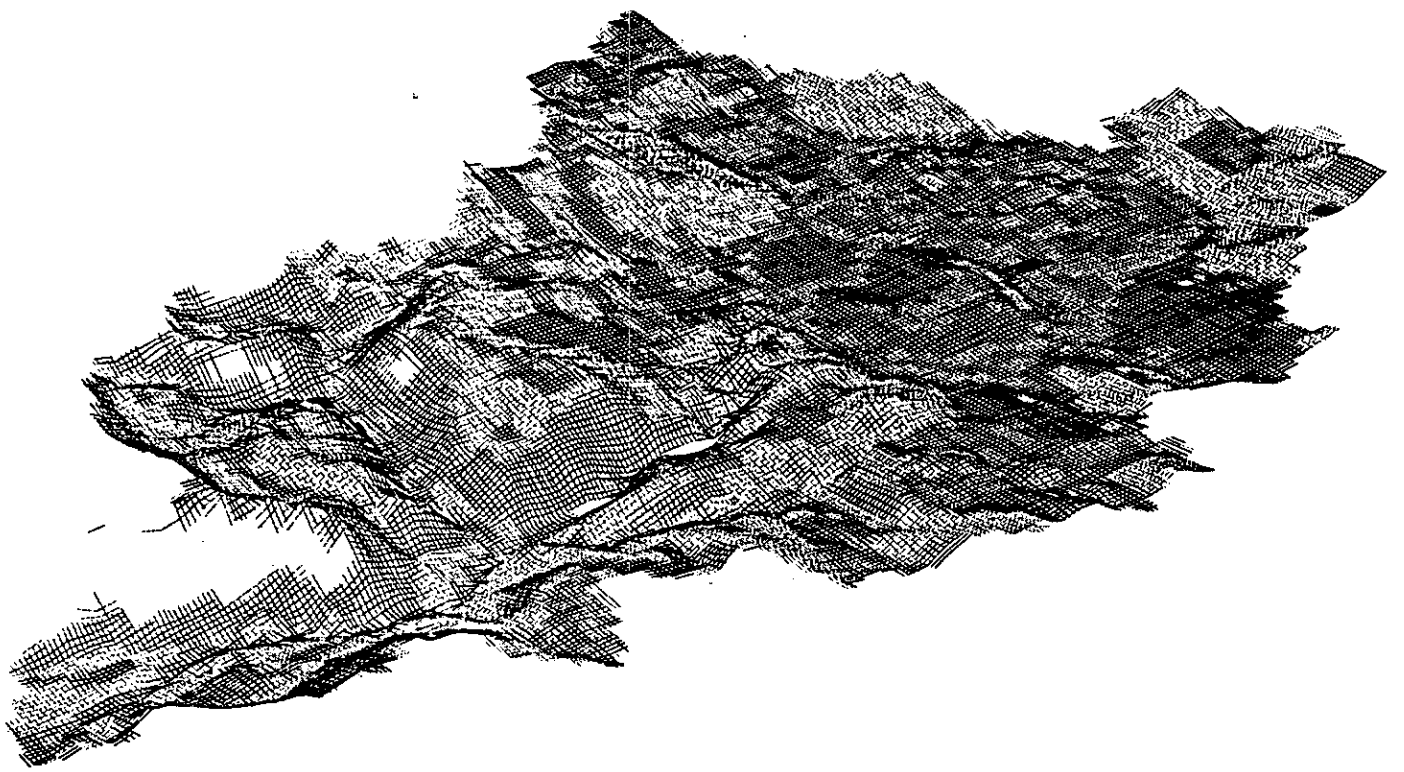
Oak Grove Watershed Analysis



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Introduction

Overview of Watershed Analysis

Watershed analysis is a procedure used to characterize the human, aquatic, riparian, and terrestrial features, conditions, processes and interactions within a watershed. It provides a systematic way to understand and organize ecosystem information. In so doing, watershed analysis enhances our ability to estimate direct, indirect, and cumulative effects of our management activities and guide the general type, location, and sequence of appropriate management activities within a watershed.

Watershed analysis is essentially *ecosystem analysis at the watershed scale*. As on of the principal analyses for implementing the Aquatic Conservation Strategy (ACS) set forth in the Northwest Forest Plan (*Record of Decision* (ROD) *for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl* (USDA, USDI 1994) it provides the watershed context for fishery protection, restoration, and enhancement efforts. The understanding gained through watershed analysis is critical to sustaining the health and productivity of natural resources. Healthy ecological functions are essential to maintain and create current and future social and economic opportunities.

Federal agencies are conducting watershed analyses to shift their focus from species and sites to the ecosystems the ecosystems that support them in order to understand the consequences of management actions *before* implementation. The watershed scale was selected because every watershed is a well-defined land area having a set of unique features, a system of recurring processes, and a collection of dependent plants and animals.

Watershed analysis is not a decisionmaking process. Rather it is a *stage-setting* process. The results of watershed analysis establish the context for subsequent decisionmaking processes, including planning, project development, and regulatory compliance.

The results of watershed analysis can be used to:

- Assist in developing ecologically sustainable programs to produce water, timber, recreation and other commodities.
- Facilitate program and budget development by identifying and setting priorities for social, economic. And ecological needs within and among watersheds.
- Establish a consistent, watershed-wide context for project-level National Environmental Policy Act (NEPA) analyses.
- Establish a watershed context for evaluating management activity and project consistency given existing plan objectives.
- Establish a consistent, watershed-wide context for implementing the Endangered Species Act and the Federal Clean Water Act.

Document organization

This document is organized around core analysis topics, as described in the Federal Guide for Watershed Analysis (1995). Only topics that were identified as issues within the Oak Grove watershed are addressed. Chapter 1-3 answer the Key Questions, those issues that are unique to the Oak Grove watershed and are key drivers of the system. Chapter 4-9 address the Core Topics. The following questions are answered in each chapter:

Chapter 1 Key Question - Hydrology

How does the change caused by hydroelectric facilities affect the riparian and stream habitats and species populations in the watershed? Would additional hydroelectric facilities and operations have similar magnitude of effets of compounding magnitude of effects? Would potential modifications or adjustments to hydroelectric facilities/operations improve habitat and/or species viability within the watershed?

Chapter 2 Key Question - Human Uses

What are the desired recreational experiences in the watershed? Which critical components are key to the balance of maximizing the opportunities while maintaining or protecting the quality of the desired recreational experience?

How is the increasing demand for recreation opportunities and facilities affecting water quality, erosion processes, species or habitats?

Chapter 3 Key Question - Species and Habitats

What role do the high elevation meadows and wetlands play in providing unique ecosystems for plant and animal species that depend upon them for one or more components of their life history requirements?

Chapter 4 Core Topic - Vegetation

What is the array and landscape pattern of plant communities and seral stages? What processes caused these patterns?

Where should well-connected stands with late seral characteristics be located in the watershed in the future? What other vegetation patterns could exist in the remaining portions of the watershed while supporting ecosystem processes and functions?

Chapter 5 Core Topic - Species and Habitats

Where are the habitat and populations of late successional associated species? What other threatened, endangered or sensitive species exist in the watershed? Are there any other species of concern? Does the amount, distribution and quality of habitat meet the specific requirements for

breeding, feeding and shelter?

What other threatened, endangered or sensitive species exist in the watershed?

Are there any other species of concern? Does the amount, distribution and quality of habitat meet the specific requirements for breeding, feeding and shelter?

Are introduced species affecting the distribution and abundance of native fish and other native aquatic species? What processes of habitat components are critical to the balance of supporting one or more native species while supporting other species desired for their recreational opportunities?

Chapter 6 Core Topic - Water Quality

Is Livestock Grazing Effecting Water Quality in the Upper Oak Grove Watershed?

Chapter 7 Core Topic - Stream Channel

Have the basic morphological characteristics of streams changed? If so, what are the causes of these changes and have these changes affected any species dependent upon riparian and /or stream habitats.

Chapter 8 Core Topic - Erosion Processes

What are the major sediment delivery processes and where do they occur in the watershed? Do turbidity levels deteriorate water quality for present or future municipal water supply uses?

Chapter 9 Core Topic - Human Uses

What effect do roads have on big game habitat effectiveness and what are the social effects of closing roads?

Initial Characterization

The Oak Grove watershed stretches from the High Cascades down the western slope of the Cascade Range. It comprises approximately 91,000 acres of the Mt. Hood National Forest and Warm Springs Reservation. Located within 75 miles of the Portland metropolitan area, it is an important area for timber harvest, hydroelectric power, and recreation as well as late seral habitat, native fish, and high elevation meadows. Elevations range from 1,340' at the confluence of the Oak Grove and the Clackamas rivers to 5,400' at Clear Lake Butte.

The Oak Grove Fork of the Clackamas River originates from rainwater and snowmelt on the western slopes of the high cascades. The major creeks in the headwater area occupy the lowlands in between shield volcanoes, characteristic of the High Cascades, that exist in the eastern portion of this watershed. Slopes are gentle, often less than 30%, and support s a diverse mix of coniferous species, dominated by Pacific silver fir.

One of the most notable features of the watershed is Timothy Lake reservoir which was constructed in 1955 for hydroelectric generation. Timothy Lake was formerly a large meadow complex. The original Timothy Meadows was a closed basin that was created by the coalescing shield volcanos and filled in with sediment. The Timothy Lake Dam created a large storage reservoir in the meadow area with a surface area of 1400 acres at approximately 3,100 feet above sea level.

Water released from Timothy Lake dam plus inflows from the tributaries (A and B channel types) and groundwater in the catchment area, flow west about eight miles to a smaller reservoir (20 acres surface area) at about 2000 feet elevation formed by Lake Harriet Dam. At Lake Harriet dam, all the water flows through an intake and control structure into a steel pipeline and is diverted outside of the watershed to Frog Lake and eventually to the Three Lynx Hydroelectric Power Facility.

The natural stream channel below Lake Harriet dam is supplied by a small amount of leakage from the dam and then is recharged with surface and groundwater inflows from the catchment below the dam. The valley is narrow with steep walls. One 20 foot bedrock falls 3.8 miles upstream from the Oak Grove Fork mouth is impassable to anadromous fish. Below this fall, river-level terraces become more pronounced and the channels and valley floor widens slightly. The Oak Grove enters the Clackamas River at 1,340 feet elevation. Most of the watershed falls within the rain-on-snow zone where rain-on-snow events produce peak flows, debris torrents and sudden rapid landsliding.

In contrast to the eastern portion of the watershed which has been only slightly modified by erosion, erosional processes dominate the landscape in the western portion of the watershed. This is due to weaker and older geological units which have resulted in deeply incised drainages and steep slopes often over 70%. The weak materials and steep slopes contribute to many landslides in the western portion. The Lower Oak Grove channel is constricted by large ancient landslide

deposits, which could reactivate and encroach upon the river. Vegetation types are characteristic of the Western Cascades and range from low elevation Douglas-fir, western hemlock forest to high elevation mountain hemlock.

The Lake Harriet Catchment supports one of the more notable coastal cutthroat trout populations in the Clackamas River upstream of North Fork Dam. The Lower Oak Grove Catchment provides suitable habitat for coho salmon, spring chinook salmon, and winter steelhead. This area, along with Big Bottom in the Upper Clackamas watershed, contains some of the best coho salmon habitat in the Clackamas River upstream of North Fork Dam. Twenty-nine permanent ponds and lakes are found throughout the watershed and of these, 15 are stocked for sport fishing.

There are numerous high elevation meadows in the watershed, including a complex of very large meadows along the Cascade Crest. These meadows are important habitat for sandhill crane, elk, common snipe, sora and Virginia rail, and numerous amphibians and sensitive plant species. Some high elevation meadows are also popular recreation areas and are part of a grazing allotment.

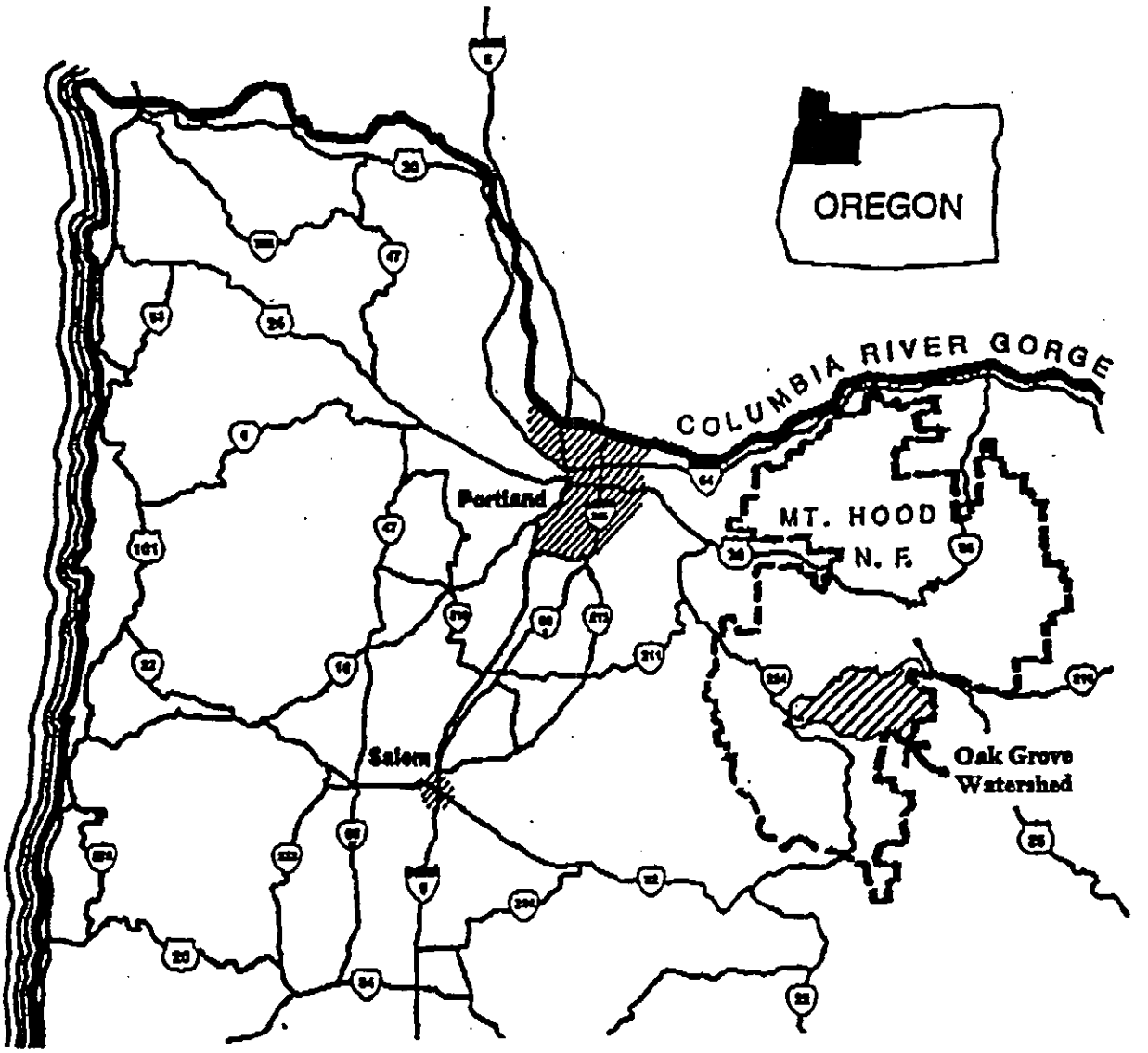
The Oak Grove is a highly fragmented watershed within a fragmented subbasin. There are many large shelterwoods, with high percent of overstory cover, in the Timothy Lake area. There are very few large blocks of contiguous, late successional forest in the watershed. The Oak Grove is at the southern end of an area that had very large stand replacement fires in the early 1900's.

The northern portion of the watershed is in a Late Successional Reserve. Numerous species that are associated with late successional habitat are found in the watershed, including: Northern Spotted Owl, fisher, pine marten, and possibly wolverine. There is a cluster of winter hibernacula for the Townsend's western big-eared bat in the western portion of the watershed. Bald eagle have been sited around Timothy Lake, but there are no known nesting or roosting bald eagles in the watershed. There are at least three elk herds which utilize the watershed.

The Oak Grove Watershed is one of the most important watersheds for recreation use in the Mt. Hood National Forest and attracts an estimated one half million visitors yearly. Although the primary recreation attraction in the watershed is Timothy Lake, the recreation opportunities also include back country lakes, historic and geologic interpretive features, meadows, deer and elk herds, sport fisheries, scenic drives, an extensive trail network, and groomed snowmobile trails.

The steep, narrow river valley of the Oak Grove river restricts recreation opportunities. Like Timothy Lake, Lake Harriet is a reservoir constructed for hydroelectric power generation and is a popular site for camping and fishing. The Shellrock area also plays an important role in the provision of semi-primitive recreation opportunities in the watershed. Limited by steep slopes, the Shellrock area is characterized by small natural lakes, high elevation meadows and wetlands, huckleberries fields, and scenic rock formations.

Vicinity Map



Chapter 1

Key Question - Hydrology

Oak Grove Watershed

- Developed Campgrounds
- Meadow
- Transmission Lines
- Trails
- Stone Creek Hydro Project
- Three Lynx Hydro Project
- Forest Boundary

Key Question - Hydrology

How does the change caused by hydroelectric facilities affect the riparian and stream habitats and species populations in the watershed? Would additional hydroelectric facilities and operations have similar magnitude of effects or compounding magnitude of effects? Would potential modifications or adjustments to hydroelectric facilities/operations improve habitat and/or species viability within the watershed?

