated gray warblers in the mixed hardwood/conifer second growths; Hermit thrushes in mature true fir forests; and many of the woodpeckers utilizing snags created by the fires.

NORTHERN SPOTTED OWL:

For the northern spotted owl, the early fires tended to reduce its habitat acres, and the owl's population in the watershed probably fluctuated to a small extent as a result of the large fires. With the large block-acreages of mature/old growth forest converted to early seral forest habitat, pairs would have been shifted around in the landscape, with possibly several pairs becoming non-reproductive due to being displaced into adjoining owl home ranges. The great horned owl populations was probably at a higher level following the two fire series, as the habitats of early seral, pole-size and open forest conditions were more suited for this large owl to forage. The great horned owl probably also caused a displacement of some spotted owl pairs.

For the wolverine which ranges over large areas, the fires probably had little effect to its habitat use, other than possibly a decrease of use within the large block-acreages of fire-created early seral forest habitats.

PACIFIC FISHER:

The Pacific fisher probably was favored by periodic fires in the ponderosa pine/Douglas-fir area. In the this area, periodic fires should have kept some acres in mixed stands of pine ages, which would have favored the porcupines, a prey species for the fisher. The fisher probably wasn't numerous in the western hemlock/Douglas-fir areas of the very large fires in the Packard and Larison drainages.

RED-LEGGED FROG:

The red-legged frog tend to favor a forested environment for foraging. The areas of the large block-acreages of fire-created early seral habitats were in steeper terrain were red-legged frog were not. A favored breeding habitat are "slump" ponds, and these areas are generally on gentler terrain that incurred underburning, retaining a forest environment.

CURRENT

The early seral forest habitats were substantially reduced in acreage (~370 acres) as they grew into pole-size and small timber forest habitats (~11,500 acres) during the early years of fire suppression emphasis.

With the advent of timber harvest in the late 1940's, acres of early seral forest habitats started to increase, with about 34,046 acres existing today. The pattern across the landscape is roughly evenly distributed in small patches, which provides an even distribution of early seral forest prey species.

Though the acres of pole-size and small timber forest habitats fluctuated over the years since the early 1900's, the acres of pole-size and small timber habitats of the 1940's (~11,500 acres) and of today (~14,700 acres) are representative of the same habitat acres (~19,550 acres) that grew out of the 1850's fires and were present at the turn of the century.

The mature/old growth forest habitats (21" dbh) increased in acreage during the years of fire suppression and before timber harvesting and are at a historic low today (~50,500 acres), due timber harvest, reservoir, roads and other land uses.

P-BIRD

The reduction in early seral habitats was probably the greatest effect of fire suppression on peregrine falcon's foraging habitats before the advent of timber harvest on a large scale. With the fire suppression emphasis starting in the early 1900's, early seral forest habitats, open mature/old growth forest habitats and meadow habitats started to decrease in acreages.

The slow ingrowth of understory trees in mature/old growth forest areas that had been maintained as open forest habitats affected a guild of prey species, as the American robin and the cedar waxwing.

OWL

The advent of fire suppression was favorable to the spotted owl. As the areas of fire-created early seral habitats grew into small timber and mature forest habitats, these areas once again became suitable for foraging by the spotted owls, less favorable for the great horned owls, and substantially reduced the the fires' fragmentation and edge effects to interior forest habitats.

The ingrowth of understory trees in the once open forest habitats has mixed effects for the spotted owl. One effect in some areas, as the pine area, is the reduction in foraging suitability on the forest floor due the density of stunted, young Douglas-fir sapling and pole-size understory. Other areas have shown an increase in advancing red cedar and western hemlock understory, forming an additional canopy structure favorable to the spotted owl. The gradual increase of large woody material is favorable for the spotted owl for rodent production, but also presents an increasing fire hazard that could result in higher mortality of the overstory trees when a fire does occur.

The advent of timber harvest reversed the loss of early seral forest habitats and presented a greater fragmentation pattern existing today.

WOLVERINE

During the period of fire suppression leading up to the 1940's, the areas of pole-size and small timber forest habitats probably received some foraging use by wolverines where there were large levels of large logs for rodent habitat.

Likewise in the unmanaged, mature/old growth forest habitats, the gradual increase in large woody material would be enhance foraging habitat for the wolverine, as for the spotted owl. The ingrowth of understory trees likely has no significant effect to the wolverine, except for the higher density areas of some of the pine area.

The numbers of wolverines that actually uses this watershed is very few. The wolverine population was never very abundance and was nearly extirpated from the Cascades by trapping in the earlier years. One confirmed sighting in recent years was in the southern portion of this watershed. Present useage of the watershed is considered as being dispersal in nature.

FISHER

The fire suppression emphasis from the early 1900's to the 1940's probably had no significant effects of the fisher or their habitats. Fishers were having the same worry as the wolverine, fur trade, and was extirpated from this watershed.

With the advent of timber harvest, some managed units were and are still being reforested with ponderosa pine to provide the young pines favored by the fisher's prey, the porcupine. Only one uncomfirmed sighting (late 1980's) of a fisher on the district, and that was crossing RD 21 near the southern end of the watershed, in the vicinity of Deadhorse Creek.

RED-LEGGED FROG

The period of fire suppression between 1900 and the 1940's only maintained the frog's forest habitat. Of the remaining mature/old growth forest habitat in the mid and lower elevation range of this frog, the gradual accumulation of large woody material and ingrowth of understory trees should have a slight beneficial effect for the frog's foraging needs.

CONCLUSIONS

Fire suppression benefits some T&E and Sensitive species and does not benefit others within the watershed.

For spotted owls and red-leeged frogs, fire suppression can be considered beneficial. Gradual increase in LWM and understory of natural forest habitats promote the prey habitat for both species, and the LWM promote moist cover for the frog during dry and hot weather.

Conversely for the spotted owl and red-legged frog, fire suppression gradually increases the fuel loading and ladder fuels, leading to increased fire hazard. Concern about large stand replacement fires within the LSR 0222 will increase, as this LSR becomes the remaining mature and old growth habitat environment for these two species within this watershed.

For peregrine falcons, fire suppression promotes the gradual loss of diversity in forest habitat, such as the gradual loss of open forest habitat in the mature/old growth seral stage, and the gradual loss of meadow sizes. Loss in acreage of these two habitats have a coinciding reduction in prey species utilized by the falcon.

Information on fire suppression's correlation to benefit or non-benefit for the wolverine and fisher is weak and not pursued further.

TRENDS

1) The slight downward trend for the peregrine associated with a downward trend in diversity of prey species available, resulting from fire suppression effects on meadow acreages, and associated prey, and effects of open mature/old growth forest habitats, and associated prey. Future program harvest in the Matrix will hasten the downward trend of the open mature/old growth forest prey species.

2) An upward trend for the remaining spotted owl habitat in the LSR, as the increase in large woody material enhances prey habitat, and younger habitats are permitted to grow toward suitable foraging habitat.

3) An upward trend in fire hazard in owl habitat of the LSR 0222 and the smaller 100-ac LSRs within the matrix.

4) A static trend for the wolverine and fisher.

5) Possibly a slight upward trend for the red-legged frog in the LSR 0222, as fire suppression increases large woody material.

RECOMMENDATIONS

1) Reintroduce fire and silviculture treatments, as thinning, where appropriate to maintain meadow complexes and to maintain open forest mature/old growth characteristics and resulting associated peregrine prey.

2) Assess the fuel loadings and appropriate areas of the LSR 0222 and smaller Matrix LSRs for reintroduction of low intensity fire, to maintain diversity of Late Successional habitats and for reducing potential for catastrophic fires in these areas. Such assessment would assist with the larger assessment for the full LSR 0222.

ISSUE: NON-NATIVE SPECIES

NS1 NON-NATIVE SPECIES (Wildlife)

REFERENCE

Prior to European settlement in mid-1850's, introduction of non-native wildlife is considered non-existent. Native species had evolved with each other to maintain their individual viability, though fluctuation in habitat conditions caused fluctuations of species populations, favoring some and disfavoring others.

By the 1930's and 1940's, certain non-native wildlife and plant species, as the bullfrog, o'possum, and Himilayan blackberry, had been introduced into the Pacific Northwest. Their presence or noticeable effects in this watershed was doubtful at that time.

CURRENT

Himilayan blackberries and bullfrogs have expanded throughout the riparian areas and ponds along the river below the Hills Creek Dam. The Himilayan blackberries form dense cover, shading out the loer riparian plant species and are believed to have an adverse effect of shading nesting sites of the westrern pond turtles.

The bullfrogs have had a major impact to native frogs and turtle populations in the ponds and backwaters of the river below the dam. The bullfrog is known to eat any that it can get into its mouth and swallow. The native species of frogs and the turtle evolved without this type of predator and have not ability to effectively avoid the bullfrog where they must inhabit the same habitat. The bullfrog has effectively eliminated the recruitment of juvenile turtles in the Ferrin Ponds and the pond below the dam.

A recent report of bullfrogs seen in the Hills Creek Lake indicates a possible expansion of bull frogs into the lake, which would threaten the low reproduction of the turtles in the lake, and in the adjacent "slump" ponds in Modoc Creek and Bull Creek drainages.

The o'possum is an opportunist that will feed on just about any smaller that itself. Native species that would be affected by this newcomer are ground nesting birds, as grouse, quail, juncos, and species that nest in low brush, as many of the warblers. The o'possum has have become fairly common around the City of Oakridge area. A sighting in upper Hills Creek suggest that this non-native is beginning to expand out into the forest environme, eventually including this watershed above the dam.

A more recent arrived non-native is the barred owl of the eastern United States. The barred owl is a close cousin of the spotted owl, with similar appearance. The barred and the spotted are of the same genera, Strix, which migrated to North America thousands of years ago via the Bering land bridge. Likely, the original Strix that arrived in North America became geographically separated by the non-forested Great Plains and evolved as slightly different species.

The Barred and the spotted are close-enough cousins to interbreed and produce fertile offsprings, called sparred owls.

THe barred owls is a little larger and much more aggressive than the native spotted owl. The barred owl also have a stronger tendency to inhabitat forested habitats with an intermix of early seral habitat, as meadows and recent timber harvest units.

Where the barred owls established a home range, displacement of or interbreeding with spotted owls is likely to occur. The harvest pattern during the past decades create ideal habitat for the barred owls, and their population growth is still in an expansion mode within the watershed.

Presently known, there are four separate observation locations from just below the dam and along the north slope of Larison Ridge, one in Bull Creek, one in Deadhorse Creek, two in Coal Creek.

CONCLUSION

Bullfrogs and barred owls are the main non-native wildlife species of concern. The expansion in range of both species has negative effects to native species, as predation on native turtles and amphibians by the bullfrogs and displacement and genetic delution of the spotted owls by the barred owls.

TRENDS

1) Upward trend in continuing expansions of non-native farther into the watershed.

In the Matrix with a program of timber harvest, the barred owl will likely become the dominate Strix species. The barred will continue to expand into the LSR 0222, until leveling off and declining as the recently harvest units grow out of early seral habitat. A dilution of spotted owl genetics as result of interbreeding by barred owls.

2) Downward trend in affected native species within the watershed.

RECOMMENDATIONS

1) Introduce water moccasions to control bullfrogs in the ponds down river from the dam.

2) Active program to eliminate expansion of bullfrogs into the watershed above the dam. Such may require special permit from the State to spotlight and shot bullfrogs at night from a boat on the lake.

3) Silvicultural treatments of managed harvest units within and adjacent the LSR 0222 to promote growth of regerated conifers for reducing the open patch-work of habitat favored by barred owls.

ISSUE: TRANSPORTATION SYSTEM

TR TRANSPORTATION (ROADS) AND SPECIAL HABITATS

REFERENCE

Special habitats were not affected by road transportation system within this watershed. The road system was confined to the City of Oakridge area and along the Middle Fork Willamette River, following the old military road. Though special habitats are generally considered as the specific habitats, as meadow, rock outcrops, bogs, etc., the surrounding forest also is a component of these habitats, by providing the interface for microclimate and habitat depended upon for plants and wildlife to inhabit or utilize the special habitats.

CURRENT

Since the commencement of timber harvesting in the 1940's, roads have been constructed throughout the watershed, transversing from riparian areas across mid-slopes to ridgelines. Ridgelines are often logical locations to access to facilitate current logging systems.

Special habitats are likewise distributed across the landscape, with the prominant special habitats, as meadows and rock outcrops, aligned on the ridgelines.

Several special habitats, and surrounding forest edges, have been impacted by placement of roads through or adjacent to the special habitats. Some of the noteable special habitats affected are:

Holland Meadows, with road through the meadow complex.
Unnamed rock outcrop with sensitive plant population affected by road and landing atop (T.22 S.,R.2 E.,Sec.13; Packard Cr.)
Johnson Meadow, with road through the meadow complex.
Bristow Meadow, with road through the meadow complex.
Joe's Prairie Meadow, with road along and through meadow complex.
Groundhog Meadow, with road through forested edge.
Unnamed meadow in Deadwood Creek, with road 5851 across top slope.
Stone Mountain, with road and rock quarry.
Loletta Lakes Meadows, with roads through the meadow complex.

CONCLUSION

Where roads cut through special habitats, as meadows and rock outcrops, the loss of that acreage is obvious. Extended effects are changes in soil and moisture regimes, affecting the botanical species and composition, usually in the downslope portions of the special habitats, and affecting wildlife species useage by road traffic disturbance.

The effect of altering the soil and moisture regimes is usually related to the road cut and fill. The road cut intercepts the surface and subsurface moisture flow to the remaining special habitat below, altering the moisture regime in the habitat below the road, either creating a wetter condition below culverts or drier conditions between culverts. Plant species and composition change accordingly. Road cuts also present an opportunity for meadow edges at the road cut to begin eroding back into the meadow.

Road fills are normally drier and promote dry-site plant species. Often, these alterations in soil and moisture regime promote off-site species to invade into the habitats.

The rock outcrop site in Packard Creek drainage with the sensitive plant species is characteristic of the effects described above. The road and landing removed a portion of the habitat. The road, thereafter, changed the drainage to the habitat below the road, providing a higher volume of runoff, and sediment, to one side of the habitat, while decreasing the water flow to the other side of the habitat below the road. The one site of the sensitive plant is located between these two extremes.

TREND

Under current standards and guides, new road construction would not affect additional special habitat, unless an assessment determined that any specific special habitat is insignificant for maintaining biodiversity.

RECOMMENDATIONS

1) Assess the roads affecting special habitats for future needs or non-needs. For non-needed roads, consider rehabilitating the roads back to habitat conditions compatible with the special habitats.

2) Apply treatments to reduce or eliminate off-site species invading special habitats, as result of past road constructions.

TR6 ROADS AFFECT RIPARIAN RESERVES

REFERENCE

Prior to the 1940's, the roads within this watershed was limited to the vicinity of the City of Oakridge, Willamette City, the Hills Creek community of Hilltop at the confluence of Hills Creek and the Middle Fork of the Willamette River, and the road up the river system following the old Military Road.

The approximate length of the Middle Fork of the Willamette River within this watershed is 30 miles. With today's standards, a minimum 800-ft riparian width (400-ft each side) would provide about 2910 acres of riparian (reserve).

The development of Willamette City along the river probably had the largest impact on riparian habitat for a single location. Considering about a mile length of residential area (maximum) and a riparian reserve width of 400-ft on one side of the river, about 48 acres of riparian reserve would have been affected by residential area including streets.

The road up the river stayed pretty much in the flatter floodplain and riparian area of the river. This road was about 22 miles in length within the watershed. Considering an average width of 40 feet for that time period, about 107 acres of river riparian habitat would have been converted to road.

With the Willamette City and the middle fork road, about 5% of the river riparian might have been affected by conversion to roads, streets and residential settings. In assumption, all the other riparian areas were not affected.

CURRENT

The total acres of riparian reserve associated with Class I - IV streams on National Forest System (NFS) lands in this watershed is 21,387 acres.

Currently, from GIS data on riparian reserves / road intersection for Class I, II and III streams, about 806 acres of riparian reserves have been lost by road construction on the NFS lands within the watershed. The deeded lands are not included as are not the Class IV riparian reserves.

Of the 21,387 acres of riparian reserves on NFS lands, the loss of 807 acres associated with Class I - III streams account for about 4%. Road impacted acres of riparian reserve associated with Class IV streams weren't calculated.

To include the riparian reserve acres of Class IV streams impacted by roads, the overall percentage would rise above the 4%, as given for the Class I-III stream riparian reserves.

CONCLUSION

Loss of 806 acres of riparian reserves associated with Class I, II and III streams. Impact to riparian reserves associated with Class IV streams wasn't assessed.

TRENDS

1) On the NFS lands, the impacts to riparian reserves initially appear minor, keeping in mind that riparian reserve acres for Class IV stream weren't assessed for overlap with roads. Usefulness of this information is as a component for assessing overall conditions of riparian reserves.

2) An upward trend in acres of riparian reserves impacted by roads if analysis includes the road intersection with Class IV stream riparian reserves.

3) A slight downward trend in riparian reserves acres affected by new road construction, mostly to Class IV stream riparian reserves and occasional spur road needs in the riparian reserves of the large streams, as we continue our program of harvest in the Matrix.

RECOMMENDATIONS

Finish the analysis for the Class IV stream riparian reserves on NFS lands that are currently affected by roads.

Where roads within riparian reserves have no further requirement for transportation needs (motor vehicle travel), rehabilitate the road to enhance recovery of riparian reserve functions. Where roads within riparian areas have no further requirement for transportation needs within the near future, one to several decades, close the road to permit riparian habitat to function without disturbance.

TR7 ROADS AFFECTS WILDLIFE

REFERENCE

The road system of the 1940's and before had very little effect to wildlife. Roads provided limited access for hunting and trapping, which were important economic uses as food and fur trade during that time period. Other than the roads in and round the City of Oakridge, the watershed had only the road up the Middle Fork Willamette River.

CURRENT

Since the 1940's, the watershed has been extensively roaded. For most wildlife species, the effects of roads are nominal. The species of concerns for roads are the big games species, namely deer and elk, and the Threatened and Endangered species.

Roads have a negative effect on habitat effectivenes for deer and elk. The watershed is divided into 13 elk emphasis areas. Each emphasis areas, High, Moderate or Low, has maximum open road density objectives for habitat effectiveness.