A. Current Conditions as compared to Reference Conditions

Three hydroelectric projects currently exist in the Oak Grove Fork watershed (Table 1-1). The Federal Power Commission (since renamed the Federal Energy Regulatory Commission (FERC)) originally licensed Pacific Gas and Electric's Oak Grove Project (FERC 135) in 1922 and Lake Harriet was constructed. FERC exempted the Douglas Water's Canyon Creek Project (FERC 6414) from licensing in 1985 and licensed the Eugene Water and Electric Board's (EWEB) Stone Creek Project (FERC 5264) in 1989.

The Oak Grove Hydroelectric Project is Portland General Electric Company's (PGE) most geographically dispersed generating facility, providing renewable and reliable hydroelectric energy. The 44 megawatts (MW) Oak Grove Project is the most efficient of all PGE hydro resources, requiring only 15.4 cfs of flow to generate 1 MW of electricity. Any reduction in flow available for electrical generation at Oak Grove has a significant effect on the power generating capability and the cost-effectiveness of the project. The Oak Grove Project generates 10% of PGE's power even though it represents only 7% of PGE's total hydro capability, indicating its importance relative to other PGE hydro resources. On average, the water diverted from the Oak Grove generates over 195,000 MWh of electricity, enough to provide the total annual use for approximately 15,500 households.

Timothy Lake Dam was constructed in 1956 to provide a 1450 acre seasonal storage reservoir which improved the Oak Grove Project's ability to operate at peak capacity in the fall and winter months when periods of dry or cold weather reduce natural stream flows. Fall and winter is also when demand for electricity is the highest. Water released from this reservoir plus inflows from the tributaries and groundwater in the catchment, flow west about eight miles to a smaller reservoir formed by Lake Harriet Dam. At Lake Harriet Dam, the water flows through an intake and control structure into a steel pipeline and is diverted outside of the watershed to Frog Lake and eventually to the Oak Grove Hydroelectric Facility.

Table 1-1. Hydroelectric projects and their Liscense and Exemption Conditions in the Oak Grove Fork.

Project Title	FERC number	License expiration	Generating Capacity (kW)	Length of Bypassed Reach	Diversion Capacity (cfs)	Min Flow (cfs)	Max Flow (cfs)	Flush Flow	Fish Screen	Fish Ladder	Ramp Rate (cfs or inch/hr)
Canyon Creek	6414	Exemption 1/	120	0.4 (1,950 ft)	2.4	0	0	N	N	N	N
Stone Creek	5264	Aug. 31, 2039	12,500	5	250	30/40 2/	NA	Y 3/	Y	Y	Y
Oak Grove - Timothy to Harriet	135	Aug. 31, 2006	44,000	6	See below	10	300	N	N	N	Y
Harriet and down-stream	135	See above	See above	5	525	0	0	N	N	N	N

1/ The agencies did not require minimum flows or other operating restrictions for the Canyon Creek project.
2/ 30 cfs November through June and 40 cfs July through October.
3/ Release entire flow for 24 hours: once in October or November and once in January or February.

Approximately 1 mile downstream from Timothy Lake Dam is the Stone Creek Project which diverts up to 250 cfs from Stone Creek and returns the flow at the power house located on the main stem Oak Grove Fork aproximately 5 miles downstream of the confluence of Stone Creek and the main stem. The generator at this power house is rated at 12.5 MW.

With the exception of occasional releases from Lake Harriet, the natural stream channel below the dam is recharged with surface and groundwater inflows from the catchment below the dam and supplied with a small amount of leakage from the dam. The Canyon Creek Project, diverts a tributary to the Lower Oak Grove for 0.4 miles and returns the flow to the main stem.

Hydroelectric projects can have an array of effects on the aquatic environment (Loar and Sale, 1981; Rochester et al., 1984). The more noticeable effects are changes in the flow regime, primarily dewatered areas downstream of the diversion or storage dams and conversion of flowing streams to reservoirs. Other physical effects include:

1) changes in habitat characteristics due to a reduction or moderation of channel forming flows,
2) disruption of natural processes of downstream gravel budgets or large woody debris levels by retaining gravel or large woody debris behind dams, and
3) alteration of temperature regimes.

Biological effects include:

1) direct mortality of fish and other aquatic organisms due to rapid flow changes,
2) entrainment into turbines, and
3) impingement on screens.

Some of these effects can shift the ecological balance of species living in the affected areas. For example, the flow regimes could be altered to the extent that conditions favor brook trout and displace native cutthroat trout from affected stream reaches.

Lake Harriet and Timothy Lake Catchment - Resident Fish Habitat

Flow Regime

Hydroelectric projects in the Oak Grove Fork have altered the flow regimes in this watershed. All three projects have reduced or dewatered stretches of streams downstream of the diversion dams. Timothy Lake and Lake Harriet have converted flowing streams to reservoirs. The Stone Creek project has required minimum flows below the diversions while the Oak Grove Fork below Lake Harriet Dam and Canyon Creek do not.

High flows were highest in the spring during snowmelt periods before the Timothy Lake Dam at two US Geological Survey (USGS) stations, one located just below the Timothy Lake Dam and the other located 1 mile above Lake Harriet Dam (Figure 1-1). After dam construction, high flows were lower in the spring as the dam limits outflow to keep Timothy Lake levels high for recreational use and for water storage. Flows were well below pre-dam levels during Water Year 1994, a recent drought year. The post dam mean annual flow calculated from the mean monthly flow (127 cfs x 12 months = 1,548 cfs) is lower than the pre dam mean annual flow (193 cfs x 12 months = 2,316 cfs). Reduction in mean annual flow could be due to ground water recharge from the flooded area which did not exist previous to the dam and to a lesser extent, from lake evaporation. Another possible cause is the cyclic changes in precipitation.

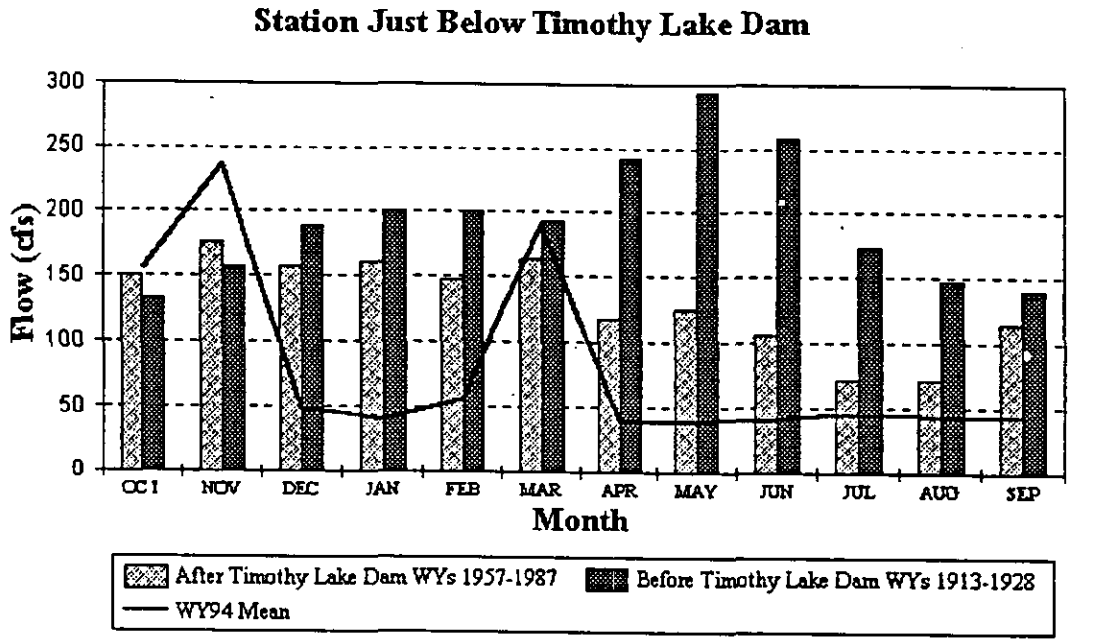
The mean annual 7-Day low flow decreased after the construction of the dam by approximately one third just below the dam and by approximately one fifth further down the watershed 1 mile above Lake Harriet Dam (Figure 1-2). For example the flow of the 5 year recurrence interval is 110 cfs before the dam and 33 cfs after dam construction. A 5 year recurrence intreval is a flow that has a 20% (1/5 years) chance of occurring each year.

Fish Habitat

Flow / Fish Habitat Relationship

The Instream Flow Incremental Methodology (IFIM) estimates preferred flow strategies for various species and life stages which is advantageous over methodologies that establish one static *minimum* flow (Bovee, 1982). The IFIM estimates the amount of habitat available at various flows by species and life stage and estimates a composite of habitat area (weighted usable area) for all species and life stages. The estimates are relative to a theoretical *optimum* in a given stream reach. The IFIM was used to develop the flow regime for the Stone Creek project while static *minimum* flows were set for the Oak Grove Fork downstream of Timothy Lake Dam.

The Oak Grove Fork between Lake Harriet and Timothy Lake contains an important coastal cutthroat trout fishery. Cutthroat are the only native trout in the Oak Grove Fork Watershed. Forty percent of the fish caught by anglers are big (greater than 190 mm fork length (FL)). The Stone Creek Project has caused loss of fish habitat in the main stem Oak Grove Fork in the five mile bypassed reach downstream of the Stone Creek diversion. Increased fish vulnerability to angling from reduced flows downstream of the Stone Creek Project was one reason the Oregon Fish and Wildlife Commission implemented special angling regulations to protect the population structure of the cutthroat trout in this area.



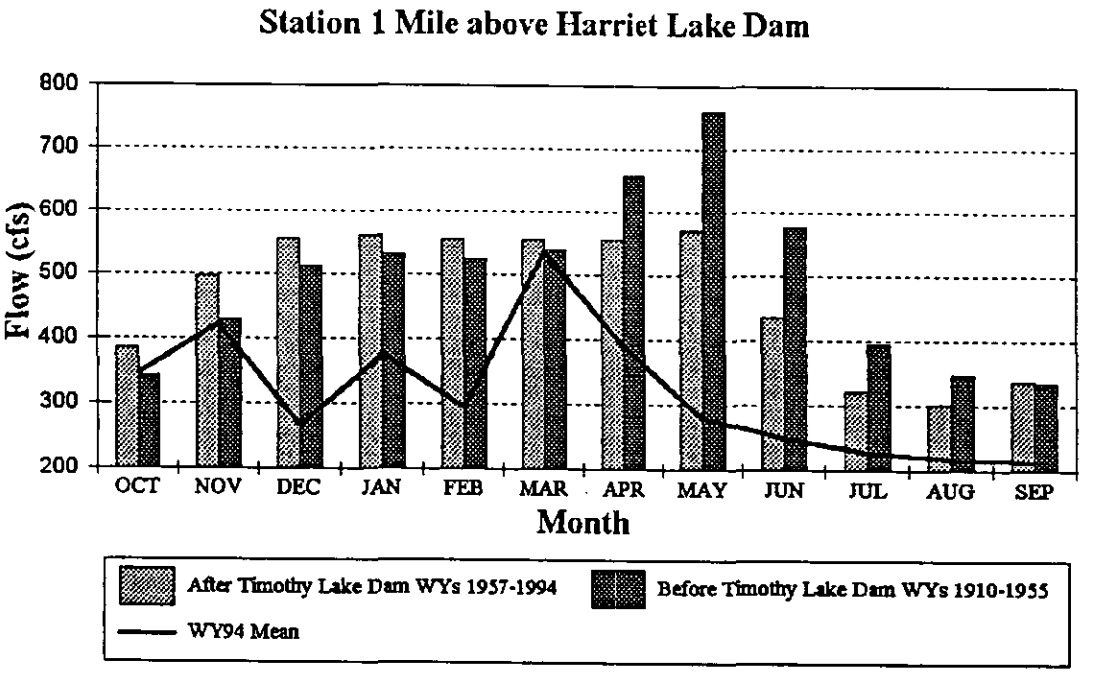


Figure 1-1. Mean monthly flows before and after Timothy Lake Dam Construction.

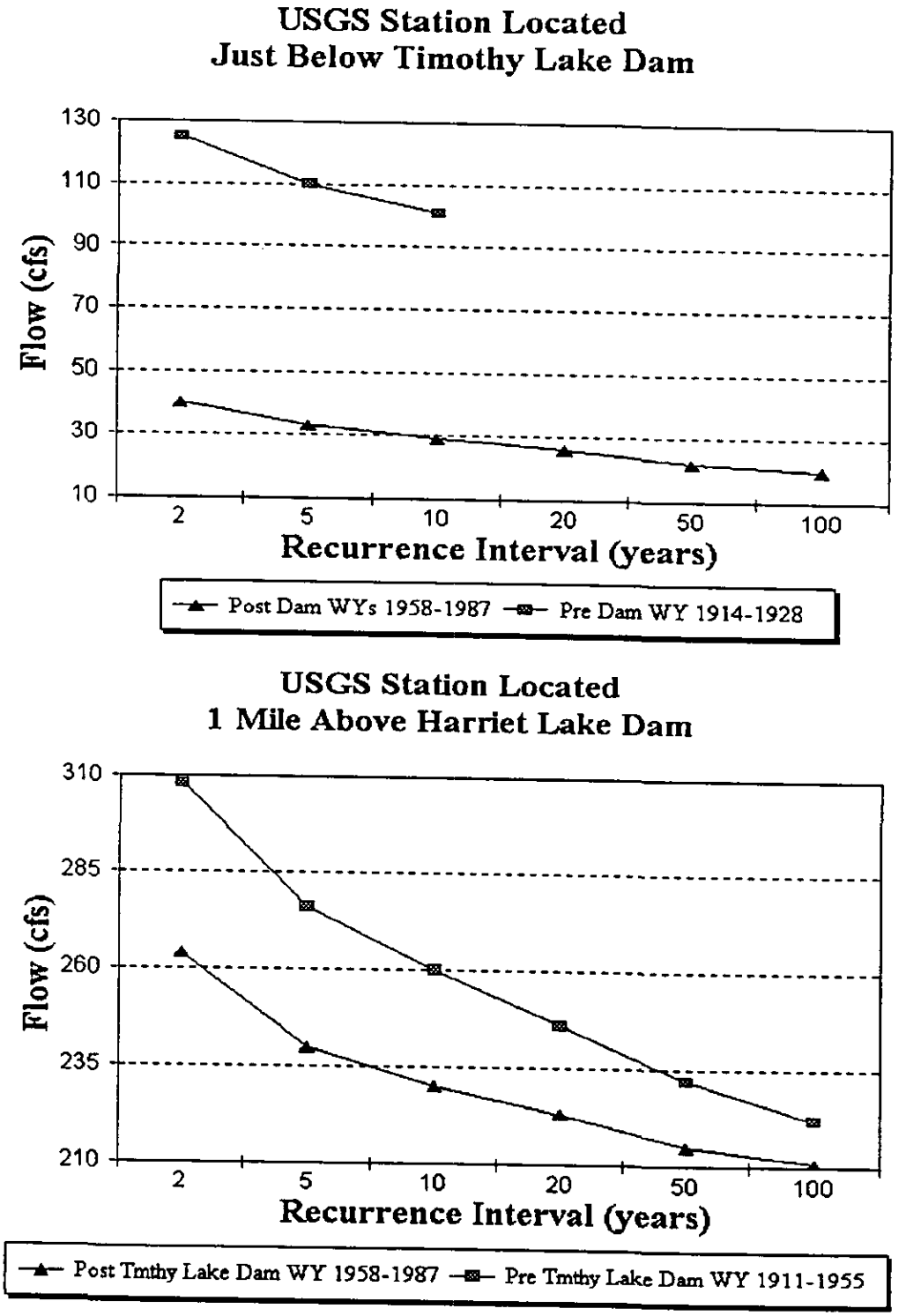


Figure 1-2. The 7-Day Low Flows Before and After Timothy Lake Dam Construction.

Flows in the range of 55 to 150 cfs provide 80 % or greater of the maximum amount of habitat available for juvenile cutthroat trout (Figure 1-3) as modeled with IFIM just below the diversion for the Stone Creek Project. Similarly, flows in the range of 80 to 175 cfs provide 80 % or greater of the maximum amount of habitat available for adults.

The Stone Creek Project license stipulates that EWEB release 30 cfs from the Stone Creek diversion from November through June and 40 cfs from July through October. Under these operating conditions, the Oak Grove Fork contains 35 to less than 60 % of the maximum amount of habitat available for juvenile and adult cutthroat trout, respectively near the diversion point.

The license also requires EWEB to maintain a flow of at least 90 % of the assumed accretion as measured at the powerhouse. Assumed accretion ranges from 106 to 130 cfs, depending on the month, which are within the range of the maximum amount of habitat available for juvenile and adult cutthroat trout. Therefore, there is a gradient of habitat availability from the diversion dam downstream to the powerhouse. Habitat availability would range from 35 to less than 60 % of habitat just downstream of the diversion dam increasing to near optimum habitat conditions at the powerhouse for both life stages.

The above analysis does not mean that an absolute loss of habitat in the Stone Creek bypassed reach has occurred. Before the Timothy Lake Dam, flows were near the optimum range as estimated by IFIM for cutthroat trout only from July through November (Figure 1-1). After Timothy Lake Dam construction, flows occurred in the near optimum range in almost all months indicating that the hydroelectric projects improved habitat availability during the winter and spring by either storing or diverting water. Stream temperatures are cold and fish activity is low during the spring snowmelt, so fish usage of habitat created by these additional flows during this time is minimal.

In Shellrock Creek the amount of available habitat changes significantly when flows drop below 40 cfs (Figure 1-4) as the wetted channel width maximizes around 40 cfs. Flows greater than 40 cfs would tend to increase water depth rather than increase the wetted width due to the high width to depth ratio. Decreases in habitat availability occur from flows above those that provide the maximum habitat availability due to the velocity preference of the cutthroat trout. Velocities become too high as flows exceed 200 cfs.

The shape of the curves in Figures 1-3 and 1-4 indicate how channel shape affects the flow/habitat relationship. A steeper curve indicates that a small change in flow has a relatively large effect on available habitat. Conversely, a more gentle slope indicates that habitat availability changes little with changes in flow up to a threshold level. Typically, channels with high width to depth ratios have steeper slopes than channels with low to medium width to depth ratios.

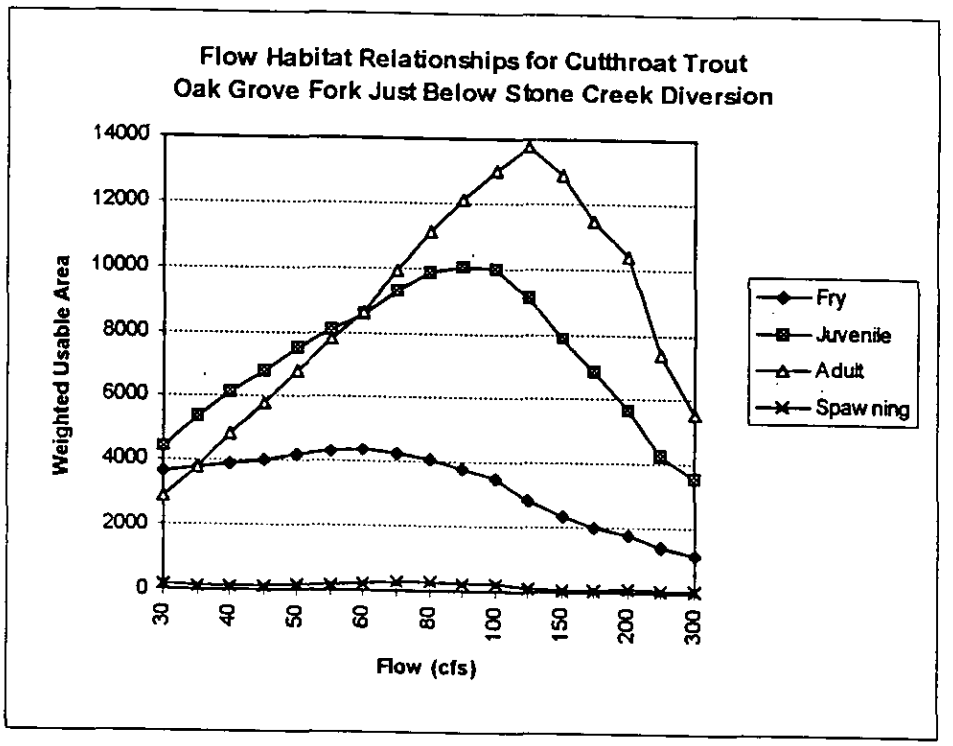


Figure 1-3. Weighted usable area for Cutthroat trout habitat in the Oak Grove Fork.

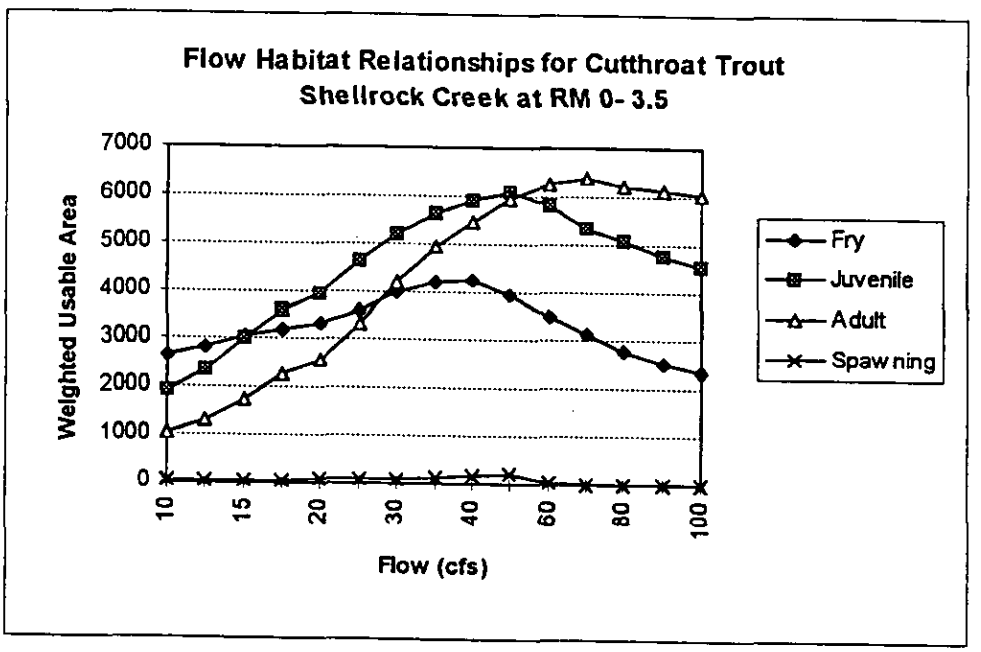


Figure 1-4. Weighted Useable Area Cutthroat trout habitat in Shellrock Creek.

Streams such as the main stem Oak Grove Fork downstream of Timothy Lake and Harriet Lake dams, Shellrock Creek, and Peavine Creek have high width to depth ratios. Therefore, additional hydroelectric projects reducing flow in these streams have a proportionately greater effect on habitat availability to the various fish stocks and species. Steep gradient streams such as Canyon and Skunk Creeks with plunge pools, have low to moderate width to depth ratios. Therefore, habitat availability in Canyon and Skunk Creeks changes little with changes in flow.

Pre and post project monitoring of the bypassed reach downstream of the Stone Creek project diversion validates the modeled flow/habitat relationship. In the first one-half to one mile downstream of the diversion, stream width and depths have decreased with noticeable loss of undercut bank cover as the stream pulled away from the banks under the new flow regime. Habitat area and number of fish living in this area were reduced, particularly just downstream of the diversion dam.

Large Woody Debris and Spawning Gravels

Although large woody debris levels in the mainstem (10-14 pieces/mile) were lower than the Mt. Hood Land Management Plan (LMP) standards (21 pieces/mile), overall on-site recruitment of course woody debris to the mainstem between Timothy Lake Dam and Lake Harriet from a late seral riparian area is good due to limited amount of timber harvest (Map 7-1).

Spawning gravels appear in fair to good amounts only in the lower gradient sections of the Oak Grove Fork between Timothy Lake and Harriet Lake Reservoirs. These lower gradient sections of the river are often braided, multi-channeled areas where gravels recruited from upstream, steeper gradient areas accumulate. Approximately three miles of the main stem Oak Grove Fork between the reservoirs contain higher levels of spawning gravels suitable for resident fish and also of a size suitable for anadromous species.

Spawning gravel presence appears low in the first three miles of river below the Timothy Lake Dam and in the Oak Grove Fork below Harriet Lake Dam. Both of these dams and to a lesser extent in the Stone Creek Hydroelectric diversion structure are impeding future recruitment of spawning gravels into the river channel. Spawning gravels that are present in the river below Timothy and Harriet Lakes are usually clean of silt and show little imbeddedness from observations made by biologists.

Temperature

Water temperatures remain cool throughout the summer in the mainstem of the Oak Grove Fork below Timothy Lake Dam and above Lake Harriet. The Lake Harriet catchment seems to be influenced by accretion flows from cold springs that keeps the majority of the mainstem Oak Grove Fork in this reach at 8.5 degrees C. (49 degrees F) or less, most of the summer. Stone Creek and Peavine Creek in this catchment have similar cold temperature regimes.

Fish Passage and Other Aquatic Species

The Stone Creek project is the only project in the watershed that has fish screens to prevent entrainment of fish into the turbines. The intake to the Howell-Bunger valve at Timothy Lake and intakes to the pipeline at Lake Harriet do not have screens. Kokanee and planted rainbow trout most likely are the most numerous fish in Timothy Lake while brown and planted rainbow trout are the most numerous in Lake Harriet. Entrainment and possible death of fish when they pass through turbines at these two areas have little effect on any of the fish species within the watershed for the following reasons: The native cutthroat and rainbow trout are not numerous around the fish screens due to their preference for habitat not available near the turbines. The kokanee have large populations, so large that their individual size is stunted, and therefore their is no evidence that their population size have been detrimentally affected. Brown trout have maintained their population structure. Oregon Department of Fish and Wildlife (ODFW) maintains the planted rainbow trout population at Lake Harriet and Timothy Lake through stocking.

Hydroelectric development has affected the historical rate and timing of fish movements in the watershed. The Stone Creek project is the only project in the watershed with a fish ladder, minimizing detrimental effect to fish movement. Lake Harriet and Timothy Lake dams prohibit upstream passage of resident cutthroat and rainbow trout and other species that migrate upstream through water (i.e. salamanders). Downstream passage of fish and other aquatic organisms continues but at an episodic or reduced rate compared to historical conditions. Downstream passage at both dams is limited to spills during high flows or through the Howell-Bunger valve at Timothy Lake dam. Smaller and fewer Pacific Giant Salamanders inhabit the watershed above Lake Harriet Dam than below.

Cope's and Pacific Giant salamanders, cascade and red legged frogs and osprey are present under the modified flow conditions. These modified flow conditions may have disrupted dispersal patterns and/or reproductive successes of these species in this watershed by changing the magnitude and timing of stream flows, decreasing the amount of wetted perimeter and changing the stream margin and hydrology of associated wetlands. Harlequin Ducks, otter and beaver are other species that may have existed or breed historically near or within the riparian area of the mainstem and are present today but may have been affected by changes in flow regime and riparian components.

One of the world's two largest concentrated populations of cold-water corydalis, *Corydalis aquae-gelidae*, a sensitive species, is widely distributed throughout the Oak Grove Fork between Timothy Lake and Lake Harriet Dams and in tributaries such as Peavine Creek. The other largest population is found in Big Bottom area of the Upper Clackamas Watershed. Cold-water corydalis is found growing in or near flowing water. The species prefers partially shaded gravel bars and deposition zones of cold water streams. Changes to the stream characteristics could affect cold-

water corydalis populations although no changes have been detected to date.

Ecological Factors

The Oak Grove project caused the greatest shift in stream and aquatic conditions in the watershed due to its size and scope. The most noticeable effect is the shift from flowing riverine habitat to static lake habitat. This shift allowed different fish species, mainly non-native fish, to displace native fish. Kokanee salmon, brook and brown trout are non-native fish introduced into these systems that capitalized on the change in environmental conditions. Brown trout are probably the top predator in Lake Harriet.

Lower Oak Grove Catchment - Anadromous Fish

Flow Regime

With the exception of occasional releases from Lake Harriet during periods of prolonged and/or intense high runoff when flows exceeds the capacity of the Oak Grove Hydroelectric project, the stream channel below the dam is recharged with surface and ground water inflows from the catchment below the dam and supplied with a small amount of leakage from the dam.

Fish Habitat

Flow/Fish Habitat Relationship

PGE conducted an IFIM on the Oak Grove Fork below Lake Harriet dam in 1994. They modeled habitat availability for coho salmon, spring chinook salmon, winter steelhead trout, rainbow trout, and cutthroat trout with various releases at Lake Harriet dam added to the existing base flow that occurs downstream. Releases of 20-30 cfs from the dam would provide near optimum rearing habitat conditions for juvenile spring chinook and coho salmon (Figure 1-5). Flow releases between 40-50 cfs would significantly improved rearing conditions for juvenile winter steelhead.

Presently, the lack of flow release from Lake Harriet dam inhibits the amount of rearing habitat for juvenile spring chinook, coho salmon and winter steelhead. Historical flow conditions, ranging from 300 to over 750 cfs during the key rearing months of May through October, probably limited production of these same species (Figure 1-1). Lake Harriet dam provides an opportunity to "design" a flow regime to improve rearing habitat for the currently existing anadromous fish.

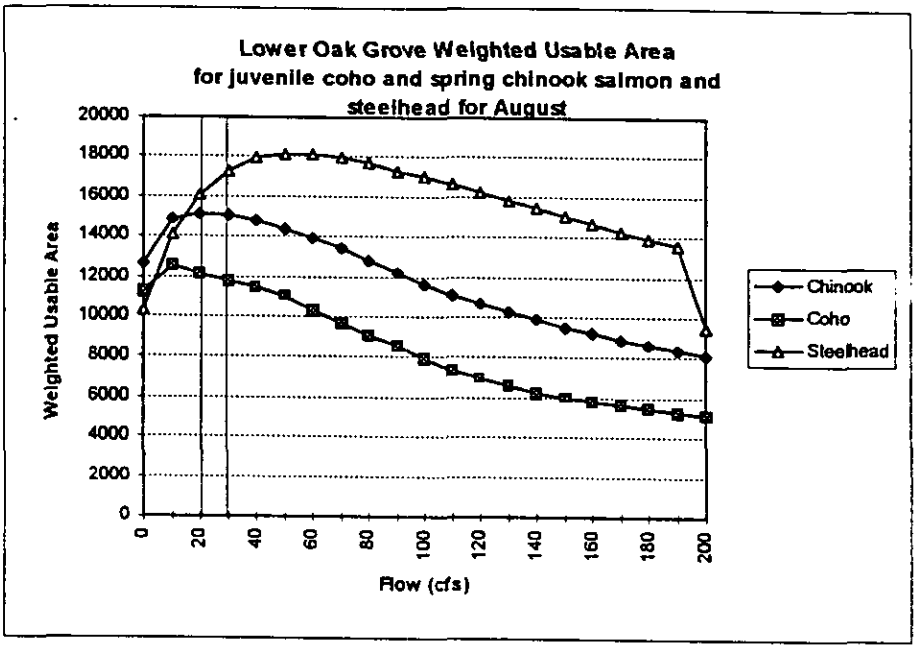


Figure 1-5. Lower Oak Grove Weighted Usable Area for juvenile coho, and adult spring chinook and steelhead for August.

Coho salmon rearing habitat is limited in the Clackamas River Basin upstream of North Fork dam. The most notable areas containing suitable coho salmon habitat occurs in the big bottom area of the Clackamas River and in some side channels and off channel rearing areas at the margins of the main stem Clackamas River and in Fish Creek. The Oak Grove Fork, with a properly designed flow regime, could significantly contribute towards coho salmon production in the watershed upstream of North Fork dam.

Large Woody Debris and Spawning Gravel

The Oak Grove Project has caused loss of fish habitat in the main stem of Oak Grove Fork for the five mile reach downstream of Lake Harriet Dam. The dam and controlled flow regime is the cause for the change in channel conditions. The Lower Oak Grove Fork main stem is wide, has a cobble dominated substrate with relatively shallow slow moving water. This stream reach has fewer gravel deposits and a lower number of pools than in similar sized non-managed streams. The substrate is larger downstream than upstream of the dam. The lack of consistent annual flushing flows and recruitment of smaller material past Lake Harriet dam has caused a loss of gravel and smaller material. The current license and exemption conditions for the Oak Grove and Canyon Creek projects do not require the projects to release channel maintenance flows.

The loss of gravel and rubble inputs from the upper watershed into the lower river may be resulting in a direct reduction of invertebrate food for fish and other organisms (Barnhart,

R.A.,1986). Much of the lower river stream bottom has an armored appearance with an abundance of small and large boulder substrate in many areas.

Short and long term recruitment of CWD has been retarded in the main stem below Lake Harriet Dam because the dam intercepts in-stream CWD during storms. CWD levels are much lower in the Oak Grove Fork below Lake Harriet Dam than above Lake Harriet (USFS 1994, USFS 1995).

Large woody debris (LWD), small woody debris (SWD), primary and total pools per mile in the Lower Oak Grove main stem were compared to similar size streams in wildernesses. In all the reaches of the Lower Oak Grove, SWD levels were lower than SWD in wilderness streams. One reach also had lower primary and total pools. Tributaries to the Lower Oak Grove had similar levels of these stream channel condition attributes as wilderness streams of similar orders (Analysis File).

The Canyon Creek project has little effect on fish populations in the watershed because limited fish habitat exists due to its steep gradient. Few fish if any occur in Canyon Creek.

Temperature

Stream temperatures below Harriet Lake Dam, where minimum flows are not required, are higher than historic temperatures for this reach. Cold summer flows that rarely exceeded 8.5 C are almost entirely diverted out of the watershed for hydroelectric purposes (<200 cfs). The Oak Grove Fork below Lake Hariet now receives a reduced summer flows (may reach 10 cfs. or less in drought years). High air temperatures may have a greater influence on stream temperatures in these reduced flow conditions. Elevated temperatures may be benefiting coho salmon rearing.

Fish Passage and Protection for Fish and Other Aquatic Species

Harriet dam had little to no effect on the upstream movement of anadromous and resident fish because of the approximate 20 foot falls 3.8 miles upstream of the mouth. Adult steelhead may have passed over the falls during specific flow events but was probably incidental.

Pacific giant salamanders are extremely abundant in the Lower Oak Grove Fork downstream of Lake Harriet dam due to the favorable channel conditions and flow regime allowed them to exploit the Lower Oak Grove Fork.

Cold-water Corydalis does not occur downstream of Lake Harriet Dam while large populations exist above the dam. Extreme presence / absence conditions above and below the Lake Harriet Dam is probably not similar to historic conditions.

Anadromous Fish Stocks

Estimates of historic numbers for anadromous fisheries have been made for the entire Clackamas River Basin (ODFW, 1992), but are not always available specifically for the Oak Grove Fork. For over twenty years almost all anadromous fisheries were blocked in the Clackamas River at Faraday Dam where the ladder had washed out and at River Mill Dam where the ladder was usually blocked for salmon egg taking purposes until upstream passage was restored in 1939 (ODFW, 1992). By the early 1960's the following anadromous runs had naturally reestablished themselves above PGE's hydroelectric dams: spring chinook runs averaging approximately 500 adults, winter steelhead trout approx. 2,000 adults, and coho salmon averaging about 1,000 spawning fish. Increasing numbers of hatchery produced smelts began to augment the natural runs listed above starting as early as the late 1950's. For historic fish stocks, run size, stocking information and spawning times refer to the Analysis File.