The effects of roads pertain to increased human access, both in numbers and frequency, and the resulting consequences of disturbance and harvest of elk and deer. The disturbance result is related to energy expenditures.

Wildlife species, including deer and elk, need the spring, summer and fall to put on fat reserves (energy reserves). The fat reserves are the primary sources of energy for surviving through the winters. Increased frequencies of disturbance and resulting increased expeditures of energy during the spring, summer and fall reduce the quantity of fat reserves that deer and elk have to enter the winter season. Likewise, the increased expenditures of energy, due disturbances during the winter, hasten the loss of energy reserves and can have a detrimental effect of herd numbers by increaseing winter mortality and decreasing the number of live births carried through to the spring.

During the mid-1980s, the Oregon Department of Fish & Wildlife conducted a study of the elk herds' reproductive success. The study on Rigdon Anger District included this watershed. The study showed that the reproductive success of the elk herds was around 72%, which was considered within normal range.

Increased disturbances also affect calving sites for elk. Direct effects to survival of elk calves are considered very low. A higher effect would be indirect, as revealing calves to predators, namely bears and mountain lions.

In this watershed, the elk population has grown substantially over the past decades, since the 1940's, despite the coinciding increase in road mileage. However, the current rate of elk population growth is beginning to level.

Roads enhance the human access which into turn enhance the numbers of deer and elk harvested. Legal harvest is currently directed at bulls and has little to no effect to population growth. Illegal hunting takes a higher percentage of cows than bulls, which does influence population growth.

Effect of roads to Threatened and Endangered species is predominately access and disturbance by humans, which can affect reproductive success during the nesting seasons.

Presently, two bald eagle nest sites and one peregrine falcon nest site exist within this watershed. Roads exists within disturbance distances of each site. The roads of concern within vicnity of one eagle nest and of the peregrine falcon nest sites are closed during the nesting season. One road on concern within vicinity of the second eagle nest is presently open. Locations of these sites and associated road numbers are confidential.

Human access, as provided by roads, has a lesser potential for direct effects to spotted owls, as these owls have a lesser tendency to be disturbed by humans. Isolated locations are a concern, however, where nest areas are adjacent to roads. Potential for indirect effects of roads to these owls, and other wildlife, is the higher risk of human-caused wildfires related to high density of roads and access.

EMPHASIS SPECIES, ELK:

Elk migrated into North America from Seberia during the last Ice Age. The Roosevelt elk species of western Oregon is considered a product of that migration. The Lewis and Clark Expedition survived and replenished their food stocks with elk and fish during their winter stay in northwest Oregon. The first settlers in and near this watershed included elk in their sources of food. Elk numbers and locations weren't described for this watershed. Assumptions are that the elk numbers were moderate to low, compared to today's numbers, and that the predominate use area by elk was on the east side of the river from Hills Creek confluence at the north end and the Deadhorse Creek at south end of the watershed.

Assumptions are that there were small resident herds of elk, while most elk migrated through the watershed to winter toward the Willamette Valley and to summer on the east side of the Cascades Crest. Habitats that the elk would have used would be similar as today; forested areas for thermal cover and limited forage, and burned areas principally for forage. Fire areas that underburned and that were stand replacements would have provided forage.

With unregulated hunting and developing meat market in the mid and late 1800's, the elk populations were severely reduced. Around 1900, the State instituted a No Hunting restriction which lasted for thirty years. Coinciding with the late 1800's and until sometime in the 1940's, predator control was instituted in the Cascades, leading to the extirpation of the grizzly and substantial reduction in the mountain lion and the wolf populations; species which influenced the populations of elk.

ELK, CURRENT

In the 1950's elk was still considered scarce in the watershed. During the 1950's, roads were just being constructed into various drainages for timber harvest, converting forested habitat into early seral habitat that provided forage. By the 1980's every drainage had been entered for timber harvest.

With regulated hunting, low predator populations, and an increasing supply of sustaining forage, the elk populations rebounded from the lows at the turn of the century to more than three hundred head in this watershed. The largest numbers still exist east of the river and in the Coal Creek drainage.

The 1990 Wilammete National Forest Plan designated elk emphasis areas across the forest. Management emphasises for elk habitat are rated as High, Moderate or Low for each emphasis area. There are thirteen elk emphasis areas within the watershed, as described below:

5th field	Emphasis Area	Dominant Emphasis	Land Allocations
21 1 Gray	Gray	Low	LSR 0222
21 2 Lake	Modoc Bull	Moderate	Matrix
21 2 Lake	Larison	Moderate	LSR 0222
21 2 Lake	Packard	Low	LSR 0222 upper Packard, mostly Pvt. lower
21 2 Lake	Coffeehead	Moderate	Matrix
21 3 Lake	Windfall	Moderate	Matrix
21 3 Gold	Gold	Low	Matrix/LSR/Pvt.
21 3 Gold	Snake Fir	Moderate	Matrix/LSR/Pvt.
21 3 Gold	Dry Pine	High	Matrix
21 3 Gold	Indian Steeple	Moderate	Matrix/LSR/Pvt.
21 4 Coal	Coal Head	Moderate	LSR

Habitat Effectiveness Indices (HEI) for each habitat variable and overall geomentric means for the High, Moderate and Low emphasis areas are:

High Elk Emphasis Area
HEI valves for Cover, Forage, Road Density, and Size & Spacing of cover & forage should be within >0.5 and 1.0 indices. The overall geometric mean should be maintained above or increased to >0.6 within first 10 years.

The HEI valve of 0.5 for cover applies to winter range portion of the area.

Moderate Elk Emphasis Areas

HEI valves for Cover, Forage, Road Density, and Size & Spacing of cover & forage should be within >0.4 and 1.0 indices. The overall geometric mean should be maintained above or increased to >0.5 within the first 10 years.

Low Elk Emphasis Areas
HEI valves for Cover, Forage, Road Density, and Size and Spacing of cover & forage should be within >0.2 and 1.0 indices.

In addition to elk emphasis areas designated, agreement between the Oregon Department of Fish and Wildlife (ODFW) and the Rigdon Ranger District designated 'high elk use areas' within the Moderate and the Low emphasis areas to be managed with the same elk habitat principles that would apply to the High Elk Emphasis Area. Even though the minimum HEI values might be meet within most of the Low and the Moderate emphasis areas, where 'high elk use areas' exist within these emphasis areas, practices as road closures, forage enhancements, size and spacing of forage and cover, particular thermal cover, should be addresses in similar manner as the habitat variables would be for a

High Elk Emphasis Area. Presently, the 'high elk use areas' which ODFW agreed to are on a paper map at the district and need to be placed into GIS.

Of the Moderate emphasis areas, the percentages of 'high elk use area' are:

Modoc Bull:	40% high elk use area (habitat)
Larison:	40% " " " "
Windfall:	30% " " " "
Coffepot Head:	70% " " " "
Snake Fir:	30% " " " "
Indian Steeple:	80% " " " "
Coal Head:	40% " " " "

The percentages of the Low emphasis areas that have 'high elk use areas' within them haven't been calculated.

Current Condition of Dry Pine High Elk Emphasis Area:
For the Dry Pine High Elk Emphasis Area, after harvest of Boulderdash T.S. and application of prescriptions and KV projects, the HEI valves would be:

HEI Cover:	0.52; ten year trend:	0.51
HEI Forage:	0.45; " " "	: 0.41
HEI Roads:	0.39; " " "	: 0.39
HEI S&S:	0.89; " " "	: 0.90
Geo. Means:	0.54; " " "	: 0.52

The decreasing trend in HEI Cover would result from continued decrease in thermal cover by program harvest and an increase in hiding cover ingrowth, which tend to weigh down the overall cover index.

The decreasing trend in HEI Forage would result from increasing acreage of lower forage quality, on assumption that less broadcast fuel burning, seeding and fertilization might occur.

For the HEI Roads, about 12 miles are prescribed for closure in the Boulderdash EA, leaving about 30 miles to be closed to meet the target of 1.9 miles of open roads/sq. mile. Currently, there's 83 miles of roads at a density of 3.8/sq mile. A problem that applies to most areas with meeting some desired HEI valves, as road density, is the tradition of using KV funds, which are tied to a specific timber sale area that's only a small part of a larger emphasis area. Infrequent timber sale entries during past several years hinders the ability to apply KV projects and funding across a full ehasis area.

Current Condition of Coffepot Head Moderate Elk Emphasis Area:
For this Moderate emphasis area, after completion of Weeping T.S., Stonepot T.S., and Mocha T.S., and application of prescriptions and KV projects, the HEI valves would be:

HEI Cover:	0.43;	ten year trend: 0.44
HEI Forage:	0.50;	" " " : 0.42
HEI Roads:	0.46;	" " " : 0.46
HEI S&S:	0.86;	" " " : 0.78
Geo. Means:	0.54;	" " " : 0.48

The decrease in HEI Cover would result from program harvest reducing optimal thermal cover acres in the emphasis area.

The decrease in HEI Forage would result from assumption that less harvested acres in the future would be broadcast burned, seeded and fertilized.

The decrease in the Geometric Mean index would primarily result from decreaing HEI valves for Cover, Forage and Size & Spacing.

The HEI Roads is within parameters, but could enhance the Geo. Mean by lowering the miles of open roads. Currently, there's 3.39 miles of open roads per square mile. The preferable ratio for a Moderate emphasis area is 2.8 miles of open roads/sq. mile, which closure of 14 miles would accomplish.

□Current Condition of Snake Fir Moderate Elk Emphasis Area:□
For this Moderate emphasis area, after completion of Slinky T.S. and applied prescription and KV projects, the HEI valves would be:

HEI Cover:	0.33	Ten Year Trend wasn't conducted for this emphasis area.
HEI Forage:	0.36	
HEI Roads:	0.36	
HEI S&S:	0.77	
Geo.Mean:	0.43	

The HEI Cover value is a result of a high ratio of hiding cover to thermal and especially optimum thermal cover. About 40% of this area is of checker-board private lands. This area has extensive acreages of older managed plantations, on National Forest System (NFS) lands and private lands, that are providing hiding cover. The future trend for HEI Cover should increase slightly in the future as many units of hiding cover grow into thermal cover. However, that trend is not expected to reach >0.4 due the five years left of the first 10 year period and also the low acreage of optimum thermal cover.

The HEI Forage is a result of not enhancing forage by seeding and fertilizing.

The HEI Roads was increased from 0.31 to 0.36 by Slinky T.S's prescription to close 4 miles of roads. Another 5.5 miles of open roads will still need to be closed to reach the desired 2.8 mi/sq.mi density. To acheive that 5.5 miles of road closure requires cooperation with the private land owner, as most of the open roads also provide private land access.

□Current Condition of Gold Low Elk Emphasis Area:□
The current HEI conditions for this emphasis area are:

HEI Cover:	0.38	Ten Year Trend not conducted for this emphasis area.
HEI Forage:	0.37	
HEI Roads:	0.42	
HEI S&S:	0.82	
Geo. Mean:	0.47	

Other Elk Emphasis Areas have not had their HEI values fully assessed. The other two Low Emphasis Areas should easily meet the >0.2 indices. The Gray Low Elk Emphasis Area might be close to the minimum for HEI Forage and S&S, as most of this area is forested. However, the portion of the emphasis area with the higher potential of elk use, Gray Creek drainage, has recent harvest units providing forage. The Gray emphasis area is fully within the LSR, and opportunities to maintain forage and size & spacing of forage and cover may be lacking in the future.

The Packard Low Elk Emphasis Area is about 50% private land, is one large block on the lower half of Packard Creek drainage, contains most of the available winter range, and has been fully harvested of timber, with resulting mix of forage and hiding cover, no thermal cover. A small portion of the winter range of this area consists of the fringe of NFS land along the Hills Creek Reservoir and in Snow Creek. The upper reach of Packard Creek on NFS land is summer range and also fully within the LSR.

The Larison emphasis area needs about six miles of roads closed to meet the desired target of 2.8 miles/sq. mile, and the HEI Forage index should be slightly above >0.4 value. This area is fully within the LSR, and opportunities to maintain forage and size & spacing of forage and cover will be lacking.

Coal Head emphasis area is fully within the LSR, and opportunities to maintain forage and size & spacing of forage and cover will be lacking. However, most elk use in this emphasis area is on summer range toward Calappoyia Ridge where several large meadows will provide forage.

The Modoc Bull emphasis area might currently have difficulty meeting the size & spacing HEI value. The forage acres is mostly one large block resulting from the Shady Beach Fire and following salvage sales. Most of the cover quality is of thermalk and optimum thermal but is located mostly in one area on the north aspect slopes of Bull Creek drainage. Modoc Bull emphasis area is winter range, and optimum thermal cover is desirable on a southern aspect in winter range. The future trend (□>□15 years) is a loss of forage acres.

The Windfall, the Modoc Bull, the Indian Steeple, and the Coal Head moderate elk emphasis areas have open road densities low enough to meet the 2.58 mi/sq. mile maximum for moderate areas.

CONCLUSION; Elk

Elk herds have increased substantially from the reference conditions, due institution of regulated harvest and management of the habitats with provision of distributed pattern of forage and cover. However, the current management objectives for elk emphasis areas will be difficult to meet for the High and possibily the Moderate emphasis areas. Several reasons: Reliance of timber sales scheduling and KV funds; Meeting forage quality objectives with de-emphasis on broadcast burning, seeding non-native forage species; Potential conflicts in meeting road density objectives.

TRENDS; Elk

1) A downward trend for the Dry Pine High Elk Emphasis Area geometric mean, verse an upward trend to an 0.6 valve, due mainly to increasing acreages of hiding cover lowering the HEI Cover values and to reduced forage acreages and quality.

2) A downward trend for the Coffeepot Head Moderate Elk Emphasis Area geometric mean, verse an upward trend to an 0.5 value, due mainly to reduced forage acreages and quality.

3) A downward trend for the Gray, the Larison, and the Packard emphasis areas, due LSR and resulting reductions in forage acreages and size & spacing values.

4) Meeting the 10-year trend objectives for the remaining Moderate emphasis areas may be difficult, also.

5) With current practices, meeting some objectives for elk emphasis may be difficult with meeting some objectives for multiple species and site productivity. Examples: to meet forage quality values, broadcast burning, seeding, and

repeated fertilizer applications are practices; logistics for current emphasis for native plant seeding isn't developed; reduced acres of broadcast burning.

RECOMMENDATIONS:

1) Request Forest Plan amendments to change Larison Moderate Elk Emphasis Area to a low emphasis, due LSR overlap.

2) Further promote program of native seed production.

3) Continue reducing open road miles to meet the elk emphasis areas objectives of 1.9 miles/square mile for the High and 2.8 miles/square mile for the Moderate emphasis areas. For the High Elk Use Areas in Moderates and Low emphasis areas, open road densities would need to be lowered toward the 1.9 miles/square mile objective of a High emphasis area.

CONCLUSIONS

Four elk emphasis areas are above the open road density maximum for desired objectives. A total of 71 miles of open road within these four emphasis areas would need to be closed to meet the desired open road density objectives for habitat effectiveness relating to road density.

Additionally, several of the other Moderate and Low emphasis areas have High Elk Use Areas where roads would need to be closed to meet a Forest Plan agreement with ODFW.

One road within vicinity of a bald eagle nest area has potential for allowing disturbance during nesting season.

TREND

1) A static trend in effects to wildlife species, with a static trend in new road mileage.

RECOMMENDATIONS:

1) Increase habitat effectiveness for deer and elk by closure of open roads to meet the road density objectives for the elk emphasis areas within the watershed. Seventy-one (71) miles of open roads would need to be closed to meet the maximum densities for four elk emphasis areas:
Coffeehead in 21 2: ~14 miles to close; Willow Creek to Buck Creek.
Dry Pine in 21 3: ~42 miles to close; Cone Creek to Deadhorse Creek.
Larison in 21 2: ~6 miles; Larison Creek drainage.
Snake Fir in 21 3: ~10 miles; Snake Creek and Fir Creek drainages.

In addition to the 71 miles of open roads to close within the above elk emphasis areas, High Elk Use Areas within the other elk emphasis areas need to assessed for road closures to meet habitat effectiveness as pertains to open road densities.

2) Close the one open road that's within vicinity of one eagle nest, to alleviate potential disturbance.

3) Change the Moderate Emphasis for the Packard and the Coal Head emphasis areas to Low Emphasis, due the LSR/private land overlaps and projected inability to manage in the future to meet the moderate emphasis HEI objectives.

ISSUE: HILLS CREEK LAKE

HL1 HILLS LAKE AND WILDLIFE MIGRATION BLOCK

REFERENCE

Prior to the building of the Hills Creek Dam and impoundment of the Lake, the 12 miles of river floodplain and riparian habitats served as wintering areas and migration route for many terrestrial wildlife, as deer and elk, and served as a part of the fuller riparian connective corridor of the river system and tributary systems as the Larison, Packard, Big Willow, and Bull creek drainages.

Riparian associated species, as frogs, salamanders, turtles, beavers, otters, inhabited the riparian habitats of the wide floodplain, providing a continuum for interpopulation genetic interchange.

CURRENT

The dam and 12 miles of lake form a barrier for connectivity (dispersal, migration, foraging, and genetic interchange) of many species, particularly the riparian associated species as the white-footed vole.

The elk herds of the Bull Creek, Big Willow Creek and Coffeepot Creek area that once used the riparian habitats and for winter cover and forage now are restricted to the mid-slopes of those drainages for their winters.

The forested slopes around the lake are of upslope, dry forest habitat characteristics, and blocks movement for the smaller, less mobile species as salamanders and mollusks (slugs and snails). More mobile species, as beavers and river otters, are impeded by the lake's 12 miles distance, but likely not fully blocked. Birds which follow the river riparian corridor can still transverse around the lake in the upslope forest habitat.

The western pond turtle, a Sensitive species, that once inhabited the river system, have occupied some of the sheltered cove around the lake, although the lake, with its draw down regime, isn't considered ideal habitat for the turtles. Though of low possibility, maintaining these turtles in the lake provide a potential for genetic interchange between the turtles farther up river and turtle down river below the dam.

The lake has provided suitable foraging habitat for bald eagles, a Threatened species. Presently, two pairs of eagles nest in vicinity of the lake and utilize it for foraging.

CONCLUSION

The Hills Creek Lake and designated riparian reserve impedes migration and travel for most riparian-associated wildlife, due mainly that the riparian reserved provided is steep, upslope forest habitat, verse riparian habitat.