Winter Steelhead

Winter steelhead, *Onchornychus mykiss*, are the only documented wild steelhead in the Clackamas Basin. Some historic information (ODFW, 1992) on monthly steelhead harvests in the 50's - 60's and historic anecdotes lends support to speculation that the Clackamas supported native summer steelhead at one time (ODFW, 1992).

Clackamas River Wild Winter Steelhead stock is the strongest stock of wild anadromous salmonids in the Clackamas Basin. From informal observations it is estimated that only 10 to 20 adult winter steelhead typically spawn in the Oak Grove Fork in recent years. Steelhead production is limited by the lack of minimum flows from Lake Harriet Dam and reduction of spawning gravel caused by the dam. The overall population in the basin may be slowly declining. The Clackamas wild winter steelhead is one of two salmonid stocks from this basin that have been classified as a "stock at risk" by the American Fisheries Society (Nehlson, et al. 1991).

Eagle Creek and Big Creek Hatchery Winter Steelhead stocks are the two hatchery winter steelhead stocks used in the Clackamas basin. In general, hatchery steelhead have not been released on a regular basis into the Oak Grove Fork. Eagle Creek stock generally returns later (when?) than Big Creek stock (Jan - Feb) but overlap the wild Clackamas stock (March-April). This increases the risk of hatchery stock interbreeding with the native wild stock and causing genetic dilution of native adaptive genes.

Coho Salmon

Coho Salmon, *Oncorhynchus kisutch*, in the Clackamas River has an early run and a late run of naturally produced coho. Debate over whether these fish are two separate stocks or one wild population exists. The Oak Grove Fork is currently supporting an undetermined number of early

and late run spawning adults. Large numbers of coho juveniles are found in the lower two miles of the Oak Grove Fork year round. Lack of spawning gravel recruitment and minimum flows from hydroelectric are limiting habitat but the lower flows are providing fair to good rearing conditions for juvenile coho.

Clackamas River Late Run Coho is the last wild coho stock left in the entire Columbia River Basin out of over 100 coho stocks that once existed there. This is the other Clackamas basin "stock at risk" listed in Nehlson, et al. (1991). The Clackamas River Coho is also listed on the Forest Service, Region 6, Sensitive Species List.

Clackamas River Spring Chinook

In the Clackamas Basin, Clackamas River Spring Chinook, *Oncorhynchus tshawytscha*, was one of the premier spring chinook fisheries of the Pacific Northwest before 1899. Starting in the 1890's, egg taking operations involving a temporary hatchery, weirs and trapping of fish to supply eggs to hatcheries elsewhere in the Northwest began on the main Clackamas River in the vicinity of the Oak Grove Fork and on the Oak Grove Fork itself.

After the reestablishment of the fish ladder at the River Mill Dam on the Clackamas River in 1939, spring chinook naturally reestablished a upper Basin run averaging approximately 500 fish until 1980. At that time large scale returns of the new Clackamas Hatchery spring chinook began to showup, increasing total adult returns to over 2,200 fish in just one year and continues to increase

B. Trends

The existing hydropower facilities will continue to operate and some effects will continue. Some of these effects cannot be changed such as the conversion of flowing streams to reservoirs. Other effects con be mitigated with restoration such as importing CWD and spawning gravels into the main stem of the Lower Oak Grove Fork. Effects such as suboptimal flows for fish habitat and high water temperatures could be mitigated or eliminated with changes in FERC license agreements that would require flow releases from the reservoirs. Other effects such as fish entrainment and/or death as fish pass through the turbines probably are not critical to the success or failure of the fish population in the Oak Grove Fork.

Future effects of ecological shifts due to hydroelectric development could be the expansion of the brown trout into the Stone Creek project bypassed reach. The reduction in flows could provide suitable brown trout habitat conditions that did not exist prior to operation of the Stone Creek project. The cold and turbulent flow conditions existing prior to the Stone Creek project prevented establishment of brown trout in the area now occupied by the coastal cutthroat trout.

The Stone Creek license requires EWEB to release channel maintenance flows and requires EWEB to open the sluice gates at the diversion structure to pass the natural bedload downstream. Thus, the channel conditions downstream of the Stone Creek diversion dam should be maintained.

Presently, the changed flow regime in the Lower Oak Grove Fork Subwatershed provides conditions more suited to coho salmon than the historical flow regime. The shift for anadromous fish utilization would be from fish that prefer higher velocity water such as steelhead to those that prefer slower velocity water such as coho salmon.

At this time wild anadromous stocks in the Pacific Northwest are in a crisis since so many stocks are in a downward trend including some of the Clackamas basin stocks. Deterioration of aquatic and riparian habitat within the National Forest and on lands outside, hydroelectric effects to passage of adult and juvenile fish, hatchery fish interactions with wild fish and spreading of diseases to wild fish, and excessive harvest on non-target populations are all contributing factors to the population declines (ODFW,1992 and Nehlson, et al.,1991).

Specifically in the Oak Grove Watershed, for all the anadromous fish that could potentially use the Oak Grove Fork, the lack of minimum flows and interruption of spawning gravel recruitment due to Lake Harriet Dam limits use and therefore productivity of those fish species (PGE, IFIM, 1995).

Some stocks like the Clackamas River Wild coho are paralleling the status of wild Oregon coastal stocks in dramatic collapses of certain year classes. The Clackamas wild late run coho in the winter of 1993/1994 had an adult run comprised of only 60 spawners, the lowest run ever reported (PGE, Cramer and Cramer, 1994) which coincided with sever El Nino conditions. Emergency measures may be needed to save this last wild Columbia coho stock from ultimate extinction. The coho fishing harvest moratorium by ODFW has contributed to the additional protection this sensitive coho stock needs at this time.

The wild winter steelhead in the Clackamas basin appear to have stabilized at a reduced run size in the 1990's in comparison to the larger runs of the 60's and 70's (PGE, Cramer, 1995). The exact cause for the downturn in this population is unknown at this time. Summer steelhead of hatchery origin are also naturally producing in the upper basin and maybe creating competitive pressure on the wild winter steelhead juveniles (ODFW, 1992).

Although natural production of spring chinook is taking place in the upper basin, large numbers of hatchery spring chinook are likely interbreeding with whatever native stock is still left. Recent El Nino conditions in the open ocean and the detection of a number of diseases in the hatchery stock is of concern (ODFW,1992) since spring chinook have had a reduced run size recently.

C. Recommendations

1. Develop a flow regime that includes channel maintenance flows below Harriet Lake.

2. Negotiate for minimum flows from Lake Harriet Dam to increase productivity for the naturally produced coho and other anadromous species currently using the lower Oak Grove Fork. Improving flows and biological viability is a desired future condition under the Northwest Forest Plan and the Clackamas River Wild and Scenic River Management Plan.

3. Explore opportunities to replace missing gravel inputs depleted by Lake Harriet dam in the Lower Oak Grove Subwatershed.

4. Coordinate with PGE and EWAB to achieve consistency in operating conditions for the Oak Grove Hydroelectric and Stone Creek Projects.

5. Explore merit and possibilities with ODFW, PGE, and other involved agencies of implementing ODFW's draft plan for emergency hatchery intervention for the late run coho, weak year class in late 1996.

6. Implement fish habitat enhancement on the mainstem Oak Grove Fork in the uppermost two miles of the diversion reach of the Stone Creek Project.

Monitoring

1. Continue annual monitoring of *Corydalis aquae-gelidae* population to estimate potential affects from changes in steam flow and to determine if new individuals are propagating near the new wetted perimeter of the reach affected by the Stone Creek Diversion.

2. Monitor the ecological balance of the native fish coastal cutthroat in the main stem Oak Grove between Timothy and Harriet Lake.

3. Continue effectiveness monitoring of fish habitat availability and fish populations in the diversion reach of the Stone Creek Project.

Information Needs

Explaination for the large differences in flows pre and post Timothy Lake Dam to determine if their has been a significant effect on stream flows and aquatic productivity.

Chapter 2

Key Question - Human Uses

Key Question - Human Uses

What are the desired recreational experiences in the watershed? Which critical components are key to the balance of maximizing the opportunities while maintaining or protecting the quality of the desired recreational experience?

A. Current Condition

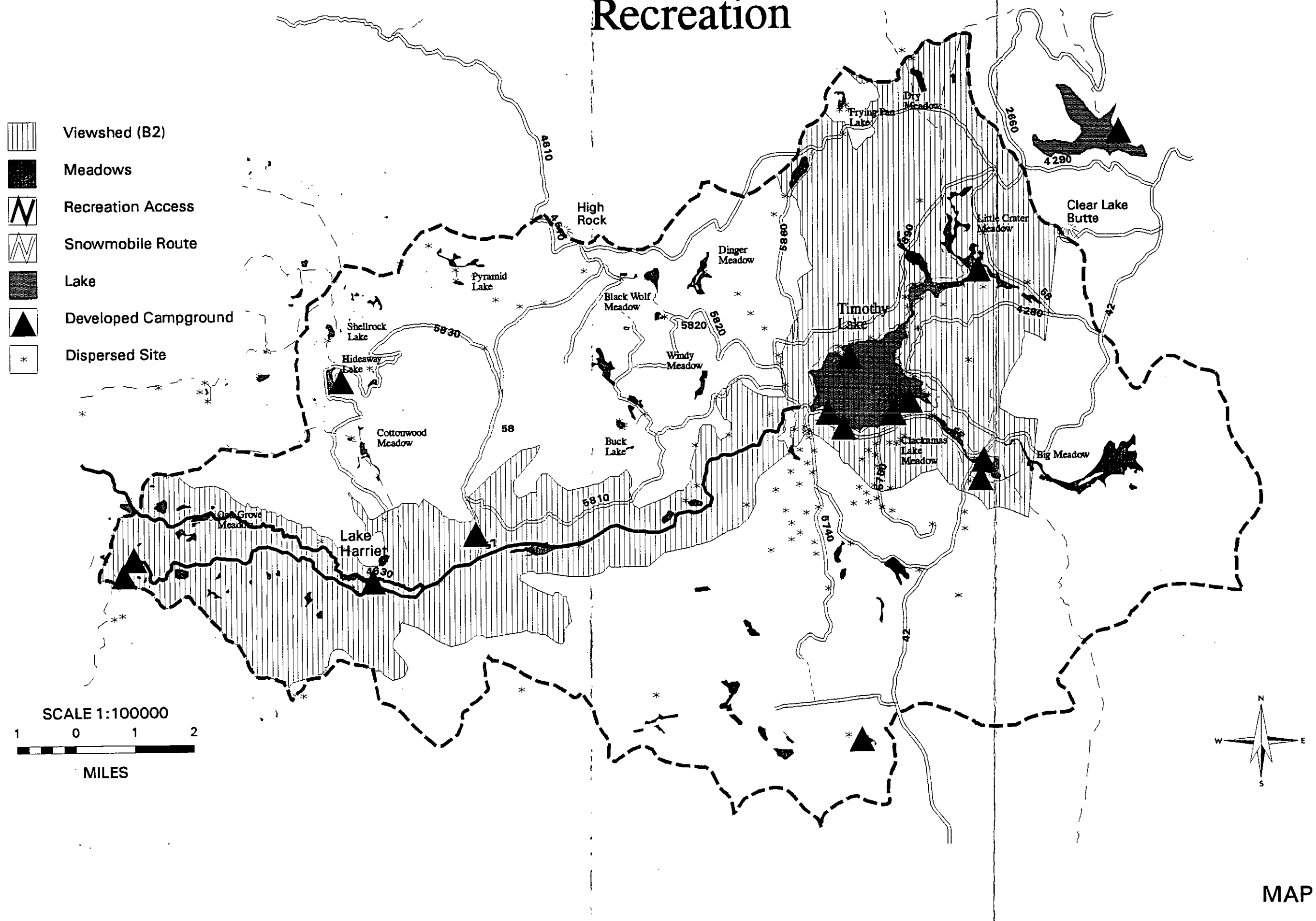
The Oak Grove Watershed is one of the most important watersheds for recreation use in the Mt. Hood National Forest. Attracting an estimated one half million visitors yearly, recreation use in the Oak Grove is comparable to many of the major ski areas on the Forest. Although the primary recreation attraction in the watershed is Timothy Lake, the recreation opportunities also include back country lakes, historic and geologic interpretive features, meadows, deer and elk herds, sport fisheries, scenic drives, an extensive trail network, and groomed snowmobile trails. (Map 2-1) The pattern of recreation use is based upon a combination of physical and biological characteristics as well as management direction and social preferences . The critical physical components of the watershed are lakes, especially Timothy Lake, rivers and creeks, consistent snowpack, and gentle slopes suitable for facility development. The critical components are the forests, big game, high elevation meadows and wetlands, non-game wildlife, fish, and huckleberries. And social factors which influence recreation use includes management direction from the Northwest Forest Plan and Mt. Hood Forest Plan, roaded access, proximity to population centers, history of facility development, and user preferences.

Because of the diverse character of the watershed, particularly the differences between the high cascades crest and western cascades, the watershed has been stratified according to physical and biological similarities which result in common recreational patterns. The stratifications are the Timothy Lake Area, the Shellrock Creek Area, and the River Corridor area. No significant or traditional use recreation destinations are identified in other areas of the watershed and recreation use is considered low, dispersed, and/or opportunistic.

Timothy Lake Area

The pattern of recreation use in the Timothy Lake area differs from the rest of the watershed because of the presence of Timothy Lake. Construction of the 1,500 surface acre reservoir for energy production in 1955 created a recreation attraction with regional importance. Because of its size and scenic setting, Timothy Lake serves as a magnet for camping, hiking, fishing, swimming, and day use. (Table 2-1) It has an easily accessible road system and is only 75 miles from Portland, Oregon's largest population center. Because the reservoir was built for power generation instead of irrigation, the reservoir retains a high water level through the summer recreation season and is the largest of the three lakes on Mt. Hood National Forest which permits

Oak Grove Watershed
Recreation



MAP 2-1

motorized boating. In addition, a number of smaller landscape features exist in the Timothy Lake Area like meadows, natural lakes, and historic landmarks which diversifies the recreation opportunities and creates a recreation complex.

Unlike the rest of the Clackamas River Drainage with linear recreation patterns following creeks, rivers, and ridge lines, the recreation use pattern in this area is radial with the most intense use focused around the reservoir. The largest and most heavily used portion of the Timothy Lake area is the southern shore of Timothy Lake where PGE built four campgrounds at the time the reservoir was constructed. These campgrounds receive over 200,000 visitors yearly and demand exceeds capacity. Currently , 67 acres containing these four campgrounds are operated by a private concessionaire under a special use permit with the Forest Service. Use is also concentrated on the south shore because facilities like boat ramps and fishing piers and the best view of Mt. Hood are located there. A private lodge owned by PGE and a small walk-in campground are located on the north shore of the reservoir. Additional dispersed camping occurs along the south shore and along the North Arm of the reservoir both as destination and overflow sites. The gentle slopes surrounding Timothy Lake make expansion of both dispersed sites and developed facilities possible

Although flat areas near water with roaded access are a uniformly preferred setting for dispersed camping, in the Timothy Lake area, the pattern emphasizes proximity to Timothy Lake and occurs primarily along roads 5740 and 5750 during the summer recreation season. A minor amount of dispersed camping occurs on Dinger Creek, Stone Creek, and the Oak Grove Fork at Clackamas Lake.

Visitor attractions also include small lakes and meadows like Clackamas Lake, Little Crater Geologic Area, and the historic Clackamas Lake Ranger Station which are valued for scenery and nature study. These features are linked to Timothy Lake through a network of trails and roads which capitalizes on the Pacific Crest National Scenic Trail (PCT). The PCT is located on both Warm Springs Reservation and Forest Service land and is the only public recreation use allowed east of the Warm Springs boundary. This trail complex accommodates hikers, equestrians, and mountain bikers though use is segregated by trail and two horse camps exist to accommodate equestrians.

Because of the presence of deer and elk herds, easy roaded access, and flat terrain, hunting is also a popular recreation activity in the Timothy Lake area. Dispersed camping during hunting season is less dependant upon Timothy Lake or scenic settings except for traditional use hunting camps. Flat areas like timber sale landings with roaded access can be preferred campsites during hunting season.

The high elevation, roaded access, and consistent snowpack also means winter sports are possible in the Timothy Lake area like snowmobiling, dog sledding, snow play, and x-country skiing. Over 40 miles of groomed trails and roads accommodate snowmobile use in the area. Because the

snowmobile trail system uses main system roads, plowed access for vehicles is limited in the winter. Snowmobile destinations include Timothy Lake and High Rock as well as Clear Lake and Warm Springs Cabin outside the watershed.

In addition to the developed facilities associated with Timothy Lake, more primitive recreation opportunities exist at Anvil, Buck, Summit, and Frying Pan Lakes, creeks, and meadows. These semi-primitive recreation settings are preferred settings for many users and cannot be substituted with developed facilities at Timothy Lake.

Scenic driving is also a preferred recreation activity in the Timothy Lake Area and the B-2 scenic viewshed allocation from the Mt. Hood Forest Plan specifies the highest level of scenery quality objectives for recreation facilities, trails, and major roads.

River Corridor Area

The steep, narrow river valley of the Oak Grove River restricts recreation opportunities in the River Corridor Area. The pattern of recreation use in this area is linear occurring within the mainstem of the river which is more consistent with the general recreation pattern in the Clackamas River Drainage. Low elevation in this part of the watershed means that access roads are usually free of snow from April to November.

Like the Timothy Lake Area, the River Corridor also has a constructed reservoir which serves as recreation magnet. Lake Harriet, however has only 23 surface acres and only three acres suitable for facility development receives only a fraction of the recreation use found at Timothy Lake. And like Timothy Lake, it is also one of the three lakes on Mt. Hood National Forest designated for motorized boat use. Stocked with sport fish, fishing in this area is concentrated at Lake Harriet. It is also the only water body in the River Corridor Area which is suitable for canoeing, kayaking, rafting, or swimming. The campground and day use area are popular beyond capacity without any additional suitable flat land for facility expansion. Because road access to Lake Harriet is on FS road 4630, a one lane road with turnouts, conflicts and safety hazards can occur between recreation vehicles.

Rainbow Campground and Ripplebrook Campground are two popular campgrounds located in the riparian zone of the confluence of the Oak Grove Fork with the Clackamas River. Because these facilities are accessed by road 46, they are a part of the linear pattern of recreation use and facility development along the Clackamas River instead of the Oak Grove.

Dispersed camping occurs in the riparian area along the river corridor in flat areas accessible by road. Fishing and hunting use is considered low in the River Corridor Area because access is limited by the steep slopes and dense vegetation. Scenic driving and access to Timothy Lake are primary uses of this area during the summer and the average daily traffic count at the junction of

Roads 57 and 42 in August of 1995 was over 3,000 vehicles. The Forest Plan allocation for the River Corridor Area is B-2 Scenic Viewshed. Other main access routes to Timothy Lake from Road 46 are Roads 58 and 5810. Trail development has not occurred in the River Corridor Area because of the steep slopes but road 57 follows the approximate route of the old administrative use trail connecting Estacada with the Clackamas Lake Ranger Station.

Shellrock Area

The Shellrock Area plays an important role in the provision of semi-primitive recreation opportunities in the watershed. Limited by steep slopes like the River Corridor Area, the Shellrock Area is characterized by small natural lakes, high elevation meadows and wetlands, huckleberries, and scenic rock formations. The pattern of recreation use focuses on destination sites in the riparian areas, high elevation huckleberries sites and the vista point High Rock. Camping facilities include three small campgrounds, Shellrock Creek, Hideaway Lake, and High Rock Spring, which receive capacity use on summer weekends. Dispersed campsites are located in a linear pattern along Shellrock Creek which also receive high summer weekend use. Like the River Corridor Area, fishing is limited in Shellrock Creek because of the steep slopes and dense vegetation but fishing is a popular activity at the back country lakes.

Over seven miles of trail serve to access the lakes and also connect with the Rock Lakes Basin to the northwest outside the watershed. The trails accommodate both hikers and equestrians with limited mountain bike use and feature mature forest, wildflowers, and huckleberries in season. High Rock is a popular recreation destination for its scenic vista and huckleberries. It is also a winter snowmobile destination although use is considered low to moderate. Hunting is also limited in the Shellrock Creek Area by the steep slopes and use is considered low. Dispersed hunting camps reflect the pattern found in the Clackamas River Drainage and flat areas like timber sale landings with road access receive opportunistic use.

B. Social Trends

One of the most important trends affecting recreation opportunities in the Oak Grove Watershed is population growth. As an urban forest within the Portland Metropolitan region, population growth will affect both demand for recreation resources as well as the condition of those resources. The preferred settings in the Oak Grove Watershed, Timothy Lake, Lake Harriet, back country lakes, meadows, and river, can be expected to receive even more demand as the population grows. In 1991, the Oregon State Parks and Recreation Department completed the Statewide Comprehensive Outdoor Recreation Plan (SCORP) which examined user demand, supply, and preferred settings for all geographic regions of the state. According to the SCORP results, all recreation uses currently in the watershed are projected to increase in demand.

Because some recreation uses can not be transferred to alternate settings, e.g. motorized boat use cannot be transferred to a shallow back country lake or creek, facilities which accommodate those uses can become overcrowded or degraded. Other uses which can be transferred, such as camping at a back country lake, could mean a relocation of use to an undeveloped site or overcrowding.

In addition to user demand, the SCORP study also included a needs analysis for Forest Service lands based upon use, user demand for preferred setting as defined by the Recreation Opportunity Spectrum (ROS) and the supply of settings as allocated in Forest Plans. The study concluded that the greatest discrepancy between supply and demand occur in the provision of settings on the primitive and semi-primitive end of the ROS settings. For the Mt. Hood National Forest , the category of semi-primitive motorized settings show the greatest discrepancy between supply and demand while surpluses occurred in almost every other category.

An increase in demand for current recreation uses does not preclude shifts in demand or new recreation uses. At Timothy Lake, for example, a new trend is developing for day use and scenic loop tours by Portland users.

C. Recommendations

General

1. Expand developed recreation facilities around Timothy Lake Area.
2. Complete Master Plan for the Timothy Lake recreation area.
3. Explore opportunities for decreasing safety risks present on Road 57 and Road 42 east of junction with 5810.
4. Pave Road 57 for user comfort, safety, and reduction of sediment delivered to streams.
5. Emphasize wildlife viewing opportunities in the North Arm of Timothy Lake.
6. Rehabilitate, relocate if possible or necessary and/or modify dispersed recreation sites in Riparian Reserves.
7. Decrease safety risk on Road 4630 from road 57 to Lake Harriet Campground.

Monitoring

1. Dispersed recreation use levels and distribution to estimate user preferences and to establish trends.
2. Establish photo points to determine compliance with B2 viewshed objectives.

Information Needs

1. User demographics to estimate user preferences and to establish trends.
2. The amount of money generated by Timothy Lake recreation.
3. User preference survey.
4. Hunter uses and preferences.
5. Angler survey on the Oak Grove between Timothy Lake and Lake Harriet.

Table 2-1 Comparison of Recreation Features and Use in the Oak Grove Watershed

area	Timothy Lake	River Corridor	Shellrock Creek
landform	small shield volcanos slopes < 30% small lakes & meadows	narrow river valley slopes can exceed 70%	deeply incised slopes exceed 70% small natural lakes
vegetation	High Cascades Transition Mtn. Hemlock series Pacific Silver Fir series lodgepole stands	Western Cascades Pacific Silver Fir series Western Hemlock series	Western Cascades Mtn. Hemlock series Pacific Silver Fir series
recreation attractions	Timothy Lake (1,500 acre) numerous back country lakes meadows and wetlands view of Mt. Hood	Lake Harriet (23 acre) river corridor	Shellrock Creek back country lakes High Rock (vista) huckleberry areas
recreation activities	camping fishing day use scenic driving hunting hiking huckleberry picking mountain biking equestrian use boating snowmobiling winter camping snow play dog sledding off highway vehicle use lodge	camping fishing day use scenic driving hunting	camping fishing day use scenic driving hunting hiking huckleberry picking
# developed campsites	256 campsites	44 campsites	24 campsites
boat ramps	4 boat ramps	1 boat ramps	none
miles of trail	> 30 miles	no trails	>7.2 miles

Table 2-1 Comparison of Recreation Features and Use in the Oak Grove Watershed

area	Timothy Lake Area	River Corridor Area	Shellrock Area
# dispersed campsites	>112 dispersed sites	>27 dispersed sites	>17 dispersed sites
# winter users	200 snowmobiles/weekend (est) 1,000 people/weekend (est)	no estimate available	no estimate available
season of use	all year	summer (at full capacity) hunting season fishing season	summer (at full capacity) hunting season (low use) fishing season (low use)

Key Question - Human Uses

How is the increasing demand for recreation opportunities and facilities affecting water quality, erosion processes, species or habitats?

A. Current Condition

Also see Chapter 2-question 1.

Timothy Lake Area

Water quality is a concern for Timothy because of past increased levels of nuisance algae like *anabaena* in the north arm and higher levels of bacteria such as E.coli and coliform bacteria. This is a particular concern for human health and safety.

Dispersed recreation along the west shore of the north arm of Timothy and at smaller lakes, ponds, and wetlands in the Timothy Lake area has degraded habitat values and increased compaction and sedimentation.

River Corridor Area

The primary concern in the River Corridor Area are the site specific effects from dispersed recreation to Riparian Reserves along the Oak Grove Fork and to bat hibernacula.

Uncontrolled vehicle access and camping in riparian zones can cause erosion and runoff from exposed and compacted soils, elimination of understory vegetation, and damage to large trees from root exposure, bark removal, and branch removal. These areas can also be lower than Forest Plan standards for woody debris.

Two old shafts from abandoned mining claims located in the lower Oak Grove Fork have been verified as hibernacula for Townsend's Big Eared Bat. Dispersed recreation use at these sites can cause habitat disturbance.

Shellrock Creek Area

In addition to the consistent resource concerns for dispersed recreation within riparian reserves and meadows throughout the watershed, an additional concern is noted for peregrine falcon in the Shellrock Area. High Rock is a cliff site with high potential to support peregrine nesting habitat. Although peregrine presence has not yet been documented, potential conflicts with recreation include rock climbing and any unusual loud human disturbance.

B. Trend

Recreation use will continue to increase for all current recreation uses in the watershed.

C. Recommendations

General

1. Restrict boat use to minimize effects of wave action on shoreline and noise levels in North arm of Timothy Lake.
2. Rehabilitate Road 5890-12 along North Arm
3. Assure that sanitary facilities adequately meet level of human use.
4. Rehabilitate, relocate if possible or necessary, and /or modify dispersed recreation sites in Riparian Reserves.
5. Close access routes leading into bat hibernacular areas and discourage human visitation.
6. Inform people about bats.
7. Prohibit grazing outside of the allotment area.(see Chapter 6)

Monitoring Need

Monitor bacteria levels in Timothy Lake during high recreational use periods (especially in North Arm) to determine compliance with state standards for swimming and to determine the effects of human activity on water quality.

Information Gap

Effects of recreational use on wildlife and habitat use on Timothy Lake (especially in North Arm)

Chapter 3

Key Question - Species and Habitat

Key Question - Species and Habitats

What role do the high elevation meadows and wetlands play in providing unique ecosystems for plant and animal species that depend upon them for one or more components of their life history requirements?

A. Current Condition as Compared to Reference Conditions

There are ten major high elevation meadows in the watershed (Map 3-1). They comprise a complex that provides diversity not found elsewhere in the watershed. The meadows range in elevation from 3300' to 4200' and in size from 10 acres to 200 acres.

The meadows are interconnected by a series of factors, not all of which are readily obvious: by movements from large home range wildlife species ranging between them; by genetic similarities of vegetation populations (probably some of which is facilitated by animals spreading seed); and historical use by humans as transportation routes and for consumptive and recreational purposes.

The size, hydrology, and vegetative structure of the large meadows located along the Cascade Crest combine to create uniquely valuable conditions for several species, including sandhill cranes, elk, common snipe, sora and virginia rail. The cranes and rails do not apparently inhabit smaller wetlands and meadows within the watershed. Most of the meadows contain small lakes or ponds that are seasonally or permanently flooded and thus also support a diverse assemblage of waterfowl and amphibians. The lakes attract many human visitors.

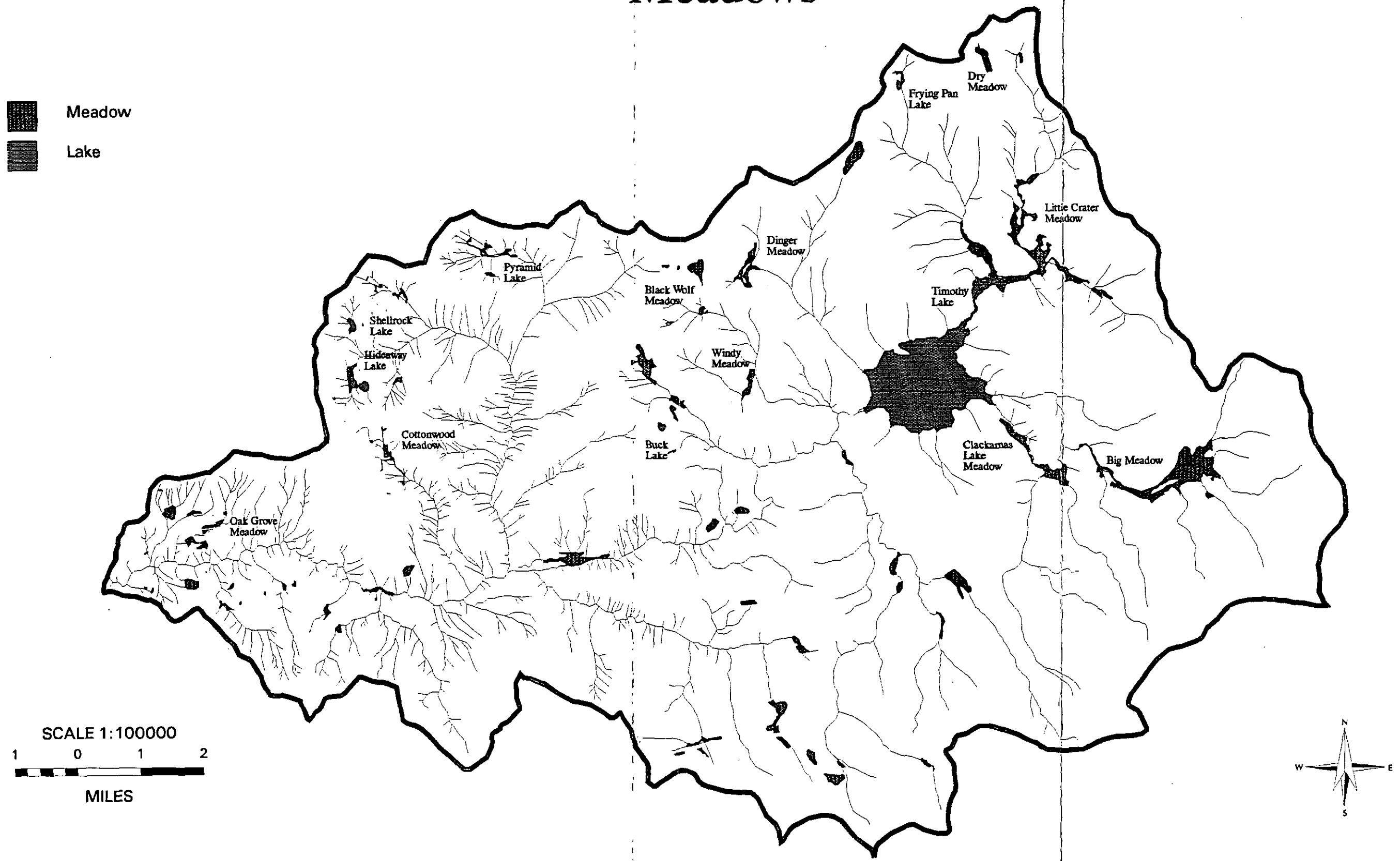
The meadows also contribute greatly to plant species diversity within the watershed and are the habitat for numerous sensitive plant species such as *Scheuchzeria palustris* var. *americana*, *Coptis trifolia*, *Sisyrinchium sarmentosum*, and *Agoseris elata*. Plant species lists for most of the major meadows can be found in the analysis file.

Sandhill Cranes

Sandhill cranes have been found in several of the large meadows, including Black Wolf Meadows, Clackamas (Big) Meadows, Little Crater Meadows, Jackpot Meadows, Dry Meadow and Windy Meadow. Breeding has been confirmed by at least one pair in Big Meadows and one pair in Little Crater Meadows. At Little Crater Meadows, increasing human visitation is possibly stressing sandhill cranes. Cranes have been observed to move to parts of the meadow that are infrequently visited by humans, which may be more marginal habitat. Since 1987, there has not been a known fledgling crane to survive to maturity, though most years reproduction has been observed.

Breeding potentially could occur in several of the other large meadows, but at least at present,

Oak Grove Watershed
Meadows



MAP 3-1

they appear to serve primarily as late summer stopovers before sandhills gather at their fall migration staging areas. Surveying has occurred annually in most of the large meadows since 1987.

Elk

As documented in Calvin et.al. (1994), the high elevation meadows play an important functional role for elk summering along the crest. Cows, in particular, congregate in and near the meadows during calving time. The cows are probably attracted to the meadows' quality and quantity of forage, combined with the proximity to water and hiding / security cover. The Big / Clackamas Meadows complex is preferred , perhaps due to the high recreational presence at Little Crater Meadows.

Amphibians

Although amphibians are not confined to the large meadows, they do find excellent breeding habitat in many of these areas. In particular, red-legged frog, Cascades frog, and Western toad are present. Northwestern salamander, long-toed salamander, and rough-skinned newt are also present in some of these areas.

Impacts

Visible impact to stream banks and vegetation from cattle grazing is documented at Little Crater Meadows and other grazed meadows. As cattle have been excluded from the riparian areas, natural rehabilitation has been observed. Past harvesting of timber in close proximity to the meadows has reduced hiding cover for wildlife species and created higher potential for noise disturbance. The construction of roads and trails to popular meadows has increased human use, creating the potential for disturbance related impacts. Many trails and roads were poorly located to funnel traffic through or away from the meadows; most were designed to bring people to the meadows as a destination.

Most of the meadows are somewhat degraded from their reference conditions. The amount of degradation is different in each case. Historic photographs reveal that most of the existing high mountain meadows in the watershed are approximately the same size as in the 1940's and that tree encroachment has not much affected most of the meadows in the last 50 years. The reference condition of herbaceous species composition in the meadows is unknown. There is evidence of a stand replacement fire around Dry Meadow in the early 1900's.

Timothy Lake Reservoir was constructed atop a large finger-like complex of meadow habitat that connected to both the Little Crater Meadows and the Clackamas / Big Meadows complex (Figure 3-1). Approximately 170 acres of meadow habitat were covered by Timothy Lake. Some additional wetland habitat was created along the North Arm of the lake.

Plant species composition and habitat for both wildlife and plants in the Oak Grove Meadow has been altered by the construction of the pipeline from Lake Harriet and the re-routing of Station

Creek, coupled with years of use as a horse pasture. There has been restoration work in this meadow in recent years.