TRENDS

No change

RECOMMENDATIONS

1) Apply silvicultural treatments to the dense, overstocked young conifers between the high pool line and the road system on both sides of the lake to promote growth and canopy structure. Several stretches along the lake that were harvested of timber as preparation for impoundment of the lake have regenerated into dense stands of Douglas-fir. Opening these stands by thinning would hasten their development to large trees with deep canopies and facilitate passage around the lake by those species that can or could utilize the shoreline for dispersal and migration.

2) Windthrow and felled hazard trees should remain in the prescribed riparian reserve around the lake to facilitate overland movement for the less mobile species.

3) Coves which are inhabited by the western pond turtle should be managed to protect the the turtles from plinkers, as providing vegetative screening.

4) Apply habitat enhancement practices within the coves and upslope areas for nesting to maintain a the population within the lake.

4) Management activities within a quarter-mile of such coves need to be assessed for potential impacts to turtle nesting areas.

K

APPENDIX K

Botanical Document

Middle Fork Willamette Downstream Tributaries WA
Botanical Input
Jennifer Dimling, Willamette National Forest Botanist
1995

Historical Conditions

Sensitive and Rare Plants

No plant species listed as Threatened or Endangered by the US Fish and Wildlife Service occur on the Willamette National Forest; Candidate species occur elsewhere on the National Forest, but not in the Middle Fork Willamette River Downstream Tributaries.

The Willamette National Forest has designated a list of sensitive plant species by the Regional Forester. The Region's Sensitive Species Program is designed to manage rare species and their habitats to prevent a need for federal listing at a future date. Sensitive species are vulnerable due to low population levels or significant threats to habitat (USFS, R-6 FSM).

A number of populations of *Romanzoffia thompsonii* are located within the Middle Fork Willamette Downstream Tributaries Watershed. This species is an annual mistmaiden which is found in rock garden and rock outcrop habitats. Sites always have an abundance of water in the springtime; Thompson's mistmaiden is only found associated with seeps, blooming while they still run in April and May. Soil development is minimal and is usually composed of gravel or scree with soil in small pockets in the rocky crevices. The substrate on which the plant survives is often a moss mat, most commonly *Bryum miniatum*. Other commonly associated species on Rigdon are wild onions and monkeyflowers. Populations are found in the Dinner Ridge area (EO# 050) and in the Coal Creek area (039).

This species is greatly dependent on the hydrologic regime; populations would be devastated if these habitats were to undergo a loss of or change in the water flow pattern.

Table . Sensitive Plants of the MFWDT Watershed

Species	Unique #	Sitename	Subpops
Romanzoffia thompsonii	039	Coal Creek	2
Romanzoffia thompsonii	050	Dinner Ridge	3

The Willamette National Forest also tracks rare and unique species which have the potential to become listed as Sensitive. These species may be associated with habitats which are disappearing or they may be common elsewhere, and at the edges of their range on the Willamette. They make a major contribution to the overall biodiversity on the Forest. The Willamette Forest Plan directs the Botany Program to create a Forest Watch List for such species (USDA, 1990).

A number of these species are found in the Middle Fork Willamette River Downstream Tributaries. *Phacelia verna*, spring phacelia, is a very diminutive plant whose northern part of the range is found on the Willamette National Forest. This species grows in rocky basaltic bluffs along ridgelines. Plants emerge from protected crevices (Abrams, 1951, Vol. 3). Three populations are known from this Watershed. *Cercocarpus ledifolius* var. *ledifolius* is a mountain mahogany which is usually found on the east side of the Cascade Mountains in the desert foothills and mountains. However, there is one population on the Willamette in Moon Lake Special Interest Area. These species prefer rocky habitats with little soil development; these are the preferred sites for roads and rock quarries.

Other species prefer wet meadow or pond habitats. *Sidalcea cusickii* is a bright pink checkermallow which inhabits moist meadow habitats which are mostly found along the crest of the Calapooya Mountains in this Watershed. The distribution of this species is patchy across the forest. *Veratrum insolitum*, Siskiyou false hellebore, reached the northern part of the range along the Calapooya Mountains. This species grows in habitats ranging from open meadows to thickets (Abrams,1951 Vol. 1) and mixed evergreen forests on red clay (Hickman,1993). The little grapefern, *Botrychium simplex*, is found most often in midmontanme meadows, growing among the grasses and other herbaceous species. One population has been located in the Middle Fork Willamette River Downstream Tributaries. The one-flowered gentian, *Gentianopsis simplex*, prefers mountain bogs and meadows. Rigdon is the only District on the Willamette where this species is found; it ranges south to California and east to Idaho (Hickman,1993). One of the three populations of *Epilobium luteum* on the Forest are found here. Yellow willow-herb grows at middle to high elevations in moist soil. One population of *Sagittaria cuneata*, wapato, is a hydrophilic plant found along the edge of Bradley Lake. Large-flowered brickellia, found in a large range of habitats, but usually associated with rocky soil, is also found in this area. Apparently, the last two species are again eastern Cascade species which have jumped the crest and landed in this watershed. Since these species occur in wet habitats, the hydrologic regime is of paramount imoprtance to their survival. These species have adapted to open canopy conditions; alteration of hydrology or fire suppression which could allow tree species to move into the meadows could allow shaing out of these species. some species, the grapefern in particular, is highly dependent on a fungal symbiont.

Some rare species are found in forested habitats. The pine broomrape, *Orobanche pinorum*. This mycotrophic species lacks chlorophyll and receives nutrients from the host, most often ocean spray. The plant is found in dry coniferous woods; plants have never been relocated in clearcuts as the host is normally destroyed. Populations are sprinkled as far north as the Gifford Pinchot National Forest in southern Washington. The giant chain fern, *Woodwardia fimbriata*, is found along stream banks and wet places from lowlands to midmontane in the understory of confierous woodlands. This species seems to be at the northern part of its range in the southern part of the Willamette National Forest. This species also depends on an intact overstory as well as an adequate amount of water.

Table . Rare and Unique Plants in the MFWDT

Species	Site Name	Status List	Total Populations on the WNF
Phacelia verna	Little Deception Rock Bearbones (2)	[1]W	5
Cercocarpus ledifolius var. ledifolius	Moon Lake	C	1
Sidalcea cusickii	Gray Creek Holland Meadows - Umpqua NF side W. Buck Mountain	W	14
Veratrum insolitum	Packard Creek (2) Johnson Meadows Moon Point Bristow Prairie	[2]R	7
Botrychium simplex	Gertrude Lake	[3]C	4
Gentianopsis simplex	Bradley Lake	C	4
Epilobium luteum	Loletta Lakes	R	3
Sagittaria cuneata	Bradley Lake	C	1
Brickellia grandiflora	Bradley Lake	C	1
Orobanche pinorum	Snow Creek	C	9
Woodwardia fimbriata	Upper Willow Creek	C	2+?

[1] W- Watch List - Oregon Natural Heritage Program, taxa of concern, but not currently threatened or endangered.

[2] R- Reviw List from Oregon Natural Heritage Database. Species for which more information is needed before status can be determined, but which may be threatened or endangered throught their range.

[3] C- Concern List from the Willamette NF. Directed by the Willamette Forest Plan Monitoring. Purpose is to avoid need to list species, so track them prior to their loss.

Survey and Manage Species

The Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (USDA, 1994b) contains a list of species we must consider when planning projects called Survey and Manage Species. A large list of old-growth-dependent species (the results of which is Table C3 in the ROD) was created and affects of alternatives on each species were analyzed by a number of panels of experts during the EIS process.

In the ROD (USDA, 1994), the standard and guideline for managing survey and manage species, which applies forestwide (regardless of land allocation) is divided into four components. Survey strategies include: Strategy 1: Manage known sites: initiate in 1994; Strategy 2: Survey prior to ground-disturbing activities: initiate in 1999; Strategy 3: Extensive surveys: initiate in 1996; Strategy 4: General regional surveys: initiate in 1996. Each species was rated during the analysis for the EIS and is designated certain survey strategy(ies) to follow, depending on the rarity of the species, potential threats to the species, and a whole host of other factors. Strategies 1 and 2 will be the responsibility of the National Forests while strategies 3 and 4 will be conducted at the Regional level.

Botanical Survey and Manage elements include lichens, bryophytes (mosses and liverworts), fungi and vascular plants. No forestwide or Regionwide surveys of these species have been initiated; information is incomplete.

Lichens are organisms composed of both a fungus and an alga or a cyanobacterium. A number of nitrogen-fixing lichens are found throughout the Forest in old-growth stands, and although exact locations are not known, they are sure to exist in the Middle Fork Willamette River Downstream Tributaries Watershed. Examples are *Lobaria oregana, Lobaria pulmonaria, Peltigera* species and *Pseudocyphellaria* species. These species are conifer epiphytes, so they require retention of aggregates of standing trees to maintain a suitable microclimate and to provide for dispersal (USDA, 1994a).

No known Survey and Manage bryophytes or fungi occur in the Watershed, although 2 vascular plants have been documented here. *Allotropa virgata*, the candystick, is a mycotrophic species, a plant with no chlorophyll, which requires an association with another plant for food. The plant grows in the Douglas fir series in the Watershed, and may be associated with hemlock, fir and lodgepole pine elsewhere. This species is not restricted to old growth, but the largest populations occur there. It does not tolerate competition; it is never abundant. The plant prefers dry, well-drained soils and abundant coarse woody debris (USDA, 1994a). Although only one site is documented in the Watershed (ecology plot #6078), a number of populations are found just to the east. Because the ecology plots were not systematically placed, we can only use their information to make assumptions about the distribution of species within an area. In this case, I assume that there are more populations within the Watershed. This species has not been relocated in clearcuts but some populations have been found in second growth stands.

The second vascular plant, known historically from the Middle Fork Willamette River Downstream Tributaries, is the mountain lady's slipper, *Cypripedium montanum*. This lovely orchid has been reduced in number to approximately 20 populations west of the Cascades. It grows in forested habitats and persists in areas which have been burned. Establishment and growth rate are very slow. Specific fungi are required for germination and establishment. No plants have survived timber harvest.

Special Habitats

Special habitats are those areas which contribute to the overall biodiversity across the landscape and are important for plant and wildlife habitat. For the most part, these areas are non-forested including meadows, rock outcrops, ponds and talus slopes. Some special habitats, swamps and mineral deposits, are forested.

The Willamette National Forest has recognized the significance of these sites (which comprise approximately 1 % of the Middle Fork Willamette River Downstream Tributaries) in its standard and guideline FW-211. This S&G states that we will maintain or enhance (repair) these sites and that areas surrounding the sites will be pulled out of their management allocation and be treated as non-mapped special wildlife habitats (Management area 9D) or Riparian reserves.

The most prevalent special habitats in the Middle Fork Willamette River Downstream Tributaries are dry rock garden are rock gardens (267.38 acres), mesic meadows (241.69 acres), dry meadows (123.60 acres), wet meadows (91.42 acres) and rock outcrops (17.24 acres).

These habitats are important for both wildlife and plant habitats. Functions of each type of special habitat outlined above and with wildlife species which use them are outlined in the Special Habitat Management Guide (Dimling and McCain,1992).

Calapooya Mountains

The Calapooya Mountains are a unique feature in the Middle Fork Willamette River Downstream Tributaries Watershed. They essentially ring the southwestern and southern part of the Forest. This area is of interest for a number of biological reasons. It forms both a physical and a climatic barrier for plant species migrating south, north and west; it is a center of amazingly high botanical diversity (See Table). It forms ridgetop corridors for wildlife. It was a main travel route of Native Americans and contains untold numbers of archaeological sites. This area, because it harbors such a range of habitat types and species, could act as a refugia for species during global climate change.

A variety of habitats are found along the Calapooyas in the Middle Fork Willamette River Downstream Tributaries Watershed. A variety of meadows (Holland, Johnson, Gertrude Lake, Rangers Prairie, Bristow Prairie, Bradley and Loletta Lakes) are found in basins between the high ridge peaks. These areas have largely been allocated under the Willamette LRMP as Special Wildlife Habitats, although a few are considered scenic (10e, 10f). The majority of the Divide was allocated to Late Successional Reserve in the EIS (USFS,1994a). Interspersed between the meadowed basins are the high rocky talus ridgetops and rock garden sideslopes which also contain a variety of unique plant species: Grass Mountain, Bearbones Mountain, Spring Butte, Steeple Rock and Bulldog Rock.

Even though the peaktops are non-forested special habitats, the remainder of the area has been highly fragmented by timber harvest because it is in the general forest land allocation. In the 1950's road 5850 was built along the crest of the mountains, most of the way on top of the old Native American trail.

Noxious Weeds

Noxious weeds have increased in abundance since the turn of the century. Established weed species have been around for a while. Scotch broom was introduced as an ornamental shrub and an erosion control agent in the 1920's (Miller,1995). St. John's-wort has been a medicinal herb for many years; it was probably a garden escapee. Thistles traveled west as contaminants in alfalfa and other crop seed bags and came into Portland in the ballast of sea-faring vessels (Forcella and Harvey,1988). Most of these species would have been considered newly invading species in the 1930's. Knapweed, toadflax and giant knotweed probably were not found anywhere on the forest.

Grazing History

Two major grazing allotments existed in the Middle Fork Willamette River Downstream Tributaries, one of which was on the Calapooya Mountains and thus shared with the Umpqua National Forest. Records show that the Bristow Prairie allotment, on the crest, was grazed more or less continuously from 1918-1927. Records since are spotty but we know that the last record was in 1971, The Bristow Allotment took in the Loletta Lakes area, Deadwood Creek, upper Coal and Indian Creeks, Bristow and Ranger Prairies on the Willamette side. The number of animals on the area ranged from an average of 1800 sheep/year in the early part of the century to 50-200 cattle/year from the 1950's on.

The second major allotment (2000 acres) centered around Warner Mountain. The allotment included Groundhog. Little Groundhog, Juniper, Logger Butte, Warner, Moon Lake area, Joe's Prairie and the upper reaches of Noisy, Deadhorse, Youngs, Boulder, Pine, Buck, Joe's Prairie and Groundhog Creeks. This was the only C&H Allotment on the District. The latest management plan (Condon, 1965) states that the area had been used for sheep grazing since the late 1800s. Records show an average of 1200 sheep roamed the area. Cattle grazing began in 1951. The area supported approximately 75 head annually.

Even back in 1943, conifer encroachment was noted as a problem in the Warner area, although no control efforts were documented. At the same time, both gophers and erosion were considered problematic. Erosion was most severe on Little Groundhog; so much so that sheep had to be removed.

In 1965, gophers were not seen as a large problem, but erosion continued. Water bars were called for at Little Groundhog. Coneflowers at Moon Point upset a Regional Office observer, so aerial spray of 2,4-D at Moon Point, Juniper Ridge and Tally Meadows was prescribed. Aerial application of non-native forage grass seed was a common practice and a special project was initiated, attempting to replace the beargrass at the top of Warner Mountain. with grass seed, to increase overall forage area within the allotment.

Special Botanical Areas

Two areas of special botanic richness were designated as Special Interest Areas in the 1990 LRMP. Moon Point is a 2000 acre parcel, 60% of which is found in the Middle Fork Willamette River Downstream Tributaries. The SIA includes Moon Point, Moon Lake and its associated meadow and bog habitat, the beargrass-covered peak of Warner Mountain and the headwaters of Deadhorse, Simpson's and Youngs Creeks. A 1.0 mile hiking trail leads through meadow and timber to the rocky point. Wildlife use is heavy throughout the area. Plants of interest include Siskiyou false hellebore and mountain mahogany.

The second SIA is Bradley Lake, in the southwest corner of the forest, on the ridgeline of the Calapooya Mountains. The area includes the lake, Dog Cabin Camp and some of the headwaters of Deadhorse Creek. Plant habitats include rolling basalt ridges with rock gardens, moist meadows and parklike forested stands with huckleberry and beargrass understories. The area is used for elk calving in the spring and as thermal cover in the hot summer. Plants of interest include wapato and large-flowered brickellia.

Current Conditions

Sensitive and Rare Plants

The current distribution of sensitive and rare plant populations is assumed to be generally similar to that of the historical with the exception of the two species which are dependent on moderate intensity fires for germination: woodland milkvetch, *Astragalus umbraticus* and branching Montia, *Montia diffusa*. The assumption is that there were more populations of these plants scattered through the watershed when fires were allowed to comb the area.

The milkvetch, a Region 6 Sensitive species, was located to the north of the Watershed, in the Warner Creek fire area, in 1993. The central part of the range of this species is the Umpqua National Forest, just to the south of Rigdon RD. It is assumed that some population(s) connected the Umpqua watershed to the North Fork of the Willamette Watershed. That link had to be the Middle Fork Willamette Downstreams Tributaries.

Branching montia was first found on the Willamette National Forest following the Shady Beach fire of 1988 in ecology plots designed to look at succession following the fire. The fire is at the eastern edge of the MFWDT Watershed. Since populations are found on the east edge of the Watershed and similar habitats to Shady Beach exist in the Watershed, an assumption is made that branching montia existed here in greater numbers in the past.

Survey and Manage Species

No surveys have ever been conducted for survey and manage species. One may surmise, however, that there were probably more riparian-dependent and old growth-dependent species prior to the advent of accelerated levels of timber harvest in the 1950s because these habitats have been the preferred choice for harvest in the last 40 years.

Special Habitats

I assume that most of the habitats that are found in the Watershed today were found in the watershed in the 1930's. Fire suppression and grazing cessation may have allowed tree encroachment, so the total acreage of dry and mesic meadows seen today may have been higher back then. In the 1930s, some of the wetter meadows and riparian areas along the Calapooya Divide and the Warner Mountain Allotment may have been impacted by cows, horses and/or sheep, depending on the rotations of the livestock.

Noxious Weeds

The Willamette NF initiated an Integrated Weed Management Program in 1993. The standard and guideline in the Forest Plan directs us to identify and analyze sites for the most effective control methods based on site-specific analysis of the weed populations (USDA,1993).

The highest priority species for treatment are new invaders, those weeds that are in early stages of invasion and have not naturalized to the point that resource damage is occurring. A number of new invaders are found in the Upper Middle Fork, including spotted knapweed, diffuse knapweed, meadow knapweed and giatn knotweed. Most populations of new invaders are restricted to roadsides (Table) or road shoulders, although one population os spotted knapweed is found in Packard Creek Campground. New invaders are of biological concern in this Watershed because of their potential to move from the road system into special habitats like meadows. their ability to outcompete natives have been widely documented. giant knotweed could move up the Middle fork into tributaries as it has in the Coast Range (Grenier,1994).

Spotted and diffuse knapweed are moving from the east side of the Cascades to the western part of the state; it is speculated that the method of movement is seeds caught in mud and transported on vehicle tires and undercarriages. Meadow knapweed is common in the Willamette Valley and is moving up in elevation. Methods of movement are unknown but seeds could be transported as above or in the guts of pack horses or grazing animals being transported through the Forest. The knotweed is a garden weed; populations near the Hills Creek Reservoir are from yard debris dumped adjacent to the water's edge.

Control of new invaders could include manual hand-pulling, mechanical mowing or chemical methods, depending on the characteristics of the weed site, closeness of water and human uses.

Table New Invader Noxious Weeds in the MFWDT

Latin Name	Common Name	Location
Centaurea maculosa	Spotted knapweed	Packard CG 21/2135 2102 2120 21
Centaurea diffusa	Diffuse knapweed	21/2135
Centaurea pratensis	Meadow knapweed	21/2127
Polygonum sachalinense	Giant knotweed	2106/105,107 2127/180,188

Other weeds found on the Forest are termed established infestations. These weeds have spread to the point that eradication is impossible and resource damage is unacceptable. Established weeds in this watershed include Canada thistle, bull thistle, tansy ragwort, Scotch broom and common St. John's-wort.

The thistle species, tansy and Scotch broom may be found in any disturbed site, but are most commonly associated with clear-cut logging units, landings, and logging roads. These species are generally outcompeted, due to lack of sunlight, in moderately young (20 year) forest plantations. St. John's-wort can be found in these sites, but is also common in meadow habitats which often harbor natural soil disturbers such as groundhogs and mountain beavers. One extreme example in the Middle Fork Willamette River Downstream Tributaries is Little Groundhog Meadow. The site was severely grazed prior to 1951. True to its name, the area harbors a plentiful population of groundhogs. St. John's-wort, once established, has outcompeted the native species, causing a severe reduction in the biological diversity of the site.

Because of the sheer acreage these infestations cover (literally thousands), control methods are limited to mainly biological control. This type of control involves the use of insects which naturally feed on the plant or its seeds, eventually causing an equilibrium in population numbers. A section of the Federal Department of Agriculture, APHIS, is responsible for the testing and release of biological control agents. Testing must be conducted because insects are imported from the weed's place of origin (usually Europe or Asia) and effects on native flora must be checked. One such release, the cinnabar moth, was not tested vigorously enough. It was released in western Oregon in the 1960s to combat the upsurge of tansy ragwort. After demolishing tansy populations, the moth has begun to feed on a native member of the same genus, arrowleaf groundsel. At the headwaters of Gold Creek, the meadow next to Gertrude Lake and in Johnson Meadows, these natives are being moderately impacted by this moth.

Records of biological control releases indicate that insects have been active in the MFWDT Watershed since 1981. The first species targeted was tansy, which had moved into the National Forest from the Willamette Valley (see Table). In 1988 biological control agents for both St. Johns-wort and Scotch broom became available: a beetle and a seed-eating weevil, respectively. And finally, a new root-boring beetle was introduced to the St. John's-wort population on Little Groundhog Mountain in 1993. Monitoring transects were set up prior to release. These plots have been revisited for the past 2 years but no beetles recovered (Miller,1995).

Table Biological Control Releases on MFWDT Watershed Noxious Weed Populations

Target Weed	Insect	Year	Number	Location
Tansy	Lonitarsus jacobaea (root-eating flea beetle)	1981	500	23S 3E Sec 12
St. John's-Wort	Chrysolina quadrangularis (Leaf-feeding beetle)	1988	500	21S 3E Sec 34
Scotch Broom	Apion fuscirostre	1985	500	21S 3E Sec 32
			1000	21S 3E Sec 27
			500	21S 3E Sec 30
		1987	1000	21S 3E Sec 27
			500	24S 3E Sec 15
			500	22S 3E Sec 27
		1988	270	21S 3E Sec 18
		1990	300	22S 3E Sec 11
			200	21S 3E Sec 26
			200	23S 3E Sec 4
			200	22S 3E Sec 14

Analysis

Issue 1- Vegetation Manipulation

Habitat Diversity/Species Composition/Interior Habitat/Connectivity

The habitat diversity in both forested and non-forested stands has changed dramatically due to vegetation manipulation. Forested stands which existed as a mosaic pattern of ages and structures within stands (due to the frequent underburning and reburning of the stand) created a range of habitat types or niches for both plant and animal species. The movement to managing stands for timber based on clearcut methods of harvest (the dominant harvest method) have created a great number of young single-aged stands with little habitat complexity (thirty-three percent of the watershed is currently in 0-30 year stands as compared to 2% in the 1930's). This dramatic increase in young stands results in a much higher percentage of sites where early pioneer species may survive. Species composition has been shifted from a mixture of species (overstory dominating Ponderosa and sugar pines and Douglas fir with understory tolerators (hemlock, yew and true fir) to a predominant monoculture of Douglas fir, except for some stands in the pine belt where Ponderosa has been planted.

Vegetation management has had a direct effect on one subpopulation of the Sensitive Thompson's mistmaiden in the Dinner Ridge area. This population is below a landing created for a unit in Knoll Timber Sale. Recommendations are to mitigate by permanently closing the road and by recontouring the slope so that the original hydrology of the site may be restored.

The only known population of mountain ladyslipper (an orchid on the C3 list in the ROD), was eradicated when a clearcut changed the overstory and mycorrhizal composition of the site, making it impossible for the species to survive. The plant was found adjacent to the road after harvest, but did not survive (see files on Salix Timber Sale, 1980). In a number of instances, when a rare plant is extirpated from its former habitat, conservationists suggest reintroduction of the plant (via seed or cutting). In this case, however, this option will not work. As mentioned above, orchids need a fungal symbiont for survival. If that fungus has been damaged (which is quite likely considering the former habitat has been both clearcut and burned) or extirpated itself, there is no chance that reintroduction would work. Orchids are notoriously difficult to grow from seed and trasplanting has never been successful (Everett, 1995).

The absolute effect that vegetation manipulation has had on the species featured in Table C-3 of the ROD is unknown. The majority of these species are associated with either old-growth or riparian (or both) habitats. Since the amount of these types of habitat have decreased over the past 30 years, both in number of acres across the landscape and in structural complexity necessary for the epiphytic members on the list, it can be safely stated that habitat for these species is decreasing at an alarming rate and that in the center of the watershed (matrix), a concerted effort ought to be made to conserve these species, given the overall management standards and guidelines. For example, mitigation measures outlined in FEMAT (USDA,1993) and Appendix J of the EIS (USDA,1994a) that could be used include:

- maintaining leave trees in patches 4 acres in size to become a source of genetic material (prescriptions should include coonsiderations for wind-firmness to avoid blowdown) and function as refuges;

- maintaining the same leave trees over several rotations due to the slow growth, poor dispersal and slow colonization of many of these organisms;

- selecting diverse leave tree species and structure in leave tree patches to maintain microhabitats and microclimates and selecting trees with a large variety of bryophytes and lichens;

- ensure large downed woody debris is left on-site;

- retention of riparian buffers;

- maintain patches throughout the watershed (use the existing pattern of pileated and pine marten and other non-harvest allocations to provide larger blocks of habitat) and connect them to act as dispersal corridors if there are no riparian corridors in the area;and

- scatter leave trees around rock outcrops and along ridgelines.

Mitigation measures for the candystick found in Appendix J of the ROD (USDA, 1994a) include developing a map of the populations, analysis of ecoplot data to further refine potential habitat, surveys for *Allotropa* during Watershed Analysis (this will happen at the project level on the Willamette National Forest), revisiting historic sites, survey in areas slated for prescribed burning, and restricting salvage of down logs in high probability habitat.

Various types of vegetation manipulation have affected special habitats: timber harvest and grazing. Timber harvest has indirectly affected these habitats by cutting roads across the bases of wet areas, meadows and ridgelines (see Roads section). Grazing by sheep has decreased the native vegetation to the point that non-native species have been able to outcompete a number of the native species. This problem is especially evident in the Little Groundhog Mountain area Bristow Prairie.

Managed stands, especially clearcuts, are perfect habitat for noxious weeds. These areas which have been recently disturbed and have, until recently, been denuded of vegetation are where Scotch broom, thistles, tansy, and to a lesser extent St. John's-wort and knapweed, thrive. Almost every young stand has these species so an estimated 30% of the watershed has been infested (and that's not counting the roadside populations). These species will eventually be outcompeted by the shading done by the young trees. But until the trees overtop the weeds, they will be making and distributing seed via the wind, birds, deer and elk.

Interior Habitat and Connectivity

The watershed has been highly fragmented by timber harvest and associated road building over the past 30 years. Large unfragmented blocks, similar to historic stands in character, survive in the Late Successional Reserve which wraps around from the Umpqua National Forest and touches on the Middle Fork Willamette Downstream Tributaries in the upper, middle and bottom part of the Calapooya Mountains. The center of the watershed, however, is terribly choppy, especially along the Watershed's eastern ridgeline and the Shady Beach fire area. Fragmentation is an issue because of the "edge effect" which means the microclimate is different on the edge of a stand than the interior part of a stand (some suggest it takes 500 feet to reach interior conditions). Some species need interior habitat for survival. It is also important because some species need certain types of cover or interior habitat for migratory or dispersal purposes.

Some species which need interior forested habitat include the old-growth associated C-3 species in the ROD. The actual requirements of each species (relative humidity, temperature, moisture, etc) may never be known but we do know that certain species need closed canopies and cannot survive in young stands. In order to maintain this diversity, we need to implement mitigation measures in the Matrix similar to those outlined in the habitat diversity and species composition section.

Riparian Habitat

Riparian areas in forested habitats were harvested with the rest of the timber from the 50's til the 1980's. Some rare plants like the giant chain fern could have been affected by this practice. Some riparian-dependent species from Table C3 in the ROD, especially the moss and liverworts associated with maple, probably experienced decreases in population size.

Issue 2: Fire

Habitat Diversity

Forested habitats, under the historic fire history, looked a great deal different from today. Fires burned in a somewhat regular pattern across the landscape (no area escaped) and fires were predominantly underburns in nature. Infrequently, during a very dry summer after a period of very wet summers when little burning occurred and some fuel was allowed to accumulate, large-scale, stand-replacing fires such as Shady Beach occurred, but most were smaller, frequent and of low-intensity. This would result in a real mosaic of species and stand structures, with fire-tolerant species being selected for, especially in the understory, as well as disturbance-tolerant species.

There are less acres of meadow now than in the past due to fire suppression and subsequent tree invasion. This is true of all the grazed meadows along the Calapooya Mountains as well as the Moon Lake/Joe's Prairie/Warner Mtn. area. This is something which needs to be analyzed during project level planning as these meadows are important features for both plant and wildlife diversity and prescribed burning might be one way to reintroduce the natural disturbance regime in the especially diverse Calapooya Divide in a safe way.

TES Species

Prescribed fire might also work well in stimulating some of the uncommon fire-dependent species, woodland milkvetch and branching montia, populations. Both places where these species have been discovered (Warner Creek and Shady Beach fires, respectively) burned in the fall. Burn intensity was moderate, leaving some green overstory to provide shade and some dead and down to hold water. It is unknown whether spring fires will stimulate these species to germinate or whether an early spring burn will affect growth and reproduction of other species.

Question 3- Roads

Wildlife and <u>Plant</u> Effects

One population of the Sensitive plant, Thompson's mistmaiden, is found above road 2123 (Coal Creek Road.) where the road was blasted into a rock outcrop. The area seems to have maintained its hydrological integrity because the plants were located after the road was built. We should monitor these populations. One other rare plant that has probably been affected by roads and/or quarries is spring phacelia. One known population occurs less than 1/4 mile from a quarry site just east of Bearbones Mountain. Further road-building or quarry activity ought to take these species into account.

Special Habitats

Roads have had a great effect on plant populations up along the Calapooya Mountains where 5850 runs through a series of meadows (Holland, Johnson, Gertrude Lake, Bristow, Bradley and Loletta Lake basins) as well as rocky ridgetops. At the eastern edge of the MFWDT, the meadows around Groundhog and Little Groundhog Mountains and Joe's Prairie have also been dissected and had drainage patterns disrupted. Roads are also vectors along which noxious weeds travel. During the Access and Travel Management and SIA management plan writing, we ought to be looking for roads to close/put to bed that run through or adjacent to these habitats. This should be analyzed in all project-level planning.

Issue 4- Non-Native Species

Effects on Flora

The increase in noxious weeds is directly attributable to increased management and use of the national forest. As mentioned, timber management, from clearcuts to landings to the roads that allow the truck haulers access facilitate both the growth and movement of these species. As the harvest has moved from the flat ground adjacent to rivers to the steeper, higher elevations, so have the weeds moved. The species which had barely made it on to the forest (Scotch broom, tansy, St. Johnswort, Canada and bull thistle) are now established members of our flora. These species are particularly difficult on the meadows which were heavily grazed and commonly seeded with "good forage" (all non-natives, I'd wager) species. The native grasses here are bunchgrasses which, true to their names, grow in bunches, leaving the ground in between them somewhat open and easily colonized by weeds. This can be detrimental from not only a biodiversity standpoint, but also from a decrease in natural forage for deer and elk. New such as spotted and diffuse knapweed, giant knotweed and toadflax continue to flow into the forest, by seeds caught on the undersides of vehicles, in lawn clippings dumped near the reservoir, in horse droppings along trails. The best thing to do is to continue prevention efforts through public education, eradication of the new invaders (where possible) and continuation of biological control releases on established infestations.

Other non-native species have contributed to a loss of diversity in riparian areas. Reed canarygrass was planted along Hills Creek Reservoir for bank stabilization during the 1980's. this species has since moved up riparian corridors into natural stream systems like Packard Creek. A second group of plants taking over riparian habitat are the blackberries. One may see evergreen, Himalayan and blackcap plants in the forest. These species seem to persist, despite shading by old conifers. It is unknown how many miles of stream are affected by these species as no inventories have been conducted.

Issue 5 - Hills Creek Reservoir
Riparian Habitat Quality

Riparian plant species have been severely alterd along the reservoir system. Formerly, typical riparian understory species like ferns, willow, alder and maple, would have grown at the water's edge. The seasonal change from filled to drawn down state makes for a climate few plant species can tolerate. Approximatley 50% of the plant species surveyed along the reservioir's edge in revegetation plots were weedy like wild lettuce, dock, bull and Canada thistles, cat's ear dandelion, tansy, chickweed, St. John's-wwort, cheat grass, oxeye daisy, birdsfoot trefoil, velvet grass, perennial rye, salsify and barley. Efforts at vegetating the Reservior have beenmixed; typical riparian species (will, sedge, cattail and bulrush) have been planted and survive. However, the majority of native species found on the site are normally found in dry habitats.

The creation of the dam has blocked movement of hydrophylic (water-loving) plant species down the Middle Fork River. Prior to construction, a variety of tidepool and floodplain type habitats supported a variety of plant species. The river acted as a dispersal agent for some seeds (most of them float). Now the seeds are caught within the "lake" and there is no habitat for germination and/or long-term survival.

Recommendations

Sensitive Plants

1. Continue surveying for sensitive and rare plants to determine whether management actions will coincide with populations and to recommend mitigation measures if they are found.

2. Close and recontour the road to restore the hydrologic regime for the Thompson's mistmaiden population on Dinner Ridge adjacent to the Knoll Timber Sale landing.

3. Continue monitoring and conduct an extensive survey of the Coal Creek population of Thompson's mistmaiden to ensure that the hydrologic regime maintains intact and to delineate the whole population.

4. Use prescribed fire as a tool to encourage germination of fire-dependent species such as woodland milkvetch and branching montia. Monitor burns to determine whether they were successful in releasing these species from the seed bank.

Survey and Manage

1. Conduct surveys to determine which C-3 species occur in the Watershed and where. Survey for candystick in all planning areas in the Watershed.

2. Use mitigation measures outlined in the Vegetation Management section (VW-2) to ensure survival of C3 species, especially in Matrix and where riparian areas do not provide dispersal corridors.

3. Consider survey and manage species when working in riparian areas. Consider retention of a diversity of tree species and maintenance of the diverse structural components (snags, down woody) where feasible.

Special Habitats

1. Continue to identify and classify special habitats during project level planning. Those found within stands (not delineated for this Watershed Analysis) that may have been affected by timber management or roads should be buffered in the next round of harvest and restoration efforts analyzed in the planning area document.

2. Consider closing spur roads into Loletta Lakes, Little Groundhog Mountain, Holland Meadows and Gertrude Lake. Recontour roads to restore meadow habitat (some fill is 12 feet high) and hydrologic regime during ATM and SIA Management planning efforts.

3. Put rare forested TSHE/RHMA/OXOR special habitats in GIS and delete it from future planning efforts.

4. During planning efforts, keep an inventory of stand types and plant species found along the Calapooya Mountains. This information will be used to identify why this area is of such high biodiversity.

5. Use prescribed fire, girdling and selective harvest methods to restore mesic and dry meadows back to their natural size and species composition. These sites should be analyzed at the project level and prescriptions written in SIA or Special Wildlife Habitat Management Plans.

Noxious Weeds

1. Continue noxious weed surveys to identify new invaders. Eradicate new invaders. Include blackberries and reed canary grass in surveys to determine the extent to which they have taken over.

2. Continue introduction of biological control agents. Monitor effectiveness of biological controls on St. Johnswort on Little Groundhog and, if effective, release at Bristow Prairie. Look for opportunities for future introductions.

3. Use every opportunity to decommission roads, as these are the main travel routes for weeds. Continue collecting and propogating native species (both grasses and herbs) for use on decommissioned roads.

4. Experiment with use of prescribed fire to eradicate noxious weeds. Small test plots would be the best way to start. Monitoring of effectiveness of this control method is mandatory.