B. Trends

Large meadows are naturally dynamic systems, affected seasonally by climatic conditions and more gradually by beaver activities, tree encroachment and fire occurrence. Since fire has been excluded, some concern has been expressed over the potential for loss of meadow habitat due to tree encroachment. Tree encroachment may also be due to the drought conditions over the past 7-10 years, allowing tree and shrub growth to occur where it may be normally inhibited by flooded or saturated soils.

Conflicting uses will need to be closely evaluated in the future. Meadow ecological systems are sensitive to high levels of human disturbance. Noise, trampling, road systems that disrupt hydrologic flows and cattle grazing all pose potential conflicts to the continued use of meadows by the species present today. Though only a few years of baseline data has been collected on (some) vertebrate populations in the meadows; no clear patterns are yet evident. Continued heavy use in the future could cause adverse impacts to plants, wildlife and hydrology.

Amphibian populations have dropped around the globe over recent years. Habitat loss, introductions of exotic species, acid rain and atmospheric changes have all been named as possible contributors to the decline. Population level monitoring in the watershed is insufficient to draw firm conclusions about the population trends in this watershed

C. Recommendations

<u>General</u>

These recommendations do not apply to Big Meadows, other than to cooperate with the Confederated Tribes of Warm Springs on mutually beneficial projects.

1. Promote mid and late-seral habitat within 1,000 feet of high elevation meadows. If A9 allocation exists around these meadows, the A9 allocation is considered adequate, with the exception of the Clackamas Lake Meadow in which case the 1,000 foot vegetation retention zone is preferred.

2. Develop plans to manage people use in popular meadows. Little Crater Meadows and North Arm of Timothy should be highest priority. Develop a strategy to reduce human access to the back side of Little Crater Meadows.

3. Relocate the North Arm road away from the riparian edge.

4. Limit motorized boating access to the North Arm to reduce disturbance.

5. Limit camping to a minimum in the North Arm to reduce disturbance.

Monitoring

Monitor the following indicators to get a better understanding of changes that might result from grazing, recreation, and other potential disturbances: sensitive plant populations, sandhill cranes, bacteria, stream bank erosion, in-stream sediment, species composition of disturbed areas, amphibian presence and population numbers, forest carnivore presence, elk calf/elk cow ratios.

Monitor tree encroachment on meadows.

Information Needs

Species preference for distance of forested cover around meadows.

Historic fire occurrence within the meadows.

Figure 3-1. Aerial photo of Timothy Meadows before construction of the dam.

Chapter 4

Core Topic - Vegetation

Chapter 4 Core Topic - Vegetation

What is the array and landscape pattern of plant communities and seral stages? What processes caused these patterns?

Where should well-connected stands with late seral characteristics be located in the watershed in the future? What other vegetation patterns could exist in the remaining portions of the watershed while supporting ecosystem processes and functions?

A. Current Condition as Compared to Reference Conditions

Landscape Structure

The structural elements of the Oak Grove landscape are divided into six broad categories (Map 4-1):

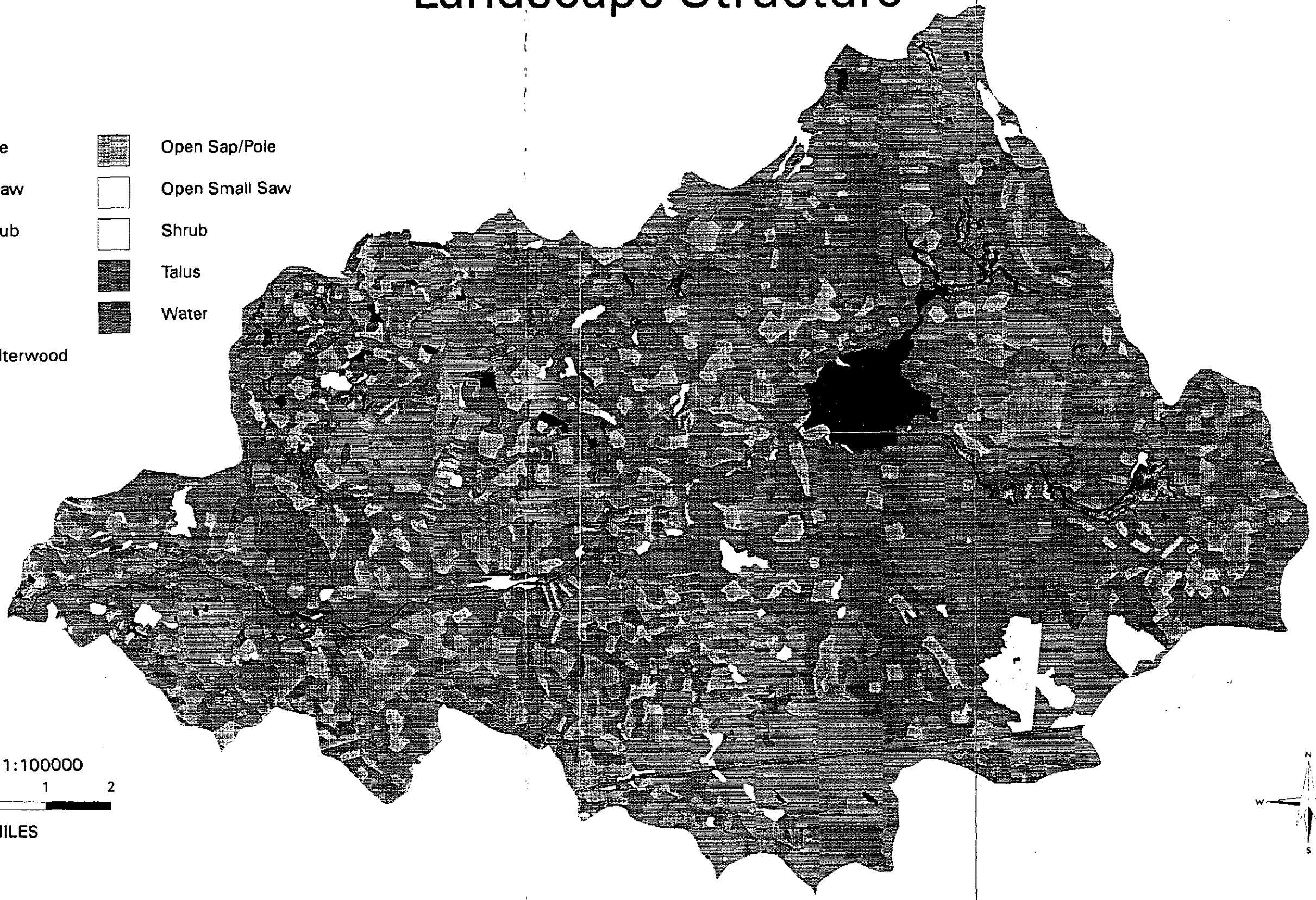
- Matrix (landscape ecology definition)
- Hardwood patches
- Immature forest patches
- Wetland patches
- Aquatic patches
- Rock patches.

The "matrix" within the Oak Grove watershed, based on the criteria of relative area, connective, and control over landscape dynamics (Forman and Godron 1986, Diaz and Apostol 1992), is defined as mature forest, a combination of large and small sawtimber. The matrix is composed of three different structural classes: large conifer, closed small sawtimber, and open small sawtimber.

Immature forest patches include the following structural classes: grass/forb/shrub, open sapling pole, closed sapling pole, and leave tree and shelterwood stands. Shelterwood stands contain structural characteristics of both mature and immature forest patches. They are primarily a grass/forb/shrub type with a component of residual mature trees, and were classified as immature for the purpose of this analysis. The Oak Grove watershed contains 7637 acres of shelterwood stands, with stand sizes up to 394 acres (Map 4-2). Many of the shelterwood stands in the Timothy Lake Area have two remnant canopy layers and more overstory cover than a typical shelterwood stand. Canopy cover of mid and overstory trees is as high as 55%.

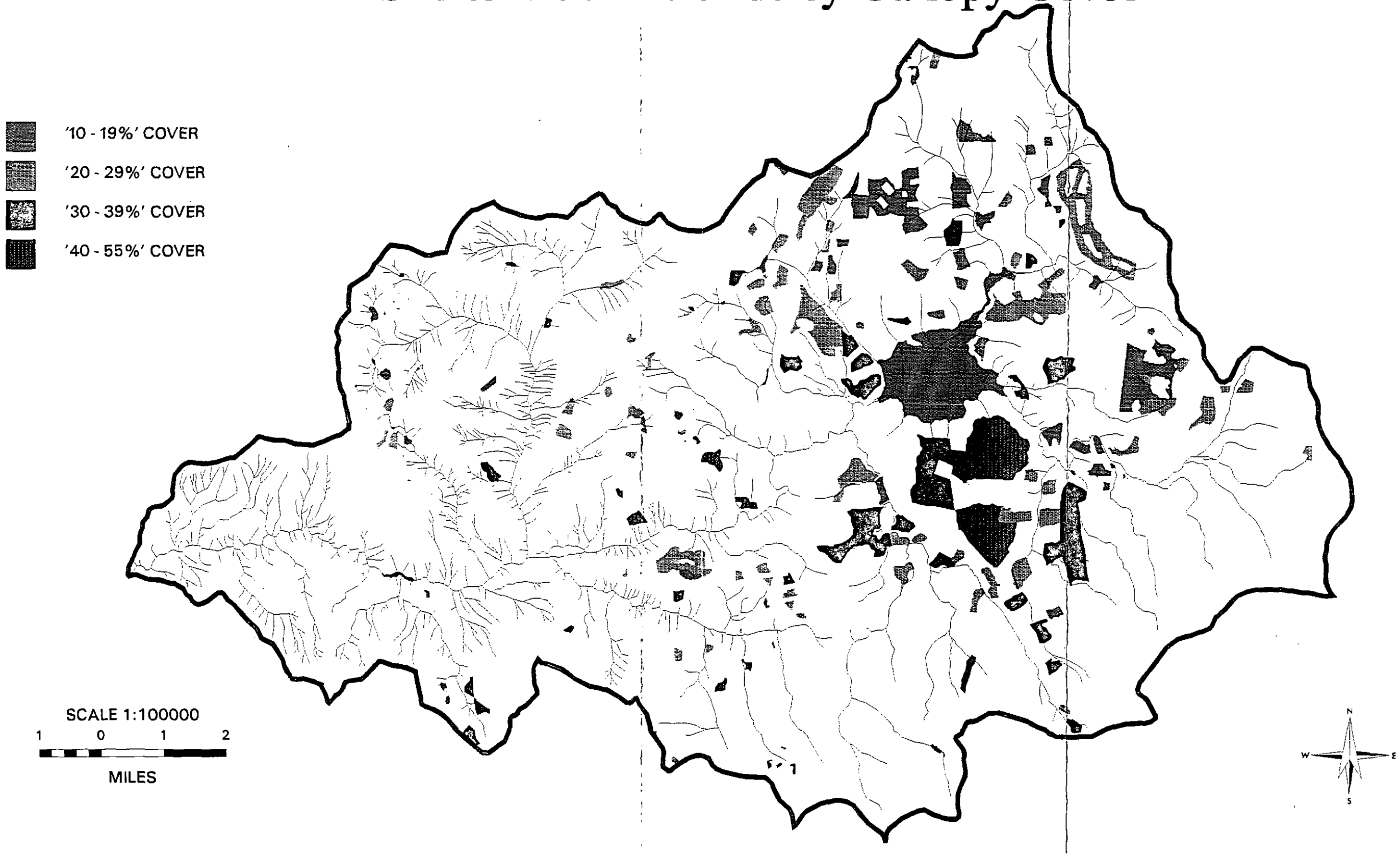
Other patch types identified within the Oak Grove watershed are considered "special habitats", these include: hardwood patches (both mixed red alder-conifer stands and stands of pure red alder (*Alnus rubra*)); wetland patches (grass-forb dominated meadows, shrub wetlands, and red alder

Oak Grove Watershed
Landscape Structure



MAP4-1

Oak Grove Watershed
Shelterwoods Stands by Canopy Cover



MAP 4-2

swamps); aquatic patches (lakes and reservoirs); and rock patches (rock outcrops and talus slopes). These areas contribute significantly to species and habitat diversity within the watershed, for animals, vascular plants, and also lichens, mosses, and fungi. For more information on the special habitats within the Oak Grove watershed see: Chapter 3, High Elevation Meadows; and Chapter 6, Species and Habitats.

Seral Stages

Seral stages within the Oak Grove watershed can be grouped into three broad developmental stages: early, mid, and late seral (Map 4-3). The three seral stages vary by both species composition and structure of the vegetation. Seral stage is an important ecological driver within the watershed affecting a variety of ecosystem functions, including: wildlife species use and migration, nutrient cycling, hydrologic function, production of snags and coarse woody debris, and disturbance processes (fire, insects, disease, and windthrow), among many others. Seral stage also greatly influences aesthetic and potential economic aspects of the watershed.

For this analysis, seral stages were defined according to stand structure rather than stand age. This means that some older stands on poorer sites are included in the mid seral rather than the late seral category. Late seral stands were defined as stands dominated by conifers at least 21 inches in diameter. The late seral category includes both old-growth and mature stands that have not yet fully developed old-growth characteristics. The mid seral category includes closed sapling/pole stands (average stand diameter less than 8 inches, dense canopy) and small sawtimber (stands dominated by conifer trees ranging from 8-21 inches in diameter). The early seral category consists of grass/forb/shrub stands (clearcuts that have not yet advanced to the sapling/pole stage), shelterwoods, meadows, and open sapling/pole stands (conifers greater than 10 feet tall, less than 60% canopy cover).

Currently, 28% of the vegetated acres in Oak Grove are in an early seral condition, 29% in mid seral, and 43% in late seral. Fifty-three percent of the vegetated acres within the LSR are in late seral, compared to 42% in the remainder of the watershed (Figure 4-1).

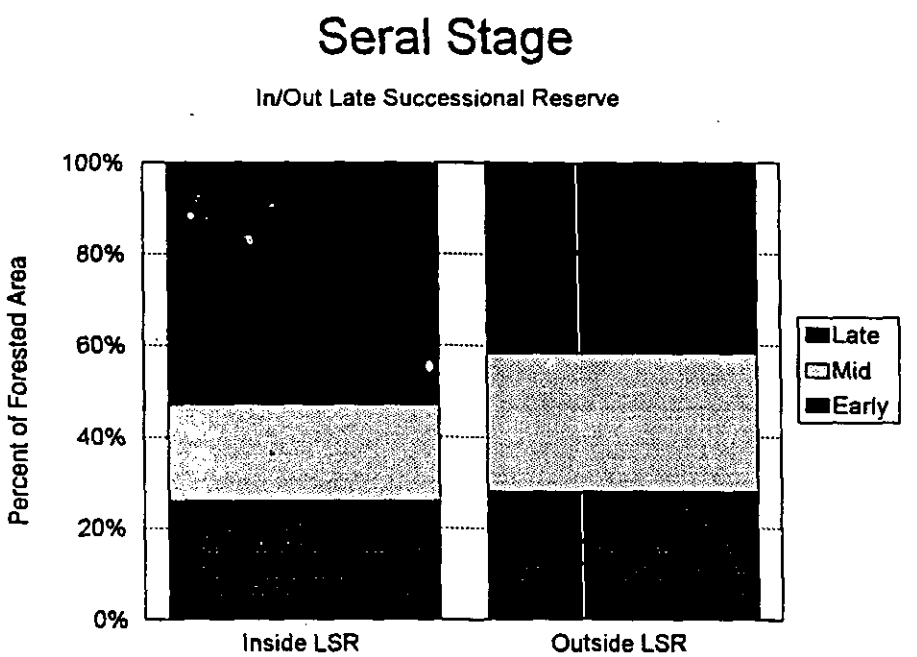


Figure 4-1 Seral stage inside and outside of the LSR. Values shown are percentage of each area in early, mid and late seral.

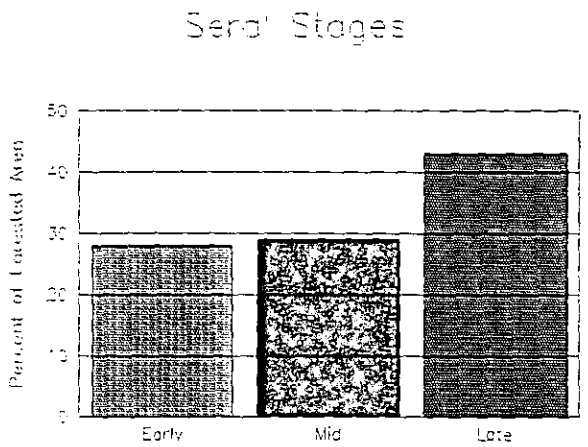
Forest Series

Three forest series that occur within the Oak Grove watershed: western hemlock, Pacific silver fir, and mountain hemlock (Map 4-3). Forest series represent major differences in ecological factors such as plant community composition, growing season length, snow accumulation, productivity (particularly, the maximum size attained by mature trees), and wildlife use patterns.

Seven percent of the Oak Grove is in the western hemlock series, located in the lower portion of the Oak Grove River corridor. Twelve percent is in the high elevation mountain hemlock series. Most of the remainder of the watershed is in the Pacific silver fir series, with some of the eastern portion of the watershed on the Warm Springs Reservation in the grand fir series.

The Oak Grove watershed is a transition area from the Western Cascades to the High Cascades, and contains a mix of East and Westside tree species. The eastern portion of the watershed contains species such as western larch (*Larix occidentalis*), western white pine (*Pinus monticola*), lodgepole pine (*Pinus contorta*), grand fir (*Abies grandis*), Engelmann spruce (*Picea engelmannii*), and some Ponderosa pine (*Pinus ponderosa*). There are portions of the watershed, especially in the southeast, that contain large areas of lodgepole pine (*Pinus contorta*).