□‡W- Watch List- Oregon Natural Heritage Program, taxa of concern, but not currently threatened or endangered
□‡R- Review List from Oregon Natural Heritage Database. Species for which more information is needed before status can be determined, but which may be threatened or endangered throughout their range.
□‡C- Concern List from the Willamette NATIONAL FOREST. Directed by the Willamette Forest Plan Monitoring. Purpose is to avoid need to list species, so track them prior to their loss.

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L

Appendix L

Transportation Document

Transportation Document

Keith Wheeler, Transportation Planner

1995

Transportation system development in the Middle Fork Willamette Downstream Tributaries Watershed began 1940's with facilities constructed for timber access of private lands by the Pope and Talbot Company, and by the Forest Service to access U.S. Government land. By early 1980's approximately 85% of currently existing roads in the Watershed were in place, with only relatively short local roads left to be constructed. There exists now about 540 miles of system road in the Watershed with a minor amount added each year. This existing road system includes 43 miles of paved roads and 519 miles of aggregate surfaced roads.

Most of this transportation system (75%) was constructed prior to 1980, utilizing sidecast construction methods and usually made no provisions for fish passage. These methods represented state-of-art road construction practices at the time. Many of our roads are now about 20 years old, which is about the right age for latent construction defects to begin showing up as road failures. Woody material in fills will have rotted and begun to settle, side cast fills will have begun to creep and show edge cracks or fall away from culvert outlets.

There are approximately 540 miles of existing road within the Watershed providing access for a variety of commercial, administrative and recreation uses, including dispersed recreation sites, trailheads, campgrounds and the Middle fork Willamette River Basin.

This 540 miles of road includes 32 miles of maintenance level one roads, where recreational use is generally prevented; 423 miles of maintenance level two roads, where recreational use is discouraged; 43 miles of maintenance level three roads, where recreational use is accepted; and 43 miles of maintenance level five roads, where recreational use is encouraged.

This road system was constructed and has been maintained primarily with timber sale revenue up to now. However, greatly reduced timber sale activity in recent years has lead to an accompanying reduction in road maintenance deposits. Appropriated funding for road maintenance is also declining. There simply is not enough funding to maintain the entire road system to prescribed road maintenance standards.

Willamette National Forest average cost to maintain up to standards is $1960.00 per mile. Based on projected funding for FY96 of $207,500.00 for Rigdon Ranger

District, we could maintain approximately 106 miles of road throughout the District.

In recent years, the declining budget trend has forced us to make hard decisions on where to spend our maintenance dollars. As a way to keep the entire road system open, minimum levels of maintenance are performed. This type of maintenance approach leads to a general degrading of the road system, and especially of maintenance level two roads. Many roads are brushing in or showing signs of neglect, and increasing the risk of road failures due to lack of maintenance. Recent road maintenance costs for maintenance level one = $160 per mile; maintenance level two = $660 per mile and maintenance level three through five = $1140 per mile. If we used the cost of maintaining level two roads as an average, we could maintain about 314 miles of road per year, district wide. The roads in this Watershed represent 42% of the total miles of road on the Rigdon Ranger District.

All of this leads us to the point where were are at today. We must determine the transportation network needed to meet current resource management objectives. Some roads will have to be closed, some obliterated, some put into long term storage (decommissioned). All roads should be maintained at the lowest possible maintenance level.

These determinations can be best made within the framework of an Access and Travel Management Plan. This process is described in the Willamette National Forest "access and Travel Management Guide: and would be developed within the framework of the Willamette Forest Plan and the Northwest Forest Plan. Since District Road Management Objectives have not been updated recently, part of this interdisciplinary process would e the development of Road management objectives that reflect current Management Area direction, Standards and Guidelines, Best Management Practices, and the Aquatic Conservation Strategy objectives.

M

Appendix M

Geology and Soils Documents

Lower Middle Fork Willamette Watershed Analysis
Geology and Soil
August, 1995

Mark Leverton
Geologist

GEOLOGY AND SOIL
LOWER MIDDLE FORK WILLAMETTE

CHARACTERIZATION

The Lower Middle Fork Willamette Watershed Analysis area lies within the Western Cascade subprovince of the Cascade Range. For purposes of this report, the analysis area is divided into two areas by a line connecting Bearbones Mountain, Joe's Prairie and Buck Mountain. This division is based primarily on lithology and relevant geomorphic processes.

The northern area is composed primarily of pyroclastic rocks (tuffs and breccias) with minor amounts of lava flows and intrusions. This area has been tectonically sheared and hydrothermally altered to low-grade mineral assemblages. Soil derived from this parent material is often high in clay and silt content, thus generating colloids as an erosion product. The upper slopes are commonly steep with shallow soil overlying weak rock. Lower slopes tend to have a deeper soil profile with high clay and silt content. Slope failure mechanisms range from debris flows in the steep upper slopes and drainage sidewalls to deep-seated landslides in the lower slopes.

The southern area is composed predominantly of basaltic and andesitic lava flows. Soils derived from this parent material tend to be granular, i.e., silty sand with rock fragments, and generate sand, silt and a minor amount of colloids as erosion products. Upper slopes are frequently steep with shallow soil overlying massive rock. The dominant failure mechanism in this area is debris flows coming off the steeper valley sidewalls.

The remnants of alpine glaciation are evident in the southern reaches of Coal Creek and the upper end of Buck Creek (Warner Mountain area). Broad, U-shaped valleys are being reshaped by streams which are modifying the valley configuration by either incising downward or eroding headward as shown in Coal Creek and Buck Creek respectively. Another, less obvious remnant of alpine glaciation is the tremendous amount of cobble and boulder-rich alluvium which occupies the Middle Fork Willamette channel and sideslopes.

REFERENCE CONDITION

Pre-management (reference) conditions were established by reviewing older air photo sets (1946, 1955 and 1959). Most of the analysis area was unroaded, particularly in the upper reaches of streams and on the ridgelines. Large, contiguous stands of timber predominated the area with the exception of Willow Creek, Coffeepot Creek, Buck Creek and the privately owned parcels in the lower reaches of Indian Creek.

Debris flows were used as the primary evaluation mechanism for determining the reference or baseline condition of the analysis area. Debris flows typically occur on steep ground with shallow, rocky soil. 66% of the analysis area fits this criteria and is evenly distributed throughout the analysis area.

A comparison was made between events which occurred in unroaded, unharvested areas that appeared in sequentially younger air photo sets. For purposes of this report, these are referred to as "natural" or "naturally occurring". Of the 9 events noted, 8 appeared between 1959 and 1967, presumably in conjunction with the 1964 flood (a 100-year event).

Evidence of numerous "pre-historic" debris flows was noted, although there was no clear means of determining whether they occurred 100 years ago or 1000 years ago. Because of this ambiguity of a time reference, these slides were not used for comparative purposes with more recent slide events. They do, however, indicate the spatial distribution as compared to processes which may no longer be in effect, i.e., glacial retreat, different climate, etc.

Of the 9 naturally occurring debris flows, 4 were located in the Bohemia Creek drainage. The remaining 5 were distributed evenly among Estep, Gold, Snake, Indian and Deadwood Creeks. None of the pre-historic debris flows were reinitiated and the areas which had the highest frequency of pre-historic events had no new initiations during this time span.

Since all but one of the slides occurred in conjunction with a non-periodic storm event (100 year floods don't occur every 100 years), a further attempt was made to determine the frequency of debris slide events by enlarging the reconnaissance area to include the entire Rigdon Ranger District. Again, no recent naturally occurring debris flows were noted between 1955 and 1991.

With two exceptions, active slope movements involving deep-seated failure mechanisms were not apparent. Field experience in the analysis area has shown that there are numerous deep-seated landslides which have been active during the span of time covered by the photo sets, but the rate or size of movement is not great enough to exhibit signs obvious enough to been seen in the photos. The exceptions mentioned earlier are large landslides located at the confluence of Powder / Buck Creeks and the vicinity of Windfall Lake.

CURRENT CONDITION

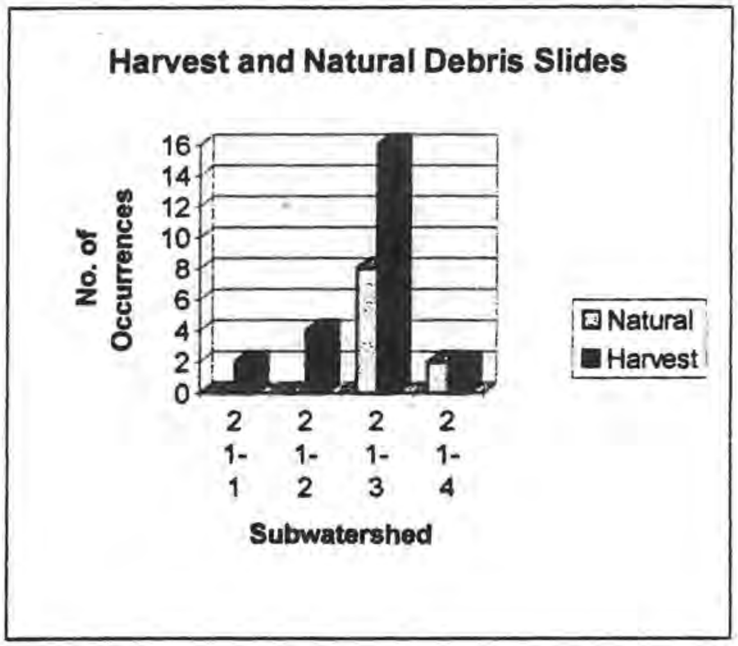
Vegetation manipulation , especially clearcut harvesting and associated road construction, has affected the spatial and temporal distribution of landslide occurrences, particularly with respect to debris flows. A listing of slope failures identified during this analysis is included in Appendix M1.

Harvest Related Landslides

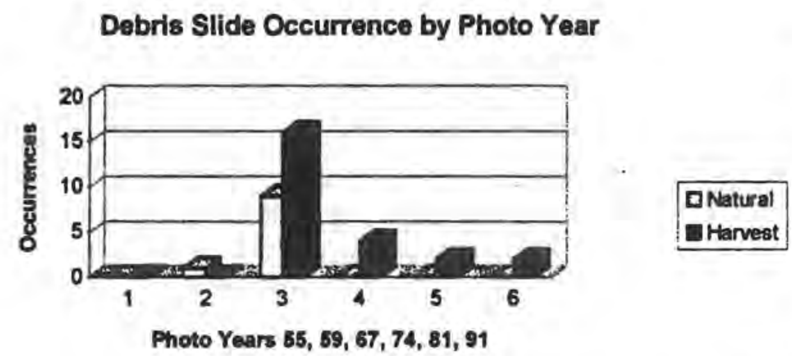
Clearcut harvesting on steep slopes with shallow, rocky soil reduces root strength and increases groundwater height until such time as the area recovers vegetatively (approximately 5 to 20 years). During this window of time, the probability of shallow, rapid slope failure on steep ground is significantly increased.

Approximately 66% of the Watershed Analysis area is characterized by steep ground with shallow, rocky soil. Between 1940 and 1995, approximately 26,219 acres have been harvested in this geomorphic setting using clearcut methods (including Private land). Approximately 45% of this harvest occurred between 1980 and present. This implies that 11,720 acres of steep ground with shallow, rocky soil are in some stage of redeveloping pre-harvest root strength and groundwater levels and is therefore at elevated risk of producing a debris slide. Of this, approximately 5,400 acres are on Private land, most being in the Packard Creek drainage.

Air photo reconnaissance spanning 1955 to 1991 indicates that 88% (21 of 24) of harvest related debris flows occur in the geomorphic category described above. Bohemia Creek and Buck Creek drainages have had 6 occurrences apiece; Windfall Creek and Indian Creek drainages have each had 2 occurrences; Short Ridge, Gray, Bull, Willow, Coffeepot, Coal and Deadwood Creeks have each had 1 occurrence.



Of the 24 harvest related debris flows mentioned above, 16 appeared in the 1967 photos, presumably in conjunction with the 1964 flood. Four were identified in the 1974 photos and 2 each in the 1981 and 1991 photos.



Deep seated landslides typically occur in clayey soils. The failure mechanism is less dramatic than with debris slides and therefore more difficult to identify using air photos. Like debris flows, landforms that contain significant amounts of clay are more prone to slope failure with vegetation removal. Even though the transport distance and energy are less than with debris slides, deep seated landslides create a persistent input mechanism of suspended sediments, thus affecting water quality and spawning habitat.

Approximately 11% of the analysis area is characterized by deep, clay soil usually on gentle, hummocky ground. Between 1940 and 1995, approximately 5904 acres of this area have been harvested using clearcut methods (including Private land). Approximately 38% of this harvest occurred between 1980 and present which implies that 2230 acres of clayey soil are in some stage of redeveloping pre-harvest groundwater levels. Unlike debris slides, the deep seated landslides take much longer to redevelop pre-failure shear strength regardless of whether they are revegetated or not. Therefore, sediment input occurs long after slope failure.

Known deep seated landslides which have either been aggravated or initiated by harvest activity occur in the headwaters of Bull Creek (Tufti Mountain), Modoc Creek, Tea Creek, Powder/Buck Creek, Windfall Creek, Big Willow Creek, and Coffeepot Creek. Tufti Mountain and Powder/Buck Creek are two of the more spectacular landslides.

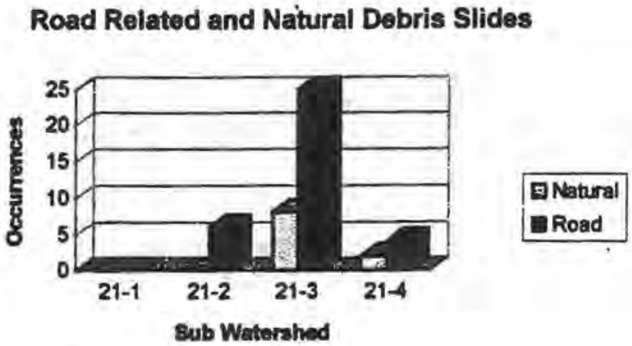
Road Related Landslides

Road construction in conjunction with timber harvest has affected the spatial and temporal distribution of landslide occurrences within the Lower Middle Fork Willamette Watershed Analysis area. Road related debris slides, localized cut and fill failures, and road locations through soils which generate persistent suspended sediment have affected the distribution of large woody material and the quality of spawning gravel within the aquatic domain.

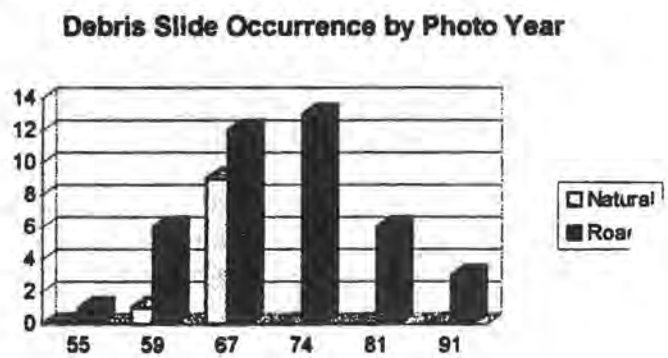
Road construction practices prior to 1980 included sidecast fills and less stringent aggregate surfacing quality standards. It was during this era when most of the road system was constructed in steep ground. The result of this was an increase in the number of debris slides soon after construction, particularly in draws, and a delayed reaction of approximately 20 years after construction when the wood buried in the sidecast fills decays. Much of the road system within the watershed analysis area is currently undergoing this delayed failure reaction.

Approximately 66% of the Watershed Analysis area is characterized by steep ground with shallow, erosive soil. Between 1940 and 1995, roughly 285 miles of road were constructed through this terrain with the vast majority being built prior to 1980. Peak road construction occurred in the 60's and 70's using sidecast construction techniques.

Air photo reconnaissance spanning 1955 to 1991 indicates that 93% (28 of 30) of road related debris slides occur in the geomorphic category described above. Windfall, Bohemia and Snake Creeks each had 5 or more occurrences of varying sizes. Bohemia Creek appeared to have been the most impacted, with several large debris slides which initiated at the top of the drainage soon after the construction of Rd. 5850. Other creeks which have been directly affected are Larison, Packard, Zup, Coffeepot, Gold, Spring Butte, Buck, Coal and Deadwood.



Of the 35 road related debris slides, 12 appear in the 1967 photos, presumably a combined effect of recent construction and the 1964 Flood. The fact that 13 new initiations appear in the 1974 photos and 6 in the 1981 photos is interpreted to imply that debris slide occurrence may be as much a product of the construction technique as it is of large storm events. The trend also indicates that the number of occurrences is declining.



However, outside edge cracking and displacement of sidecast fills is commonly observed on much of the road system located on steep ground. It is expected that the frequency of occurrence of road related debris slides will decline to some level, but will continue to occur.

Road construction through soils with high clay content have altered the spatial and temporal distribution of chronic sediment sources by providing point sources (cut and fill failures) and by expansion of the drainage network (ditches).

Approximately 11% of the analysis area is characterized by clayey soils, usually on gentle slopes. The vast majority of this is located in Subwatersheds 21-2 and 21-3. 65.2 miles of road have been constructed in this geomorphic setting, not including spur road construction on early harvest units and on Private land. Slope failure mechanisms inherent to this setting are usually localized cut and fill rotational landslides. These slope failures tend to be persistent sediment sources.

An accurate count of the total number of occurrences of these types of slope failures is not possible due to dispersed and lost records of treatments. One can assume that the distribution pattern through historical times has mimicked the road construction history, since slope failures in this setting tend to occur soon after construction. The most recently constructed roads in clayey soils occurred with the harvest of Shady Beach Fire and spurs associated with the harvest of Packard Creek drainage (Private land).

Road / Stream Crossings

Approximately 560 culverts have been installed within the analysis area where roads cross Class 1 through 4 streams as currently identified. At least four times that amount exists when ditch relief culverts are considered. Many of the culverts originally designed to allow fish passage have lost that ability due to outlet scour or different velocity and distance design requirements than currently used. In addition, most pipes were originally designed to carry a 50-year storm event if they were designed at all.

Sub Watershed	Class 1	Class 2	Class 3	Class 4
21-1	2	5	16	33
21-2	0	10	48	181
21-3	8	33	44	110
21-4	2	5	35	35

Inventory and analysis of 44 culverts within the Watershed Analysis area indicates that 43% will overtop the fill during a 100-year flood event. This value is consistent with findings for 153 culverts analyzed on timber sale haul routes on Oakridge and Rigdon Ranger Districts, the majority of which are located adjacent to the main stems of the Middle Fork Willamette, Hills Creek, Salmon Creek and the North Fork of the Middle Fork Willamette. A summary chart of culvert condition surveys is included in Appendix M4.