Oak Grove Watershed
Seral Stages



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MAP4-3

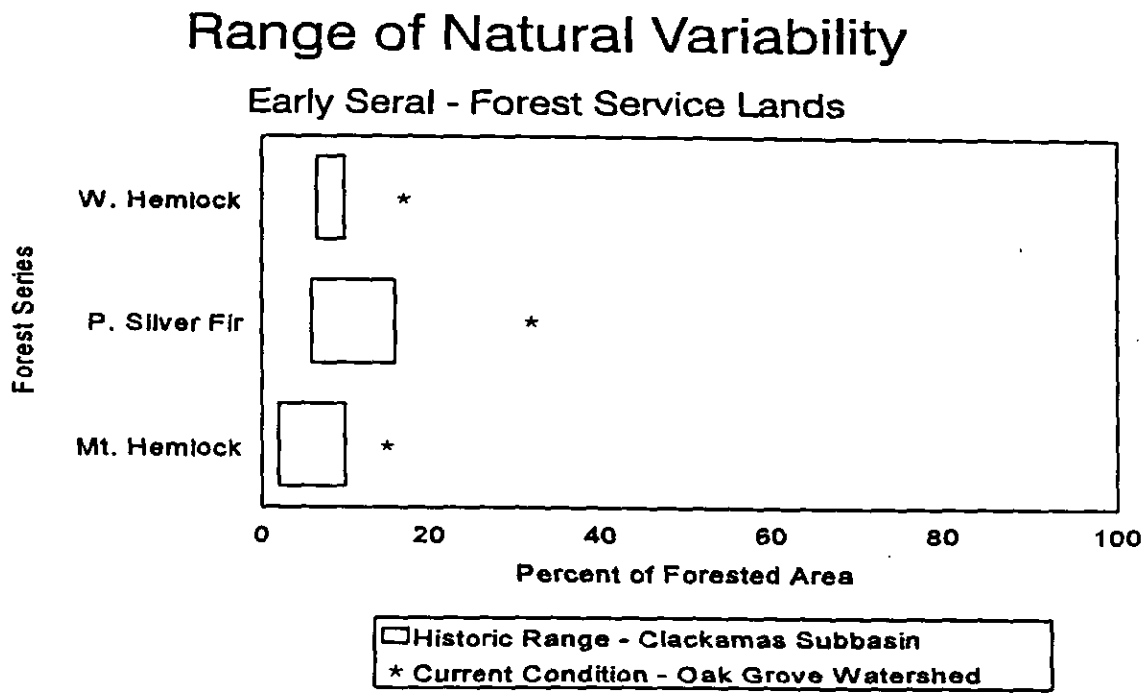


Figure 4-3. Current condition compared to historic range of amount of late seral vegetation. Values shown are percentage of the total area within each forest series.

All three forest series are outside of the RNV in terms of the amount of early seral vegetation (Figure 4-2). There is currently 7% more of the western hemlock zone in early seral than would be expected under the natural disturbance regime, 16% more in the Pacific silver fir zone, and 5% more in the mountain hemlock zone. This is due almost entirely to timber harvest and some associated blowdown.

Under the natural disturbance regime there was probably a great deal of variability between watersheds in the Clackamas subbasin. At any one point in time some watersheds probably had a higher proportion of early seral than other watersheds. Previous watershed analyses in the Clackamas subbasin (Fish Creek, Upper Clackamas, and Collawash / Hot Springs Fork) have shown that the current amount of early seral vegetation consistently exceeds the estimated RNV throughout the subbasin.

The amount of late seral vegetation in Oak Grove is within the RNV in the mountain hemlock and

western hemlock series (Figure 4-3). There is currently 2% more late seral in the Pacific silver zone in the natural range. It is important to note that for the Clackamas subbasin the Pacific silver fir zone had a very narrow estimated range compared to the other forest series.

Landscape Pattern

Current

Overall percentage of the area within various seral stages is not the only aspect of the vegetation that is different from historic conditions, the landscape pattern of the vegetation has also been affected by timber harvest activities and fire suppression. Landscape pattern is a critical determinant of landscape-scale ecological processes.

Some ecologically important features of landscape pattern are: amount of edge habitat, degree of fragmentation of late-successional forest (and conversely, connectivity of late-successional forest), and amount of interior habitat. Fragmentation is one aspect of landscape pattern that has received a great deal of attention. As fragmentation of a landscape increases, the amount of interior forest habitat decreases and the amount of edge habitat increases. Increasing edge benefits some species and is detrimental to others (Marcot and Meretsky, 1983; Rosenberg and Raphael, 1986; Temple and Cary, 1988; Yahner, 1988). As fragmentation increases, the amount of interior forest habitat decreases, impacting organisms which require large patches of interior habitat (Franklin and Forman, 1987).

The Oak Grove is a very fragmented watershed within a highly fragmented subbasin. Landscape patterns were assessed at the Forest scale (Table 4-1). Most of the watershed is classified as "fragmented". There are very few areas classified as "unfragmented" in the Oak Grove. There are areas of "aggregated" early seral in Timothy Lake, Peavine, and Lake Harriet subwatersheds. The portion of the LSR in the Oak Grove is primarily "fragmented" and "perforated", there is very little unfragmented late successional forest in the LSR.

Early seral openings in the watershed have been created mostly by clearcut and shelterwood harvesting. The open patches are relatively uniform in size, regularly shaped, and evenly dispersed within the closed canopy forest matrix. Open patches in "aggregated" areas are beginning to coalesce into larger, more irregularly shaped patches.

Table 4-1. Landscape pattern definitions.

Landscape Pattern	Percent of Landscape in Closed Canopy Forest	Description
Unfragmented	≥ 85%	**Open patches are primarily natural in origin, and are relatively permanent. There is a high degree of connectivity of closed canopy forest, and a large number of core habitat areas.**
Perforated	70-80%	**Closed canopy forest is "perforated" by fairly uniformly dispersed harvest units. Connectivity of closed canopy forest is still quite high.**
Fragmented	60-70%	**Open patches are evenly dispersed. Connectivity may begin to be significantly impaired at below 60% closed canopy forest.**
Aggregated	< 50%	**Open patches dominate the structure and function of the landscape. Few closed canopy forest core areas.**

Late Seral Habitat / Key Connectivity Areas

Connectivity has been recognized as an important consideration in wildlife habitat management for late successional species (USDA, et. al., 1994). Connectivity is primarily an issue of dispersal and gene flow between and among populations. Along with frequency and abundance, vagility (dispersal capability) is considered one of the more reliable factors to use in predicting species vulnerability to local extinctions (Lehmkuhl and Ruggiero, 1991). Dispersal habitat must provide adequate foraging opportunities and resting areas. Connectivity is important to measure at multiple scales because of the enormous variation between species in dispersal capabilities.

Watershed Scale

Map 4-4 displays current habitat availability for late seral associated species with large home ranges (1000-3000 acres). In the Oak Grove, such species include: northern spotted owl, pine marten, fisher, pileated woodpecker, northern goshawk, barred owl, and wolverine (possibly). This map only displays potential habitat on Forest Service land, the analysis was not done for other ownerships.

The map is based on a model that assigns a relative value to each block of late seral based on its connectivity and size. For management purposes, the highest risk to these species would occur by fragmenting or removing habitat within the blocks assigned values of 1, 2, 3, or 4. Harvesting the small isolated blocks labeled 5 or 6 would not significantly affect habitat for the species listed above, but could affect populations of smaller late seral associates. The best quality habitat for this guild of species (terrestrial, large home range, large trees) is in the Oak Grove river corridor, south of Timothy Lake, and in the portion of the Roaring River Special Interest Area that is in the Oak Grove watershed.

Drainage Scale

Key connectivity areas for late-seral habitat currently existing between the Late Successional Reserve (LSR) and the neighboring watersheds are important to identify now since many stands within Riparian Reserves will require time to mature and function as envisioned under the ROD. The most obvious existing late-seral connectivity blocks to neighboring watersheds and their LSRs occur via: the LSR and Special Interest Area, the Oak Grove river corridor, and Cooper and Stone subwatersheds.

The key strategy for all late seral species is to maintain larger blocks of habitat with self-sustaining populations linked by effective dispersal pathways. They would be maintained in late seral or in mid seral "enhanced" by the presence of key late seral habitat components - e.g. down logs, large snags, large remnant trees in patches supporting wind-dispersed lichens, etc.

Interior Habitat

The Oak Grove currently has 10484 total acres of interior habitat (12% of the vegetated acres in the watershed) (Map 4-5). The largest and most contiguous blocks of interior habitat are located in the Oak Grove River corridor, and in the Stone, Upper Oak Grove Fork, and Cooper subwatersheds. Fourteen percent (1473 acres) of the portion of the LSR in the Oak Grove is interior habitat.

Interior habitat was defined as late seral stands that are at least 500 feet from any opening (natural or created). Five hundred feet is used as a convention, actual width of a functional edge varies due to many site specific factors. Mid seral stands, roads, and the watershed boundary were not counted as edge for this analysis.

Historic Landscape Pattern

Fire, historically, was the dominant landscape pattern forming disturbance in this portion of the Cascades. Map 4-6 is a reconstruction of the Oak Grove landscape in the early 1900's. The map shows areas that were in an early or young mid seral (recently closed canopy) condition at this

time. Fifteen percent of the watershed (13035 acres) was in an early seral condition. Two percent of the watershed (1368 acres) was younger mid seral. Only stand replacement fires were mapped, and some smaller fires were probably missed. It is acknowledged that this is only a single point in time, and that to get a true picture of "natural" conditions, many other points in time would need to be examined.

Many of the fires mapped are portions of much larger fires, such as the Abbot burn or the High Rock area, which are part of a large complex of fires in the Salmon-Huckleberry. The fires in the southeastern portion of the watershed are also part of some larger fires, and an area that has some patchy, scattered fires. The pattern created by these fires is much different from the landscape pattern seen today. Fire created openings were larger, more irregularly shaped, and more infrequently distributed than the present pattern of harvest-created early seral stands. Late seral areas were well-connected, and there was much more interior habitat than in the current landscape.

Fire Regimes

The Mt. Hood National Forest has been divided into eleven fire ecology groups based on vegetation, fire frequency, and behavior (Evers et al., 1994). The Oak Grove watershed contains three of these groups. Most of the western portion of the watershed is in Fire Group 8, the "Warm, moist western hemlock and Pacific silver fir" group. This group is a stand replacement fire type, with a fire frequency of 50-300+ years.

Fire Group 7 occurs in the High Cascade area, running north-south through the watershed. There are large areas of lodgepole pine within this fire regime type. Fire behavior is stand replacement crown fire, with lethal underburning. Fire frequency is 100-300 years.

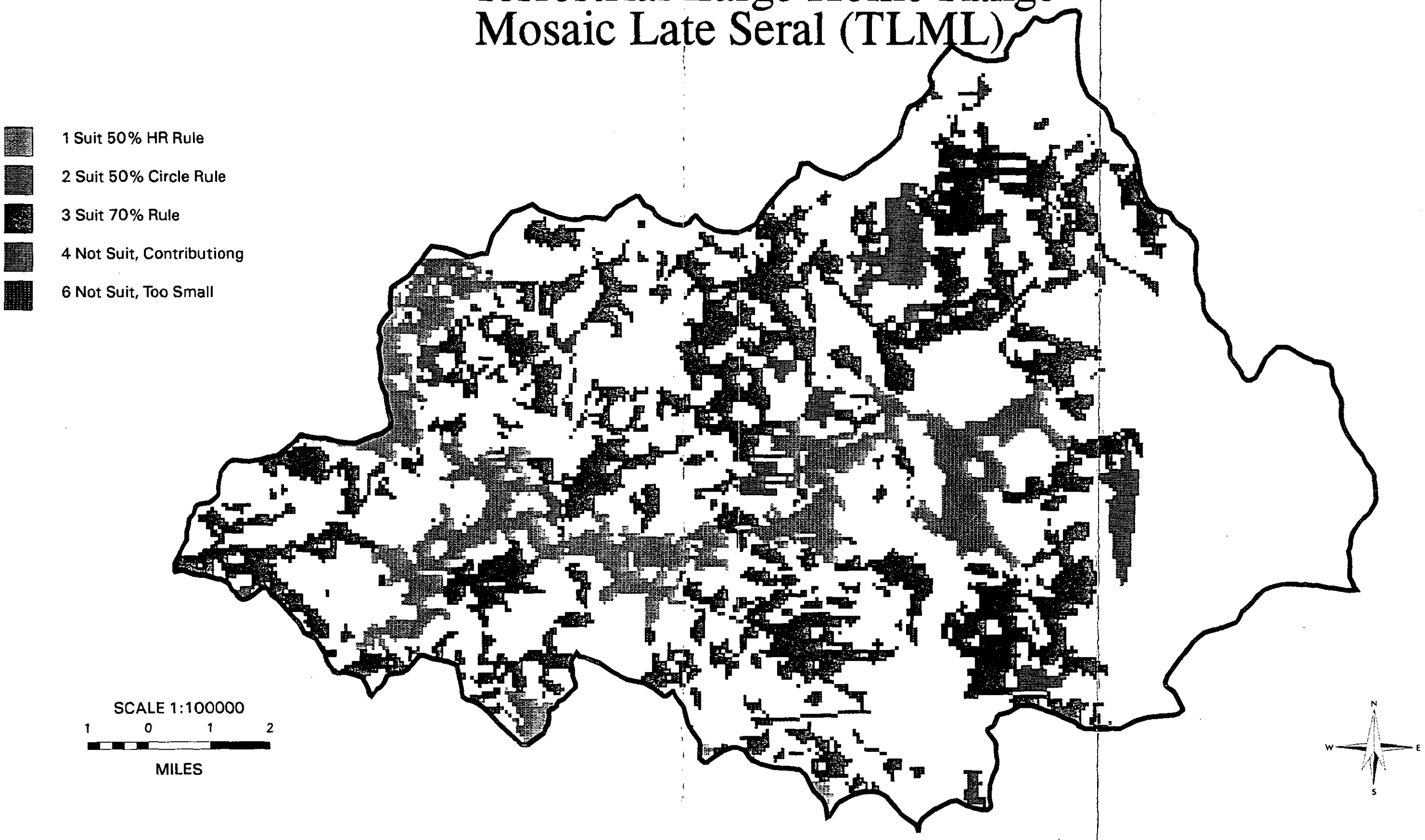
The final fire group in the Oak Grove is Group 6, the "Cool, moist lower subalpine". Fire behavior is also stand replacement, with a fire frequency of 170-430 years. It is found along some of the ridges and in the eastern portion of the watershed.

B. Trends

The landscape design (Map 10-2) displays the long-term vegetation patterns for the the Oak Grove watershed. The design is based on desired vegetation patterns, as described in the Northwest Forest Plan and the Mt. Hood Forest Plan. Additional factors incorporated in the design include: areas with regeneration concerns, remaining large blocks of interior habitat, potentially unstable landform, and high mountain meadow / forest complexes. For further information see (Chapter 10, Landscape Design).

The future Oak Grove landscape will have fewer early seral stands than are currently present.

Oak Grove Watershed
Terrestrial Large Home Range Mosaic Late Seral (TLML)