At this point in time, it is unknown which undersized culverts pose a substantial risk for fill breach or significant diversion of water to adjacent relief culverts.

INTERPRETATION

Sidecast road construction techniques on steep ground with shallow, rocky soil has resulted in a 350% increase in debris slides above natural conditions. As stated under Vegetation Manipulation, the analysis area has also had a 240% increase above natural conditions in harvest related debris slide occurrence.

Roads

The majority of road related debris slides occurred in the Little Pine West Subwatershed and affected Windfall, Bohemia and Gold Creeks the most frequently with 5 or more occurrences each since 1959. The next most impacted stream is Coal Creek with 3 occurrences during the same period.

The frequency of occurrence appears to be declining, however numerous locations on the road system in steep ground are showing signs of outside edge cracking, presumably associated with the decomposition of organic material in the sidecast fills. The emphasis of maintenance activities in these areas has been to control road surface runoff by insloping and frequent cleaning of the ditches. Declining timber sale funding opportunities is expected to result in less frequent maintenance in these areas which is likely to result in continued road related debris slides.

The frequency and distribution of slope movement in clayey soil has mimicked the construction history (roads and spurs). Slope failure tends to occur relatively soon after construction. Many of the older cut and fill failures have been stabilized with surface and subsurface drainage modification, buttresses, biotechnical techniques, etc. Some have been of a scale too large to deal with effectively (Tufti Mountain and Powder Creek).

Relatively recent construction in clayey soils in the Shady Beach Fire and Packard Creek is expected to be the areas with the greatest likelihood of future slope movement. Although the failure mechanism is less dramatic than a debris torrent, slope failure in this geomorphic setting generates persistent fine-grained sediment.

Road / Stream Crossings

Only 8% of the culverts within the Watershed Analysis area installed in Class 1 through 4 channels have been analyzed for flow capacity relative to a 100-year flood event. Preliminary results show that approximately 40% represent a strong likelihood of water overtopping the fill. This value is constant with results from culvert analyses outside the Watershed Analysis area on Oakridge and Rigdon Districts. However, the risks associated with overtopping of these culverts as well as those upslope have not yet been fully analyzed. This analysis, combined with the value of the downstream aquatic habitat and the need for fish passage is essential in developing a prioritization strategy for retrofitting or replacement of culverts.

Declining Maintenance Funding

As mentioned under TR 1&2, declining maintenance funds as a result of declining timber sale collections and appropriated money is expected to result in an increase in road related landslides. 42% of Rigdon Ranger District's 1200 miles of road are located within the Watershed Analysis area. At current funding levels, approximately 25% of the entire road system could be maintained at their current maintenance level. This funding level is expected to decline.

Timber Harvest

Harvest related debris slides have exceeded the natural background frequency by 240%. These landslides have occurred on steep ground with shallow, rocky soil, generally soon after clearcut harvesting. Including Private land, approximately 11,720 acres of the analysis area has been clearcut harvested in the past 15 years in this geomorphic setting, with roughly half of that within the past 10 years indicating a strong likelihood that harvest related slope failures will continue at some level above natural background until root strength and canopy intercept of precipitation are reestablished.

With current management direction toward the retention of more trees per acre than past harvest practices, the frequency of debris slides related to harvest activities is expected to approach natural conditions. This assumes that the effects of increased groundwater levels and loss of root strength are incorporated into the analysis and prescription.

This also applies to harvest activities on or upslope of clayey soils which have a tendency toward deep seated slope failure

RECOMMENDATIONS

Roads

- Develop an inventory of outside edge cracking on roads located on steep ground with shallow, rocky soil and cut/fill failures on recently constructed roads and spurs in clayey soil. This can be done by developing a simple form for district employees to carry with them when doing project work.

- Since we can't afford to keep all the roads open at their current maintenance level, assess potential resource impacts of the known unstable areas and those areas identified above to the value of the potentially affected terrestrial and aquatic domain and compare that with the impacts to the social domain (access) during development of an Access and Travel Management Plan. In other words, place the emphasis on the resource unless human access is important enough to warrant the expenditure of money for definitive stabilization.
- Rd. 5850 shows many areas of fill settlement which need to be treated in some fashion. Given that most of this road is near the Calapooya ridgeline and that slope failure will impact the North Umpqua drainage and the Lower Middle Fork Willamette, this work needs to be accomplished soon.

Road and Stream Crossings

Forest Plan direction states that "...existing culverts, bridges and other stream crossings determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100-year flood, including associated bedload and debris. Priority for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of a crossing failure."

- Further analysis is necessary to determine the capability of fills which are expected to overtop to withstand such an event. Bridges have already been designed to withstand a 100-year storm.
- Given that there are at least 560 crossings within the Watershed Analysis area, prioritization of inventory and analysis of crossings should be based on the identified value of the aquatic habitat downstream.
- If fish passage is not seen as an immediate need, but a desired condition at some point in the future, less expensive improvements to accommodate a 100-year flood (such as the addition of mid-fill culverts and retrofitting the existing culvert) should be considered until such time as a funding opportunity occurs for replacement.

Harvest

Vegetation manipulation has also increased mass wasting in many parts of the watershed. It is recommended that:

- additional precautions be exercised in continued harvest of unstable areas such as analysis of the effects of harvest on groundwater levels, retention of strategically placed green trees to provide root strength in potentially unstable areas, strategic placement of LWD to assist in retention of mobile soil before momentum is gained.
- biotechnical and geotechnical slope stabilization techniques be incorporated into slide treatments.
- Harvest related slides which are chronic sediment sources, i.e., Modoc Creek and Coal Creek areas, should be treated soon.

Lower Middle Fork Willamette Watershed Analysis
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Appendix A
Slope Failure Inventory

An inventory of slope failures based on air photo reconnaissance, file search, personal knowledge and discussions with District personnel.

Middle Fork Watershed Analysis

Landslide Data 6/8/95 mal

		Location			Affected	Photo			
Sub Shed	Slide #	Legal	Type	SRI	Drainage	Year	Elev	Road #	Remarks
21-1	1	21-3-21 NW/SW	Pre-Hist	301	MF Willamette		2400		
	2	21-3-29 NE/NE	Pre-Hist	301	MF Willamette		3000		
	3	21-3-29 SW/SE	PH / H	301	Short Ridge Cr	67	3100		
	4	21-2-34 NE/SW	R	313	Gray Cr		3600	5850	
	5	21-3-27 SW/NE	R	21	MF Willamette Trib	81	1800	2102-100	
	6	21-2-25 NE/NW	H	301	Gray Cr	67	1900		Debris Slide
21-2	1	22-2-3 NW/NW	R	16	Larison Cr		3700	5850	1982 Storm
	2	22-2-11 SW/NW	R	335	Larison Cr		3700	2102-101	1982 Storm
	3	22-2-15 NE/NE	R	313	Packard Cr		4400	2106-501	1982 Storm
	4	22-2-13 NE/NE	R	313	Packard Cr		3600	2106	1982 Storm
	5	21-3-31 NE/NE	R	201	Zup Cr		3100	2102-103	1982 Storm
	6	21-3-32 SE/NE	R	301	Zup Cr		2400	2102-101	1982 Storm
	7	21-3-32 SE/SE	RDS	31	Zup Cr	74	2400	2102-101	
	8	21-3-32 NE/NE	R	233	Zup Cr		3200	2102	Fill failure. Outside edge settlement
	9	22-3-3 SW/SW	R	25	Larison Cr		2000	2106	Fill Failure. Spring in ditchline
	10	22-3-3 SW/SW	R	25	Larison Cr		2000	21	Cutslope Failure below pond
	11	2-3-2 SE/NW	R	35	Reservoir		1500	2118	
	12	22-3-11 NE/SW	R	35	Reservoir		1500	2118	
	13	22-3-12 SE/SE	R	203	Bull Cr			2302	Cut failure stabilized with buttress
	14	22-4-7 SW/NW	R	203	Bull Cr			2302	Large fill and slope failure
	15	22-4-18 NW/SE	H	203	Bull Cr			2302-576	Shady Beach unit failure ca. '93

Failures

		Location			Affected	Photo			
Sub Shed	Slide #	Legal	Type	SRI	Drainage	Year	Elev	Road #	Remarks
21-2 cont.	16	22-3-13 SW/NW	R	35	Bull Cr			2118-552	Fill Failure
	17	22-3-24 SE/SW	R	33	Willow Cr		3200	2307-483	1982 Storm
	18	22-4-33 SW/SW	R	203	Coffeepot Cr		3800	2119-489	1982 Storm
	19	23-4-4 NW/NE	R	335	Coffeepot Cr		3800	2119-489	1982 Storm
	20	23-4-5 NE/SE	R	233	Coffeepot Cr		4000	2119-489	1982 Storm
	21	23-4-5 SE/NE	R	335	Coffeepot Cr		4200	2119-462	1982 Storm
	22	23-4-9 NW/SW	RDS	33	Coffeepot Cr	55	4800	2119-452	
	23	23-4-8 SE/SE	H	335	Coffeepot Cr	81	4700		
	24	23-4-8 NW/SE	R	201	Coffeepot Cr		4400	2119-521	
	25	23-4-6 SW/NE	RDS	201	Coffeepot Cr	81	3000	2119-486	
	26	23-4-6 SW/SW	PH	201	Coffeepot Cr		3600		
	27	23-3-1 SE/NW	PH	201	Coffeepot Cr		3200		
	28	23-3-1 SE/NW	PH	201	Coffeepot Cr		3200		
	29	23-3-1 SW/SW	R	201	Coffeepot Cr		2800	2119-480	1982 Storm
	30	23-4-6 NW/NW	R	203	Coffeepot Cr		3100	2118-479	1982 Storm
	31	22-4-31 SE/SW	PH	203	Coffeepot Cr		3200		
	32	22-4-31 SW/NE	R	203	Coffeepot Cr		2600	2118-479	1982 Storm
	33	22-4-31 SW/SW	R	203	Coffeepot Cr		2400	2118-479	1982 Storm
	34	22-4-31 SW/SW	PH	203	Coffeepot Cr		2900		
	35	22-3-36 SE/SE	PH	310U	Coffeepot Cr		2900		Stone Mtn
	36	22-3-36 NE/SE	PH	310U	Coffeepot Cr		3200		
	36A	22-3-36 SE/SE	R	301S	Coffeepot Cr		2400	2118-479	1982 Storm

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		Location			Affected	Photo			
Sub Shed	Slide #	Legal	Type	SRI	Drainage	Year	Elev	Road #	Remarks
21-2 cont.	37	22-3-36 SW/SW	R	301S	Coffeepot Cr		2300	2118-479	1982 Storm
	38	22-3-36 SW/SW	R	301S	Coffeepot Cr		2200	2118-479	1982 Storm
	39	22-3-33 SW/SE	H	201	Reservoir	91	2400		
	40	23-3-4 NE/NW	PH	201	Reservoir		2400		
	41	23-3-4 NW/NE	PH	201S	Snow Cr		2500		
	42	22-3-33 SW/SW	PH	201S	Snow Cr		2700		
	43	22-3-32 SW/SW	PH	301	Snow Cr		2800		
	44	23-3-5 NE/SE	PH	301	Snow Cr		2600		
	45	23-3-5 NE/SE	PH	301	Snow Cr		2600		
	46	23-3-5 NE/SW	PH	301	Snow Cr		2600		
	47	23-3-5 NE/SW	R	301S	Snow Cr		2800	2117-153	
	48	23-3-5 NW/SW	PH	301	Snow Cr		2600		
	49	22-3-31 SE/NE	R	212	Packard Cr		3700	2110-131	1982 Storm Pvt Land
	50	22-2-36 NE/NW	RDS	313	Packard Cr	91	3600	2110-131	Pvt Land
	51	22-3-1 NE/SW	RDS	203	Reservoir	67	2400	2102-557	
	52	22-3-36 NE/NE	H	602	Willow Trib	67	2800		
	53	22-2-3 NE/SW	RDS	313	Larison Cr	67	4400	5850	RDS initiates stream DS
21-3	1	23-2-2 SW/NE	R	301	Windfall Cr		4200	2117	1982 Storm Cut Failure
	2	23-2-1 SW/NE	RDS	301	Windfall Cr	81	3600	2117	
	3	23-2-12 NW/SE	R	301	Windfall Cr		3500	2117	1982 Storm
	4	23-2-12 NW/SW	PH	31S	Gold Cr		3800		
	5	23-2-11 SE/NE	PH	31S	Gold Cr		4100		
	6	23-2-13 NW/NW	R	31S	Gold Cr			2117-143	1982 Storm
	7	23-2-14 NE/SW	RDS	31S	Gold Cr	74		2117-143	
	8	23-2-14 NE/SW	R	356	Gold Cr			2117-143	1982 Storm

Failures

		Location			Affected	Photo			
Sub Shed	Slide #	Legal	Type	SRI	Drainage	Year	Elev	Road #	Remarks
21-3 cont.	9	23-2-23 NW/SE	RDS	313	Bohemia Cr	74	3200	5850-143	
	10	23-2-23 C	RDS	313	Bohemia Cr	67	3300	2117-143	
	11	23-2-23 SE/SW	R	316	Bohemia Cr	67	4000	5850	
	13	23-2-25 SE/NW	H	313	Bohemia Cr	81	3400		
	14	23-2-25 SW/SE	N	301	Bohemia Cr	67	4000		
	15	23-2-26 SE/NE	N	313	Bohemia Cr	67	3600		
	16	23-3-19 C	H	8	Bohemia Cr	67	2800		Pvt Land
	17	23-3-19 SW/SE	RDS	203	Bohemia Cr	67	2800	2117-180	Pvt Land
	18	23-3-20 NW/SW	RDS	8	Bohemia Cr	74	2800	2117-185	
	19	23-3-17 NE/SW	RDS	313	MF Willamette	91	2800	2117-152	Pvt Land
	20	23-3-17 NE/SE	RDS	313	MF Willamette	91	2400	2117-138	Pvt Land
	21	23-3-8 SW/SE	R	313	Gold Cr			2117-138	
	22	23-3-18 NE/NE	R	31S	Gold Cr			2117	1982 Storm
	23	23-3-8 SE/NE	RDS	301	Windfall Cr	67	2400	2117-020	
	24	23-3-8 SW/NE	H	301	Windfall Cr	67	2200		
	25	23-3-8 SE/NW	H	301	Windfall Cr	67	2400		
	26	23-3-8 SE/NW	RDS	301	Windfall Cr	67	2800	2117	
	27	23-3-7 SE/NE	RDS	301	Windfall Cr	67	2800	2117	
	28	23-3-7 SW/NE	RDS	301	Windfall Cr	67	2800	2117	
	29	23-3-7 SE/NW	RDS	301	Windfall Cr	74	2800	2117	
	30	23-3-7 SW/NW	RDS	301	Windfall Cr	81	2800	2117	
	31	23-3-18 SW/NW	PH	313	Gold Cr		2800		
	32	23-3-7 SW	PH	31S	Gold Cr		2800		
	33	23-3-7 SW/SE	PH	31S	Gold Cr		2800		
	34	23-3-7 SE/SE	PH	31S	Gold Cr		2500		
	35	23-3-18 NW/SE	PH	313	Gold Cr		3000		
	36	23-3-17 NW/SW	PH	313	Gold Cr		2800		
	37	23-3-17 SE/NW	PH	313	Gold Cr		2900		

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		Location			Affected	Photo			
Sub Shed	Slide #	Legal	Type	SRI	Drainage	Year	Elev	Road #	Remarks
21-3 cont.	38	23-3-17 SE/NW	PH	313	Gold Cr		2900		
	39	23-3-18 SE/SW	PH	301S	Bohemia Cr		2800		
	40	23-3-18 Se/SE	PH	310U	Bohemia Cr		2800		
	41	23-3-31 SE/SW	RDS	301	Snake Cr	81	3200	2127-288	Pvt Land
	42	23-3-31 SE/SW	RDS	301	Snake Cr	81	3200	2127-288	Pvt Land
	43	23-3-31 SW/SE	RDS	31	Snake Cr	74	3300	2127-288	Pvt Land
	44	23-3-32	RDS	301S	Snake Cr	81	2600	2127-182	Pvt Land
	45	23-3-33 SE/SW	RDS	31S	Spring Butte Cr	74	3000	2127-187	Pvt Land
	46	23-3-33 SE/SW	RDS	31S	Spring Butte Cr	74	3000	2127-187	Pvt Land
	47	24-3-9 NE/NE	H	301	Indian Cr	74	2200		Pvt Land
	48	24-3-10 NW/NW	R	301	Indian Cr			2125	82 Slide
	49	24-3-10 NW/NW	R	301	Indian Cr			2125	82 Slide
	50	24-3-10 SW/SW	R	301				2125	82 Slide
	51	23-3-35 NW/SW	R	316	Dry Cr				82 Slide, Fill Failure
	52	23-3-22 SE/NE	R	233p	Estep Cr			2124-171	Parch TS, Fill Failure
	53	23-3-23 NW/NW	N	616	Estep Cr	67	3600		
	54	23-3-13 SW/SW	H	201	Buck Cr	67	400		
	55	23-4-19 NE/NW	R	335	Buck Cr		4000	2120	82 Slide, Cut Failure
	56	23-4-17 C	H	71	Buck Cr	74	5400		
	57	23-3-13 NE/NW	N	35	Powder/Buck Cr	46	2800		Powder Cr Slide
	58	23-3-13 NE/NW	RDS	35	Buck Cr	74	2800	2120	
	59	23-3-12 SW/SW	R	335	Tea/Buck Cr		3500	2119	82 Storm
	60	23-3-11 SE/NE	R	313	Noon/Buck Cr		2800	2120	82 Storm
	61	23-3-10 NE/NE	R	33	Buck			2120	82Storm
	62	23-2-25 SW/NW	H	313	Bohemia Cr	67	3800		
	63	23-2-25 SE/NW	H	313	Bohemia Cr	67	3800		
	64	23-2-30 SW/NW	H	301	Bohemia Cr	67	3800		
	65	23-2-23 NW/SE	N?	313	Bohemia Cr	67	4200		

Failures

		Location			Affected	Photo			
Sub Shed	Slide #	Legal	Type	SRI	Drainage	Year	Elev	Road #	Remarks
21-3 cont.	66	23-2-12 NE/SE	N	31 S	Gold Cr	67	2800		
	67	23-2-26 NE/NW	RDS	6	Bohemia Cr	67	4000	5850	
	68	23-3-19 NE/SE	H	8	Bohemia Cr	67	2800		
	69	23-2-36 SW/SE	RDS	301	Snake Cr	67	3600	5850	
	70	23-3-31 SW/NW	N	301 S	Snake Cr	67	3600		Pvt Land
	71	24-3-4 NW/SW	RDS	212	MF Willamette	67	2800	2127-190	
	72	24-3-17 NE/NE	H	233	Indian Cr	67			Pvt Land
	73	24-3-18 SE/NW	N?	301	Indian Cr	67			
	74	23-4-20 SE/NW	H	201	SF Buck Cr	67	4600		Big!
	75	23-4-20 SE/NW	H	201	SF Buck Cr	67	4600		
	76	23-4-18 NW/SE	H	335	SF Buck Cr	67	4600		
	77	23-4-17 NW/SW	RDS	210 U	NF Buck Cr	67	4800		
	78	23-4-18 SW/NW	H	201 S	Buck Cr	67	4000		
	79	23-3-20 SW/NW	N?	301	Bohemia Cr	59	2000		Equipment in creek?
	80	23-2-1 W 1/2	N	35	Windfall Cr/Lake	59	4000		Active margin of old earthflow
21-4	1	24-3-1 SW/NE	PH	3	Deadhorse Cr		2800		
	2	24-3-15NW/SE	R	335	Coal Cr			2133-211	82 Storm
	3	24-3-22 NE/NE	R	203	Coal			2133-210	82 Storm
	4	24-3-22 SE/SE	PH	203	Bristow		3000		
	5	24-3-27 NW/NW	PH	203	Bristow		3200		
	6	24-3-27 NW/NW	PH	203	Coal		3200		
	7	24-3-27 NW/SW	PH	203	Coal		3200		
	8	24-3-27 NW/SW	PH	203	Coal		3600		
	9	24-3-27 SW/SW	PH	203	Coal		3200		
	10	24-3-27 SE/SW	PH	203	Coal		3600		
	11	24-3-22 SE/SE	R	335	Coal			2133	82 Storm
	12	24-3-26 SE/SW	R	335	Coal			2133	
	13	24-3-36 NW/NW	PH	203	Coal		4900		
	14	24-3-26 SW/SW	RDS	203	Coal	74		2133	Sidecast Fill
	15	24-3-35 NW/NW	RDS	203	Coal	74		2133	Sidecast Fill

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		Location			Affected	Photo			
SubShed	Slide #	Legal	Type	SRI	Drainage	Year	Elev	Road #	Remarks
21-4 cont.	15	24-3-35 NW/NW	RDS	203	Coal	74		2133	Sidecast Fill
	16	24-3-35 NE/SW	RDS	2	Coal	74		2133	Numerous fill ravel
	17	24-3-35 SW 1/4	H	203	Coal	74			Adjacent to Creek
	18	25-3-3 SE/NE	RDS	203	Deadwood/Coal	74		2133-210	Deadwood Cr Fill Blowout
	19	25-3-3 SE/SW	H	614	Deadwood/Coal	74	3600		
	20	25-3-3 SE/SE	N	614	Deadwood/Coal	67	4000		
	21	25-3-2 SE/NW	R	33	Coal				82 Storm
	22	25-3-2 SW/SE	R	313	Coal				82 Storm
	23	25-3-11 SE/NW	N	301	Coal	67	4800		
	24	25-3-23 NW/SE	R	6	Coal				82 Storm
	25	25-3-23 NW/SE	R	6	Coal				82 Storm
	26	25-3-15 NE/NW	PH	714	Deadwood		5000		
	27	25-3-10 SW/SE	PH	714	Deadwood		5000		
	28	25-3-10 SE/SE	PH	6	Deadwood		5000		
	29	25-3-13 SE/SW	PH	3	Coal		6000		
	30	25-3-13NW/SW	PH	3	Coal		6000		
	31	25-3-13 SE/NW	PH	3	Coal		6000		
	32	25-3-13 SE/NW	PH	3	Coal		5600		
	33	25-3-13 SE/NW	PH	71	Coal		6000		
	34	25-3-13 NE/NW	PH	714	Coal		6000		
	35	25-3-12 SE/SW	PH	714	Coal		6000		
	36	25-3-12 SE/SW	PH	714	Coal		6000		
	37	25-3-12 C	PH	714	Coal		5600		
	38	25-3-12 SW/NE	PH	71	Coal		5600		
	39	25-3-1 NW/SE	PH	71	Coal		5200		
	40	25-3-1 SE/NE	PH	203	Coal		4600		
	41	25-3-1 NE/NW	PH	203	Coal		4400		
	42	25-3-1 NE/NW	PH	203	Coal		4800		

PH = Pre-Historic Debris Slide. Existing chutes which existed in earliest photo sets. Appearance stayed constant.

RDS= Road Debris Slide. Directly related to road construction, usually a fill failure.

R = Road Failure. Usually a localized cut or fill failure.

H = Harvest related debris slide. Associated with either harvest practice (suspension) or increased groundwater / decreased root strength.

N = Naturally occurring debris slide. Occurs on timbered ground away from the impacts of harvest or roads.

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Appendix B
Clearcut Harvest Acres by SRI Unit by Decade

Harvest acres by Decade, LMF WA,							
SubWshed	SRI	50-	60-	70-	80-	90-	Total
21-1	15		23.9	20.7			44.6
	162	11.2	41.1	1.1	8.3		61.7
	2			4.9			4.9
	201			2.5			2.5
	203		17.8				17.8
	21	2.2				26.0	28.2
	23	106.7	9.4			24.6	140.7
	233		4.0	31.4	33.4	3.0	71.1
	301	171.8	140.7	87.7	208.1	45.0	653.3
	313		30.6	160.0	106.8		297.4
	316		18.3	6.1			24.4
	335	6.1					6.1
	602			1.6		7.4	9.0
	61	7.0	2.2	8.3	15.2		32.5
	63			16.9			16.9
21-1							**1,411.7**

Harvest acres by Decade, LMF WA,								
SubWshed	**SRI**	**40-**	**50-**	**60-**	**70-**	**80-**	**90-**	**Total**
21-2	14	37.5			4.3			41.8
	2			34.0	12.8			46.8
	201	125.3	20.1	118.5	255.9	263.7	4.0	787.4
	203	207.4		3.6	7.2			218.2
	21	17.5			11.1	3.2		31.8
	212	107.6			6.7	44.1		158.4
	23	12.4			4.8	90.9	14.0	122.0
	233	356.5	26.9	36.3	370.3	349.3	117.0	1,256.2
	235			39.2	9.9	10.6		59.6
	3	4.9	2.9		1.8		4.3	13.8
	301			40.2	19.5	325.0	13.8	398.5
	301 S	32.4	35.1		38.2	33.1		138.7
	31				8.4	18.3		26.6
	310					8.2		8.2
	311	70.6			98.1	122.9	3.3	294.9
	313	67.8	146.3	208.5	333.7	715.5	202.8	1,674.6
	316		5.5	8.1	8.7			22.3
	31 S					15.1		15.1
	33	98.6	41.7	35.4	57.0	98.7	82.0	413.2
	335	197.8	223.1	66.3	285.1	261.6	39.3	1,073.1
	35	32.9		83.9	86.3	148.2	308.6	659.9
	44			2.2		65.2		67.4
	441			64.8		229.7		294.5
	6		2.0	35.6	3.0			40.5
	602	102.0			25.9	33.9	39.8	203.9
	61		7.4	7.8	43.1	17.8		76.0
	64			10.3	42.1			52.4
	71		7.3	104.9	75.5	77.0		264.7
	8					1.3	3.9	5.2
21-2								**9,492.2**

Harvest acres by Decade, LMF WA,								
SubWshed	SRI	40-	50-	60-	70-	80-	90-	Total
21-3	15		38.4	72.2	9.2	41.8		161.7
	15W		16.8					16.8
	16			33.2				33.2
	162		25.2		24.9			50.2
	164		289.3		36.8	185.6	131.0	642.5
	168				1.5			1.5
	17		18.3		18.7			37.0
	2		45.2	7.8				53.0
	201		271.3	68.9	46.8	219.2	12.0	618.2
	201 S		65.5		6.1	1.7		73.2
	21					57.0		57.0
	210 U				10.4			10.4
	212		123.4	87.4	171.4	129.9	5.0	517.1
	23	13.7	146.9	23.1	32.7	102.5	18.2	337.0
	233		134.4	2.6	230.3	73.9		441.2
	233 P			54.9	222.1	248.5	40.0	565.5
	235		112.2	12.7	92.6		19.4	236.9
	25		35.1		31.4			66.5
	3		51.5		1.1			52.6
	301		27.2	397.6	394.9	152.6	41.1	1,013.5
	301 S		135.3	32.8	29.0	69.2		266.4
	31			40.9	10.1	26.4		77.4
	310			7.4				7.4
	310 U		9.5	2.4	3.3	48.2		63.4
	313		225.3	198.4	417.2	687.8	6.5	1,535.2
	316			115.3	22.1	95.5	29.4	262.3
	31 S		44.2	99.7	422.7	46.7		723.4
	33	8.1		24.9	48.8	138.7		220.5
	335		40.3	84.0	143.8	56.6		324.7

Harvest acres by Decade, LMF WA,								
SubWshed	**SRI**	**40-**	**50-**	**60-**	**70-**	**80-**	**90-**	**Total**
21-3 cont.	35		65.3	19.5	15.1	131.0	9.0	239.9
	356		329.8	140.9	189.2	237.2		916.7
	44				11.6			11.6
	441		34.1	165.1	42.2	214.3		455.7
	444		173.9	9.8	189.8		1.8	375.2
	6		16.1	127.0	6.0	29.0		178.1
	602			3.1	46.5	20.2		69.8
	615			167.5	73.5	110.7		351.7
	616		58.6	21.4	82.6	150.6	60.3	373.5
	63		11.3	11.0				22.3
	7			4.6	6.4			11.0
	71		176.2	386.2	162.4	48.7		773.4
	710		3.6					3.6
	714			65.2				65.2
	73		70.5	49.9	31.8	45.2	14.7	212.1
	75		115.5	32.2	73.4	14.3		235.4
	8		1.6	100.2	12.8	5.1		119.6
21-3								**12,895.2**

Harvest acres by Decade, LMF WA,							
SubWshed	SRI	50-	60-	70-	80-	90-	Total
21-4	1		15.9	2.1			17.9
	15	9.0		15.1	1.1		25.1
	16		70.5	8.4	16.7		95.6
	17		54.2		13.5		67.7
	2		23.2		8.7		32.0
	201		58.7		67.5		126.1
	203	49.9	43.4	186.9	316.1	4.9	601.1
	212		11.2	37.4	84.7		133.3
	23		9.2	19.9	1.1		30.2
	233		38.2	84.4	18.2		140.8
	235	38.6	16.2	23.7	50.3		128.8
	3		39.2	12.3	31.9		83.4
	301		107.1	4.1	35.2		146.4
	31		14.6	4.0	5.6		24.2
	313		88.7	23.2	95.8		207.7
	316				41.1		41.1
	33	1.1	144.3	38.6	157.8	20.3	362.1
	335	32.7	74.8	50.9	3.3		161.7
	335 P			46.3	35.9		82.2
	35		47.5				47.5
	444		94.9	32.9	130.2	58.3	316.2
	6		9.4	51.5	3.5		64.5
	61				9.0		9.0
	614		115.3	33.4	88.9		237.7
	615		53.2	114.3	135.3	39.2	342.0
	71		7.9	46.1	107.7		161.7
	714		167.6	313.9	108.5		590.0
	73			14.3			14.3
	74		15.5	23.6	32.5		71.6
	75		47.2	18.0	102.6		210.7
21-4							**4,572.5**

Total Harvest Acres by Decade, LMF WA	
21-1	1,411.7
21-2	9,492.2
21-3	12,895.2
21-4	4,572.5
Total Acres	**28,371.6**

Lower Middle Fork Willamette Watershed Analysis
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Appendix C
Road Miles by SRI Unit by Subwatershed

Road Miles By			SRI Category						Severe
Sub-Watershed	SRI	Type	1	2	3	4	5	Total	Erosion
21-1		Category Total	0.36	1.89	14.47	5.28	32.55	54.55	13.31
	14	Road	0.00	0.00	0.00	0.00	2.38	2.38	
	15	Road	0.00	0.00	0.00	0.00	17.73	17.73	
	16	Road	0.00	0.00	0.00	0.00	0.18	0.18	
	162	Road	0.00	0.00	0.00	0.00	3.57	3.57	
	201	Road	0.00	0.00	0.04	0.00	0.00	0.04	
	203	Road	0.00	0.00	0.11	0.00	0.00	0.11	
	21	Road	0.00	0.00	2.33	0.00	0.00	2.33	
	212	Road	0.00	0.00	0.00	0.18	0.00	0.18	
	23	Road	0.00	0.00	0.00	0.00	5.57	5.57	
	233	Road	0.00	0.00	0.00	0.00	2.71	2.71	
	235	Road	0.00	0.69	0.00	0.00	0.00	0.69	
	25	Road	0.36	0.00	0.00	0.00	0.00	0.36	
	3	Road	0.00	0.00	.63.	0.00	0.00	0.00	
	301	Road	0.00	0.00	9.08	0.00	0.00	9.08	
	31	Road	0.00	0.00	0.01	0.00	0.00	0.01	
	313	Road	0.00	0.00	0.00	5.10	0.00	5.10	
	316	Road	0.00	0.00	0.47	0.00	0.00	0.47	
	335	Road	0.00	1.20	0.00	0.00	0.00	1.20	
	6	Road	0.00	0.00	0.75	0.00	0.00	0.75	
	602	Road	0.00	0.00	0.09	0.00	0.00	0.09	
	61	Road	0.00	0.00	1.29	0.00	0.00	1.29	
	63	Road	0.00	0.00	0.00	0.00	0.41	0.41	
	8	Road	0.00	0.00	0.30	0.00	0.00	0.30	

Road Miles By			SRI Category						Severe
Sub-Watershed	SRI	Type	1	2	3	4	5	Total	Erosion
21-2		Category Total	13.07	14.73	81.86	36.50	74.65	220.81	49.76
	14	Road	0.00	0.00	0.00	0.00	0.59	0.59	
	15	Road	0.00	0.00	0.00	0.00	0.73	0.73	
	2	Road	0.00	0.00	0.37	0.00	0.00	0.37	
	201	Road	0.00	0.00	22.68	0.00	0.00	22.68	
	201 S	Road	0.00	0.00	1.55	0.00	0.00	1.55	
	203	Road	0.00	0.00	29.68	0.00	0.00	29.68	
	21	Road	0.00	0.00	1.91	0.00	0.00	1.91	
	212	Road	0.00	0.00	0.00	0.00	27.75	27.75	
	23	Road	0.00	0.00	0.00	0.00	19.41	19.41	
	233	Road	0.00	0.00	0.00	0.00	20.17	20.17	
	235	Road	1.27	0.00	0.00	0.00	0.00	1.27	
	25	Road	4.12	0.00	0.00	0.00	0.00	4.12	
	3	Road	0.00	0.00	0.50	0.00	0.00	0.50	
	301	Road	0.00	0.00	10.73	0.00	0.00	10.73	
	301 S	Road	0.00	0.00	2.20	0.00	0.00	2.20	
	31	Road	0.00	0.00	1.23	0.00	0.00	1.23	
	310	Road	0.00	0.00	0.10	0.00	0.00	0.10	
	310 U	Road	0.00	0.00	0.68	0.00	0.00	0.68	
	311	Road	0.00	0.00	0.00	3.95	0.00	3.95	
	313	Road	0.00	0.00	0.00	28.02	0.00	28.02	
	316	Road	0.00	0.00	0.46	0.00	0.00	0.46	
	33	Road	0.00	0.00	0.00	0.00	5.50	5.50	
	335	Road	0.00	14.73	0.00	0.00	0.00	14.73	
	35	Road	7.68	0.00	0.00	0.00	0.00	7.68	
	44	Road	0.00	0.00	0.00	1.48	0.00	1.48	
	441	Road	0.00	0.00	0.00	3.05	0.00	3.05	
	6	Road	0.00	0.00	0.77	0.00	0.00	0.77	
	602	Road	0.00	0.00	2.38	0.00	0.00	2.38	
	61	Road	0.00	0.00	1.75	0.00	0.00	1.75	
	64	Road	0.00	0.00	0.00	0.00	0.41	0.41	
	7	Road	0.00	0.00	0.00	0.00	0.09	0.09	
	71	Road	0.00	0.00	3.64	0.00	0.00	3.64	
	8	Road	0.00	0.00	1.23	0.00	0.00	1.23	

Road Miles By			SRI Category						Severe
Sub-Watershed	SRI	Type	1	2	3	4	5	Total	Erosion
21 3		Category Total	6.07	21.82	60.77	42.11	55.45	186.22	53.36
	15	Road	0.00	0.00	0.00	0.00	10.41	10.41	
		Private	0.00	0.00	0.00	0.00	2.28	2.28	
	15 W	Road	0.00	0.00	0.00	0.00	2.57	2.57	
	16	Road	0.00	0.00	0.00	0.00	0.26	0.26	
	162	Road	0.00	0.00	0.00	0.00	0.46	0.46	
	164	Road	0.00	0.00	0.00	0.00	7.12	7.12	
	168	Private	0.00	0.00	0.00	0.00	0.85	0.85	
	17	Road	0.00	0.00	0.00	0.00	0.58	0.58	
	2	Road	0.00	0.00	0.06	0.00	0.00	0.06	
	201	Road	0.00	0.00	6.93	0.00	0.00	6.93	
	201 S	Road	0.00	0.00	0.39	0.00	0.00	0.39	
	203	Road	0.00	0.00	2.82	0.00	0.00	2.82	
	21	Road	0.00	0.00	0.57	0.00	0.00	0.57	
	212	Road	0.00	0.00	0.00	3.30	0.00	3.30	
		Private	0.00	0.00	0.00	4.56	0.00	4.56	
	23	Road	0.00	0.00	0.00	0.00	2.61	2.61	
		Private	0.00	0.00	0.00	0.00	2.67	2.67	
	233	Road	0.00	0.00	0.00	0.00	1.72	1.72	
		Private	0.00	0.00	0.00	0.00	0.03	0.03	
	233 P	Road	0.00	0.00	0.00	0.00	7.66	7.66	
		Private	0.00	0.00	0.00	0.00	3.72	3.72	
	235	Road	0.00	1.72	0.00	0.00	0.00	1.72	
		Private	0.00	0.39	0.00	0.00	0.00	0.39	
	25	Road	0.68	0.00	0.00	0.00	0.00	0.68	
		Private	0.71	0.00	0.00	0.00	0.00	0.71	
	3	Road	0.00	0.00	0.35	0.00	0.00	0.35	
	301	Road	0.00	0.00	8.03	0.00	0.00	8.03	
		Private	0.00	0.00	1.16	0.00	0.00	1.16	
	301 S	Road	0.00	0.00	2.50	0.00	0.00	2.50	
	31	Road	0.00	0.00	2.32	0.00	0.00	2.32	
	310	Road	0.00	0.00	0.31	0.00	0.00	0.31	
	310 U	Road	0.00	0.00	0.87	0.00	0.00	0.87	

Road Miles By			SRI Category						Severe
Sub-Watershed	SRI	Type	1	2	3	4	5	Total	Erosion
21-3 cont.		Private	0.00	0.00	0.16	0.00	0.00	0.16	
	313	Road	0.00	0.00	0.00	19.50	0.00	19.50	
	316	Road	0.00	0.00	3.39	0.00	0.00	3.39	
		Private	0.00	0.00	1.81	0.00	0.00	1.81	
	31 S	Road	0.00	0.00	8.08	0.00	0.00	8.08	
	33	Road	0.00	0.00	0.00	0.00	5.10	5.10	
	335	Road	0.00	4.38	0.00	0.00	0.00	4.38	
	35	Road	2.31	0.00	0.00	0.00	0.00	2.31	
		Private	2.37	0.00	0.00	0.00	0.00	2.37	
	356	Road	0.00	15.33	0.00	0.00	0.00	15.33	
	44	Private	0.00	0.00	0.00	0.05	0.00	0.05	
	441	Road	0.00	0.00	0.00	4.07	0.00	4.07	
	444	Road	0.00	0.00	0.00	0.11	0.00	0.11	
		Private	0.00	0.00	0.00	3.14	0.00	3.14	
	6	Road	0.00	0.00	4.22	0.00	0.00	4.22	
	602	Road	0.00	0.00	4.22	0.00	0.00	4.22	
	615	Road	0.00	0.00	0.00	3.77	0.00	3.77	
	616	Road	0.00	0.00	0.00	1.90	0.00	1.90	
	63	Road	0.00	0.00	0.00	0.00	0.52	0.52	
	7	Road	0.00	0.00	0.00	0.00	1.21	1.21	
	71	Road	0.00	0.00	10.81	0.00	0.00	10.81	
	710	Road	0.00	0.00	0.33	0.00	0.00	0.33	
	714	Road	0.00	0.00	0.00	1.71	0.00	1.71	
	73	Road	0.00	0.00	0.00	0.00	3.38	3.38	
	75	Road	0.00	0.00	0.00	0.00	2.30	2.30	
	8	Road	0.00	0.00	1.44	0.00	0.00	1.44	

Road Miles By			SRI Category						Severe
Sub-Watershed	SRI	Type	1	2	3	4	5	Total	Erosion
21 4		Category Total	0.47	6.79	23.32	20.67	16.39	67.64	21.63
	1	Road	0.00	0.00	0.27	0.00	0.00	0.27	
	15	Road	0.00	0.00	0.00	0.00	0.46	0.46	
		Private	0.00	0.00	0.00	0.00	0.13	0.13	
	16	Road	0.00	0.00	0.00	0.00	1.32	1.32	
	17	Road	0.00	0.00	0.00	0.00	0.47	0.47	
	2	Road	0.00	0.00	0.16	0.00	0.00	0.16	
	201	Private	0.00	0.00	0.85	0.00	0.00	0.85	
	203	Road	0.00	0.00	8.49	0.00	0.00	8.49	
	212	Road	0.00	0.00	0.00	2.26	0.00	2.26	
	23	Road	0.00	0.00	0.00	0.00	0.34	0.34	
	233	Road	0.00	0.00	0.00	0.00	1.87	1.87	
	235	Road	0.00	1.88	0.00	0.00	0.00	1.88	
	3	Road	0.00	0.00	1.29	0.00	0.00	1.29	
		Private	0.00	0.00	0.49	0.00	0.00	0.49	
	301	Road	0.00	0.00	2.10	0.00	0.00	2.10	
	31	Road	0.00	0.00	1.25	0.00	0.00	1.25	
	310 U	Private	0.00	0.00	0.25	0.00	0.00	0.25	
	313	Road	0.00	0.00	0.00	1.47	0.00	1.47	
		Private	0.00	0.00	0.00	0.26	0.00	0.26	
	316	Private	0.00	0.00	2.97	0.00	0.00	2.97	
	33	Road	0.00	0.00	0.00	0.00	5.54	5.54	
	335	Road	0.00	3.50	0.00	0.00	0.00	3.50	
	335 P	Road	0.00	1.41	0.00	0.00	0.00	1.41	
	35	Road	0.47	0.00	0.00	0.00	0.00	0.47	
	444	Road	0.00	0.00	0.00	4.73	0.00	4.73	
	6	Road	0.00	0.00	2.58	0.00	0.00	2.58	
	610 U	Road	0.00	0.00	0.11	0.00	0.00	0.11	
	614	Road	0.00	0.00	0.00	3.24	0.00	3.24	
	615	Road	0.00	0.00	0.00	0.00	2.99	2.99	
	71	Road	0.00	0.00	2.51	0.00	0.00	2.51	
	714	Road	0.00	0.00	0.00	8.71	0.00	8.71	
	73	Road	0.00	0.00	0.00	0.00	0.34	0.34	
	74	Road	0.00	0.00	0.00	0.00	1.18	1.18	
	75	Road	0.00	0.00	0.00	0.00	1.75	1.75	

SRI Category 1: Clay soil on gentle slopes.
SRI Category 2: 50 - 60% Clay soil on gentle to moderate slopes.
SRI Category 3: Steep ground with shallow, rocky soil.
SRI Category 4: 50 - 60% Steep ground with shallow, rocky soil.
SRI Category 5: Other

6/95 mal

Lower Middle Fork Willamette Watershed Analysis
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Appendix D
Culvert Hydraulic Analysis for FY95 Timber Sales

Weeping TS

Culvert Assessment 5/30/95 mal

				Culvert			Flow Capacity		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2307	1.17		3	56	Bend			38			10	0	0	0	5		
2307	1.18		3	57	8	30	73	117	26	62	10	0	0	0	0.9	0.7	9.7
2307	1.45		3	49	12	35	55	115	30	48	20	5	0	0	0	0.6	11
2307	1.6		2	55	Bend			36			0	0	0	20	1.5		
2307	2.62		2	66	15	13	48	14	93	343	50	0	0	5	0.3	0.2	8.7
2307	3.03		4	48	7			105			0	15	15	30	0		
2307	4.45		2	Bend	Bend			73			90	0	0	0	0		
2307	5.16	Willow Cr. Trib	2	49	7	12	36	102	12	35	1	0	80	0	0	0.8	9.1
2307-475	0.17	Big Willow Cr.	4	84	6	68	204	225	30	91	0	0	0	0	2	0.9	10

Slinky TS

Culvert Assessment 5/30/95 mal

				Culvert			Flow Capacity		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2127	1.55	Spring Butte Cr	4	51	12	73	235	211	69	111	15	0	0	0	3	0.7	13
			4	51	13	73					0	2	0	0	3	0.7	13
2127	1.89	Spring Butte Cr.	4	49	6	73	317	183	80	173	15	0	50	0	2	0.8	9.4
			4	49	6	73					15	0	50	0	2	0.8	9.4
2127	3.8		4	52.5	7	64	183	32	200	572	0	0	0	5	0	0.3	5.3
2127-180	0.3	Snake Cr	5.7	47	3	175	538	677	51	79	10	0	0	0	4	1.7	10
			4	52	7	65					0	0	0	0	0	2.1	11
			4.7	57.5	3	105					0	0	0	0	4	1.9	11
2127-180	2.47		3	56	12	35	73	70	50	104	0	5	0	25	8	0.5	9.5
2127-180	2.6		3	42	5	33	44	47	70	94	0	2	0	10	0	0.5	6.5
2127-180	2.72		2	47	2	10	30	31	32	97	0	5	0	0	5	0.6	4.1
2127-180	3.22	Fir Cr.	4	140	9	65	294	44	148	668	0	3	0	5	0	0.4	6.8

Stonepot TS																	
Culvert Assessment 5/30/95 mal																	
				Culvert			Flow Capa city		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2118-479	0.95		2	102	15	12	40	31	39	129	0	0	0	0	2	0.3	8.8
2118-479	3.1		4	115	10	69	231	36	192	642	0	0	0	0	2	0.3	6.1
2118-480	0.09		2.5	60	11.5	25	49	123	20	40	0	0	15	0	0	0.5	17

Indigo Thin TS																	
Culvert Assessment 5/30/95 mal																	
				Culvert			Flow Capa city		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2135	0.57		3	63.5	12	35	94	75	47	125	0	1	0	1	3	0.5	10
2135	1.12		4	62.5	4	75	343	298	50	115	5	2	0	0	3	1.5	11
			4	62	3.5	75					0	8	0	0	3	1.2	9.2
2135	1.47		3	42	5	36	189	263	27	72	50	50	0	0	3	1.2	10
			3	50.5	2	36					60	60	0	1	3	1.5	7.3
2135-283	0.22	N Fk Simpson Cr	3	130	7	35	313	298	23	105	0	0	0	2	2	1.2	12
			3	127.5	8	34					0	60	0	5	3	1.1	13
2135-283	0.92	Simpson Cr.	6.25	54	2	219	390	731	30	53	0	10	0	0	4	1.9	9.3

Beaver Blues TS																		
Culvert Assessment 5/30/95 mal																		
				Culvert			Flow Capa city		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2153	0.01	Beaver Cr	9	67	7						0	5	0	0	3		
2153	0.35		5	50	7						0	0	0	0	1		
2154	0.9	Beaver Cr	8	103	18	400	507	909	44	56	40	10	0	0	6	1.1	22
2154	1.6		2	60	12	13	35	67	19	52	0	0	0	2	1	0.5	10
2154-380	1.89	Beaver Cr	4.5	31	8	87	124	868	10	14	0	0	0	0	1	1.8	15

Ambush TS																	
Culvert Assessment 5/30/95 mal																	
				Culvert			Flow Capa city		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2149	2.5	Pioneer Gulch	4	49	7						0	0	0	0	0		
2149-398	0.2	Pioneer Gulch	3	36	5	35	44	1412	2	3	0	0	0	0	1.5		

Boulderdash TS

Culvert Assessment 5/30/95 mal

				Culvert			Flow Capa city		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2120	4.89	Powder Cr	2.5	75	1	17	70	87	20	80	10	0	0	0	0	1	4.9
2120	4.98	Buck Cr	9.5	62	8	600	649	1098	55	59	2	10	0	10	8	1.5	15
2124	0.8	Estep Cr	5.33	63	7	140	257	272	51	94	10	5	0	1	1.5	0.8	12
2124	2	Pine Cr	5.5	77	7	162	449	270	60	166	10	0	0	0	5	0.8	11
2124	4.28	Pine Cr	5	87	10	125	346	228	55	152	2	0	0	0	0	0.7	13
2124	5.92	Pine Cr	4	45	10	70	136	199	35	68	0	0	0	0	0.5	0.8	12
2124-171	0.29	Pine Cr	3	62	20	36	81	178	20	46	0	0	0	0	0	0.6	16
2124-171	1.1	Estep Cr	4.5	55	16	101	147	144	70	102	0	0	0	0	1	0.5	13
2129	1.65	Youngs Cr	5.5	134	9	157	479	392	40	122	0	0	0	0	6	1	14
2129	4.71	Youngs Cr	6	164	7	194	595	120	162	496	10	0	0	0	0	0.6	8.2
2129	6.29	Pine Cr	4	46	8	70	129	137	51	94	5	0	0	0	0	0.7	10
2129	8.29	Buck Cr Trib	4	54	6	70	104	126	56	83	5	0	0	0	0	0.7	8.8
2129-429	0.85	Youngs Cr	6	116	14	190	525	350	54	150	0	0	0	0	2	0.8	16
2129-429	2.85	Boulder Cr	5	73	15	120	273	128	94	213	0	0	5	0	0	0.5	13

Tumble Thin TS

Culvert Assessment 5/30/95 mal

				Culvert			Flow Capa city		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2144	3.1	Fizz Cr	4	99.5	22	70	152	128	55	119	50		0	30	1	0.5	14
2144	3.91	Royal Cr	6.5	74	14	160	357	78	205	458	0		0	0	0.7	0.2	7.9
2144	5.36	Hayseed Cr	6	70	9	155	357	62	250	576	0		0	0	0	0.3	6.2
2144	5.41	Hayseed Cr Trib	6	69	16.5	200	220	87	230	253	10		0	0	0	0.3	8.5
2144	5.45		6	80	15	164	283	64	256	442	0		15	0	3	0.2	7.6
2144	5.56	Hayseed Cr	5.75	80	20	130	354	47	277	753	0	0	10	0	0	0.1	8.1

Mossback T.S.

Culvert Assessment 5/30/95 mal

				Culvert			Flow Capacity		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
2300	0.79	Shady Cr.	4	177.6	8	67	229	197	34	116	5	0	0	1	5.5	0.8	11
2300	2		3	35	8						0	0	0	2	1		
2300	2.72	Gate Cr.	3	74.67	13.5	34.5	70	131	26	53	0	3	0	2	8.5	0.6	12
2300	2.95	Crabapple Cr.	4	111.8	27	74.8	125	209	36	60	10	0	0	2	2	0.6	18
2300	3.53	Landes Cr.	5	66.07	5	141	290	469	30	62	0	0	0	0	0.5	1.3	11
2300	4.85	Skipper Cr.	2.5	40.05	5	20.1	39	135	15	29	0	0	0	10	0.25	0.9	8.7
2300	5.55		3.33	56	12						5	1	65	2	0.5		
2300	6.75	Warfield Cr.	10	103.7	12	693	1099	731	95	150	20	10	0	0	3	1	18
2300	6.9		1.5		8						0	2	0	2	0		
2300	7.25	TNT Cr.	6	139.5	23	154	713	81	190	880	60	5	75	1	0	0.2	9.5
2300	7.4	Burro Cr.	6.5	145.8	10	184	650	116	159	560	5	0	0	0	2	0.4	7.9
2300	8.09	Andy Cr.	6.5	116	7	202	573	152	133	377	10	0	0	1	2	0.6	8.8
2300	8.5		1.5	71	13						30	20	0	3	0		
2300	8.8	Tumbledown Cr.	6.5	60	10	230	297	164	140	181	0	0	0	0	1.5	0.6	9.7
2300	9.05		2.5	50	9						0	0	3	0	0		
2300	9.22	Pool Cr.	5	69.99	12	127	150	114	111	132	0	1	0	0	0	0.5	11
2300	9.8	Wolf Cr.	10	67.01	8	663	1126	568	117	198	5	0	10	0	0	1	14

Middle Fork Sales Rd. 21																	
Culvert Assessment 5/30/95 mal																	
				Culvert			Flow Capa city		Pipe	Fill	Inlet		Outlet			Q100/10	
Road No.	MP	Stream Name	Diam	Length	Slp %	Pipe	Fill	Q100	% Q100	% Q100	Plug %	Dent %	Plug %	Dent %	Drop	D	V
21	0.53		6	156	16	207	658	230	90	286	0	10	0	0	2	0.6	16
21	1.02		4	207	6	68	295	135	50	219	40	5	0	0	6	0.7	9
21	10.1		4	132	6	116	285	194	60	147	15	20	0	0	12	0.8	9.8
21	10.4		5	147	3	114		137	83	0	5	0	2	0	9	0.8	7
21	10.95		3	67	15						10	0	0	0	1.5		
21	12.04	Buck Cr.	2@ 8x6	53	3	723	977	1807	40	54	0	0	0	0	3	0.9	13
21	13.01	Cone Cr.	4	70	8	71	241	179	79	135	10	0	0	0	4.5	0.5	9
			4	70	8	71					10	0	0	0	4.5	0.5	9
21	13.55	Bills Cr.	4	53	7	73	116	73	100	159	5	0	0	2	0	0.5	8.1
21	14.5	Estep Cr.	4	109	10	144	395	359	40	110	0	5	0	0	4	0.7	12
			4	109	10						50	0	0	0			
21	15.3	Pine Cr.	5	51	7	147	131	367	40	36	0	2	0	0	1.1	1	12
21	16.4	Butcherknife Cr.	3	95	6	30	59	20	150	295	10	10	0	10	0	0.3	5.4
21	16.65	Boulder Cr.	4	55	10	80	113	224	36	50	10	3	0	0	3	0.8	12
21	18.7	Youngs Cr.	4	54	4	75	211	499	30	42	20	10	0	0	0.5	1.1	9.3
			4	54	4	75					20	5	5	0	2	1.1	9.3
21	19.7	Jims Cr.	3	48	5	35	55	59	59	93	0	0	0	0	8	0.5	6.8
21	20.2	Deadhorse Cr.	4	65	6	75	340	315	48	108	50	3	0	0	5	0.8	9.4
			4	65	6	75					50	0	0	0	5	0.8	9.4
21	23.4		3	84	8						10	0	0	0			
21	24.62		3	100	3						0	0	0	0			
21	26.51	Noisy Cr.	11.5	67	5	971	1087	971	100	112	0	0	0	0	1	1.4	13
21	27.45	Skunk Cr.	3	45.5	2	34	46	67	51	69	0	0	0	0	0.3	0.7	5.1
21	28.7	Indigo Cr.	6	110	6	192	455	160	120	284	0	0	0	0	2	0.7	9.1
21	29.3	Pioneer Gulch	11	134	8.5	882	1395	1763	50	79	0	1	0	0	3	1.7	18