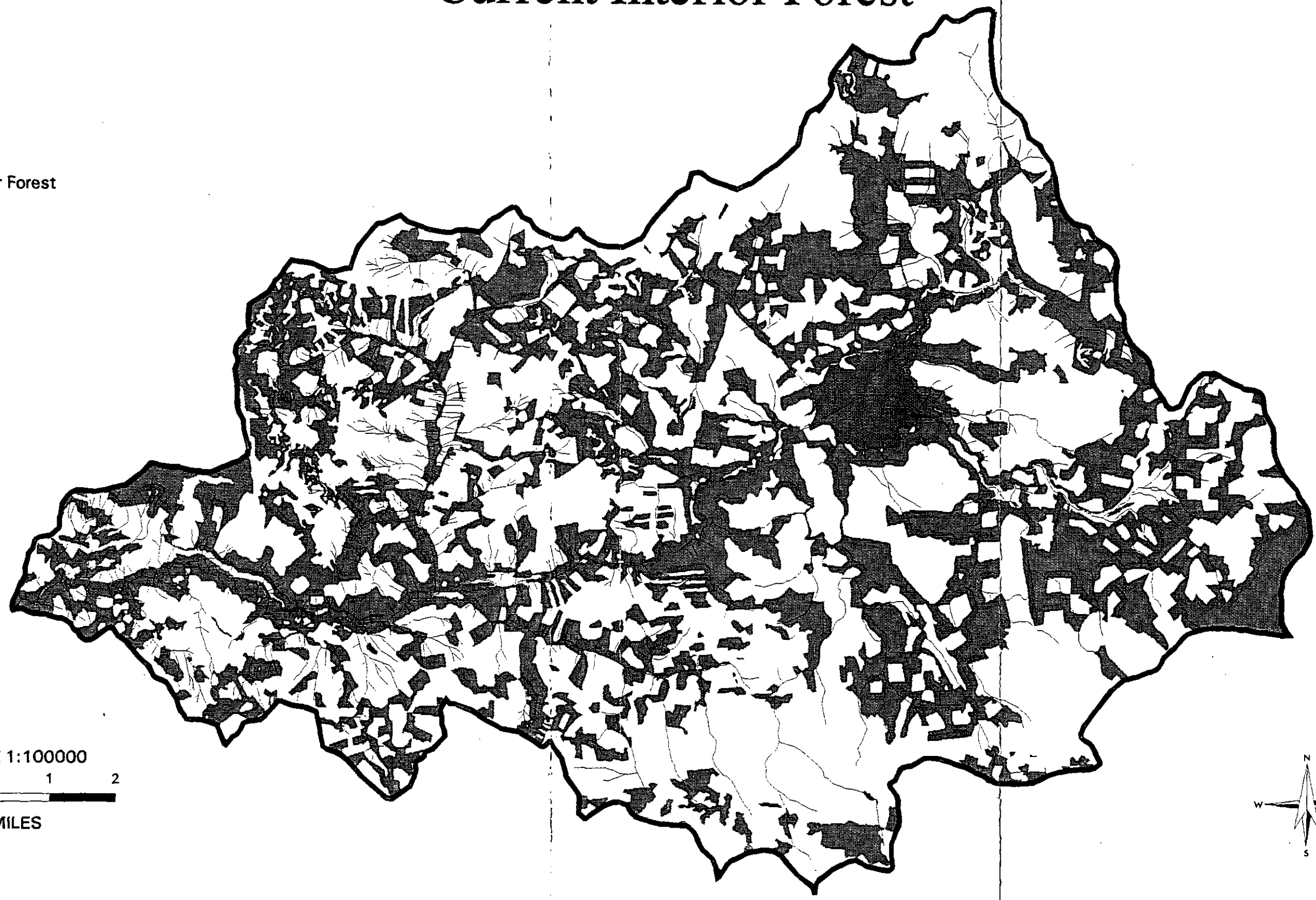


MAP 4-4

Oak Grove Watershed
Current Interior Forest

Edge

Interior Forest



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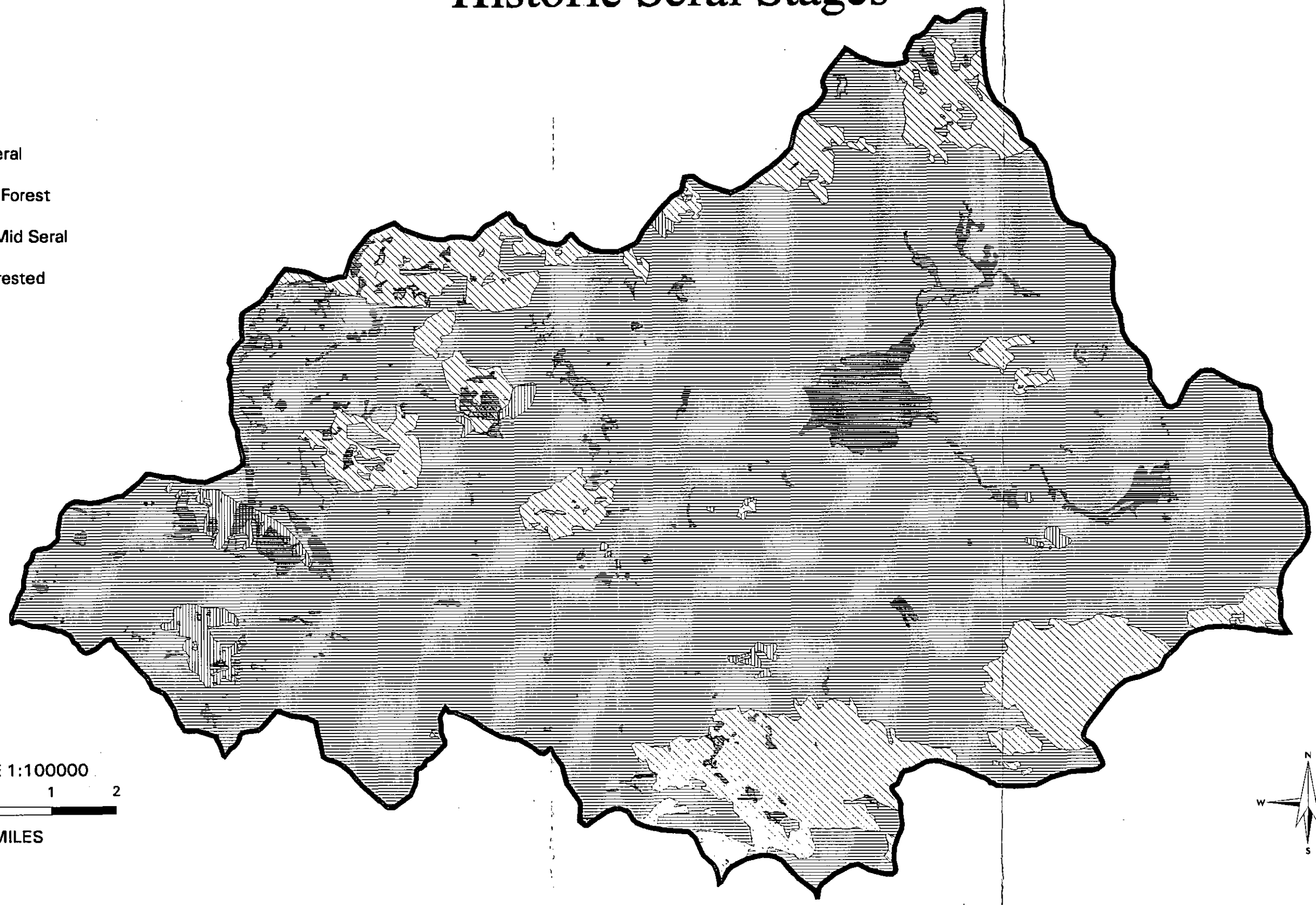
MAP 4-5

Oak Grove Watershed
Historic Seral Stages



Early Seral

Mature Forest

Young Mid Seral

Non Forested

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S

MAP 4-6

There will be larger patches of early and mid seral mosaics. The amount of mid seral stands will increase, as existing plantations grow. Late seral connectivity in the watershed will increase.

Table 4-2. Future Vegetation Pattern

PATTERN TYPE	ACRES	INCLUDES
Continuous Forest Cover (70%) with 2-5 acre Perforations	1372	* Ancient (active and inactive) landslides * Middle ground Viewshed (B2)
Rehabilitation -- shape stands to create future addition to connectivity	248	* Fragmented area of Viewshed (B2) in Interim Connectivity area
Interim Connectivity	13857	* Largest blocks of existing interior habitat * Foreground Viewshed (B2) * Some potentially unstable areas * *Connections to LSR and neighboring watersheds*
Late Seral and Meadow Mosaic	1338	* Areas surrounding large, high elevation meadows * High quality bald eagle habitat
Continuous Forest Cover with Thinning and Small (1.5 - 2 acre) Perforations	11753	* Viewshed (B2) * High Cascades area
Aggregate	11523	* Timber Emphasis (C.) * *Portions of middle ground Viewshed (B2)*
Lodgepole / Fragmented	2000	* Timber Emphasis (C.) * Large area of lodgepole forest type
Large Perforations (<20 ac.), Retain Overstory Cover	3996	* Timber Emphasis (C.) * Areas with regeneration concerns
Summit Lake, Thinning and Group Select	52	* Back country Lake (B12)
Uneven-age Management	309	* Timber Emphasis (C.) * Silvicultural trial in Buck Lake area
Retain and Promote Late Seral Forest Structure	33188	* LSR * Riparian Reserves * 100 acre owl LSR's * Roaring River Special Interest Area (A4) * Key Site Riparian (A9) * Bald Eagle Habitat (A13)

C. Recommendations

General

1. Implement the Conceptual Landscape Design. This will increase connectivity of late seral habitat in the watershed in the future, will increase the amount of interior forest habitat, will increase the patch size of early seral openings (more closely resembling the natural disturbance regime), and will provide for a continued production of timber and other forest products.

2. Conduct preference testing related to the B2 Viewshed.

3. Retain the following B5 (Pileated Woodpecker / Pine Marten) areas: 2101M, 2041W. In the remainder of the watershed, retention of Late Seral and Interim Connectivity design cells is believed to be sufficient for late seral connectivity for pileated woodpecker and pine marten.

4. Recommend no further final overstory removal in shelterwoods.

Monitoring

1. Establish photo points to determine be in observance with B2 Viewshed Objectives.

2. Assess changes in the vegetation patterns at the watershed scale. Map updated vegetation layer as necessary.

Information Needs

1. Verify Vegetation Layer on the Bear Springs District.

Chapter 5

Core Topic - Species and Habitat

Chapter 5 Core Topic - Species and Habitats

Where are the habitat and populations of late successional associated species? What other threatened, endangered or sensitive species exist in the watershed? Are there any other species of concern? Does the amount, distribution and quality of habitat meet the specific requirements for breeding, feeding and shelter?

A. Current Condition as Compared to Reference Condition

Species Associated with Late Successional Habitats or Structures

Spotted Owl Habitat Availability / Population:

Late successional habitats comprise approximately 43% of the watershed (Map 5-1). Primary owl habitat (habitat available for nesting, roosting and foraging) is concentrated in the center of the watershed. Habitat is isolated and fragmented around the upper edges of the watershed, especially on the eastern and southern fringes.

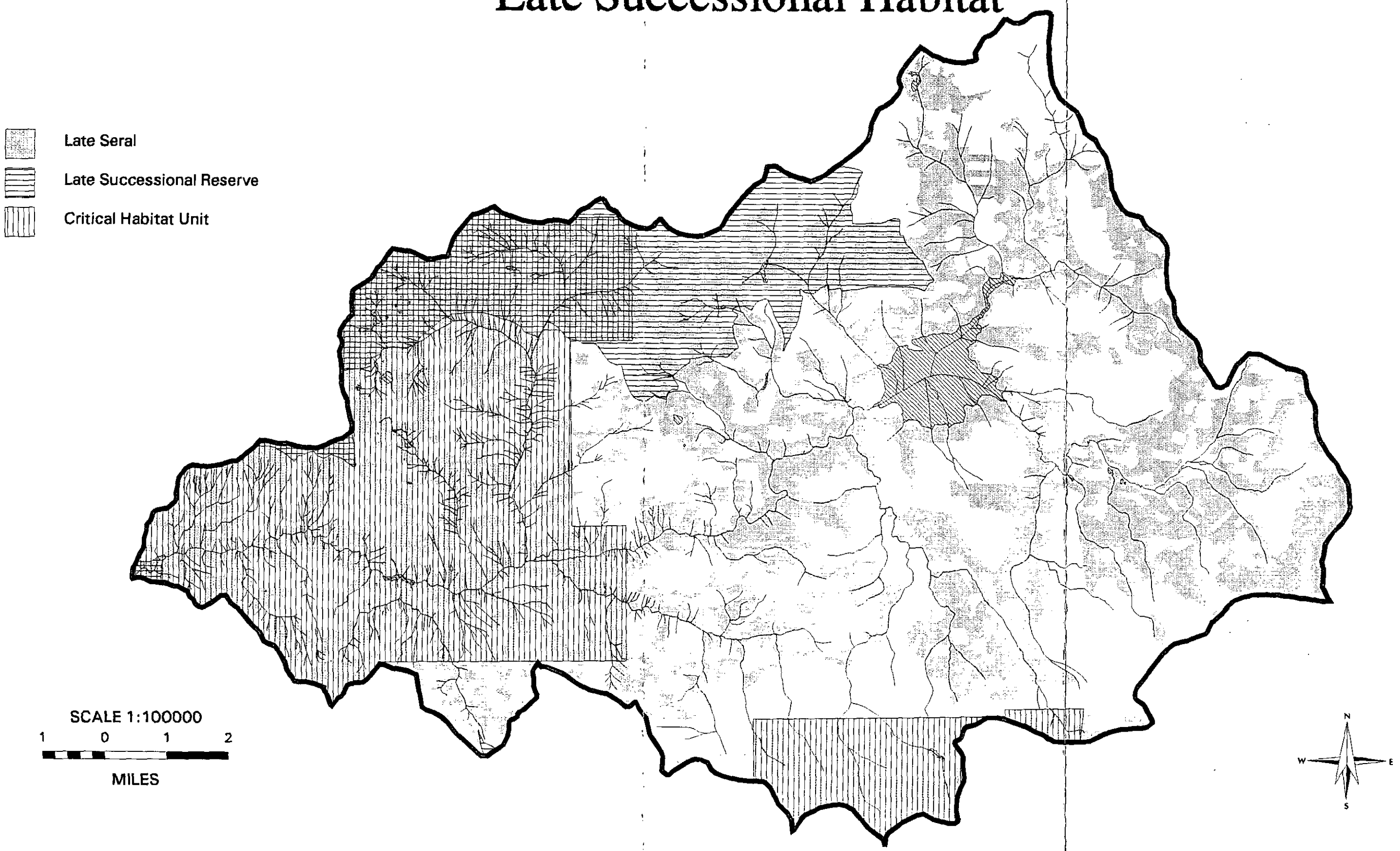
Thirty-one activity centers are known within the watershed, with 1/5 of these occurring within the portion of LSR #207 that extends into this watershed. Owl distribution is strongly linked to the availability of habitat. The low density of owls near and around Timothy Lake may be related to the large shelterwoods in this area (Map 4-2). No owls are known in the large aggregation of closed small saw forests around the powerline. Other habitat is available and unoccupied, particularly along the border with Warm Springs Reservation southeast of Timothy Lake.

Two of six LSR activity centers within this watershed are at or near the minimum level of habitat required before "take" is expected to occur. Two-fifths of the Matrix owls are under or near take. Most of the "at risk" owl centers are located on the eastern and southern edges of the watershed where habitat is scarce and fragmented.

Six owl centers are known above 4000' elevation. About 60% of the LSR land in this watershed is at this elevation or higher. In other watersheds, data suggests that owls are relying primarily on the lower elevation forests (Western Hemlock and Pacific Silver Fir series) to provide primary nesting, roosting, and foraging habitat. Special considerations may be required in the higher elevation LSR areas to maintain and create spotted owl habitat.

Portions of two Critical Habitat Units OR-10 and OR-11, (designated by the US Fish and Wildlife Service, 1992) are within the watershed. OR-11 includes a small section along the south-central edge and OR-10 includes most of the western half of the watershed. Dispersal conditions north and

Oak Grove Watershed
Late Successional Habitat



MAP 5-1

west of Warm Springs Reservation were identified as a concern during the 1995 consultation process between the U.S. Fish and Wildlife Service (USFWS) and USFS (meeting notes 2/3/95) . Further study of the existing and potential dispersal habitat in the lodgepole stand types were discussed to explore the role lodgepole pine plays in dispersal. These types of stands often do not meet the 11/40 guideline for dispersal habitat. OR-11 will be managed according to the NW Forest Plan.

Barred owl numbers in the northwestern part of the Warm Springs Indian Reservation have been increasing (Doug Calvin, pers. comm.). The barred owl is considered a competitor of the spotted owl that generally is more successful in fragmented habitats.

Other Late Successional Associates:

C-3 species (includes species on C-3 list and those for which buffers or special habitat management is prescribed by the ROD)

A large number of plant, animal, and fungal species depend on late-successional (old-growth) forests (FSEIS (USFS, 1994)). Potential habitat for many C-3 species exist in the Oak Grove watershed although limited data is available for the C-3 vertebrate and amphibian species expected to be present (Table 5-1). Some of the C-3 species such as the red tree vole, amphibians and fungi are dependent on high levels of stand connectivity for population mixing. Potential habitat for other C-3 species exist in this watershed.

Bridges and buildings are available in several places in the watershed. Roosting bats have been located at night under nearly all of the bridges surveyed. Concrete box bottom bridges seem to be more heavily used than the few existing wooden bridges in the subbasin.

Table 5-1. Known C-3 animal and amphibian species in the Oak Grove Watershed.

Species	Habitat Available	Sightings	Location
Red Tree Vole	Yes	No	
Bats Little Brown Myotis Big Brown Long-legged Myotis Myotis spp unknown Fringed Myotis Townsend's Big-eared Long-eared Myotis Silverhaired	Yes	Yes	Mostly in the Lower Oak Grove Subwatershed
Great Gray Owl	Yes	Possible	Little Crater Meadows Shelterwood south of Timothy Lake

The following fungi, and vascular and non-vascular plant species have been located in the Oak Grove watershed:

Vascular Plants: *Corydalis aquae-gelidae, Coptis trifolia, Allotropa virgata*
Lichens: *Bryoria subcana*
Fungi: *Gastroboletus subalpinus, Cortinarius wiebeae*

Forest Carnivores

Wolverine, pine marten and fisher are mustelid predators rare in the watershed and on the Mt. Hood Forest. These predators are of concern due to 1) uncertain population status regionally and locally and 2) dependence on aspects of natural forests (such as complex structure, low fragmentation and/or large unroaded expanses) that have become increasingly scarce in the Pacific Northwest. Wolverine may find suitable denning habitat in the talus areas in Shellrock subwatershed. Fisher and possibly wolverine have recently been sighted in the watershed (see Analysis File).

Species reliant on late-successional structural components

Surveys completed over the last several years have shown that large downed logs (peices >21" DBH and > 16' long), scattered large snags (>21" DBH), and patches of unburned trees, often found after catastrophic fire disturbance, are missing or present in low densities in harvest created openings (Figure 5-1 through 5-4). Managed stands contain, on average, fewer large snags and logs than non-managed stands. Large snags and down log density are also influenced by stand structure and forest series. In general the large tree stands have greater densities of large and medium sized logs than small sawtimber stands. The mountain hemlock zone generally contains far fewer large and medium sized snags than the other series.

Forest LMP standards require leaving enough snags in new harvest units to support at least 60 percent of the biological potential of cavity excavators, over time. Estimates of biological potential currently tier to a model devised by Neitro, et. al. (1985). The model estimates that approximately 2.6 snags per acre are necessary to achieve 60% biological potential for woodpeckers at the stand level. One weakness of this model is that no agreement exists that this level of snag retention provides an equivalent level of biological potential for other snag users (e.g. bats, arboreal rodents, bluebirds, swallows, and denning carnivores). At this time, snag levels are below LMP standards in most small saw stands and in all managed stands. Recent actions to retain and top wildlife trees after harvest have increased snag density, but snag density in managed stands is still considered to be low.

Firewood cutting has contributed to the low availability of large down logs in recent harvest units. Fewer decks are now available for cutting and also firewood gatherers cut further into harvest units.

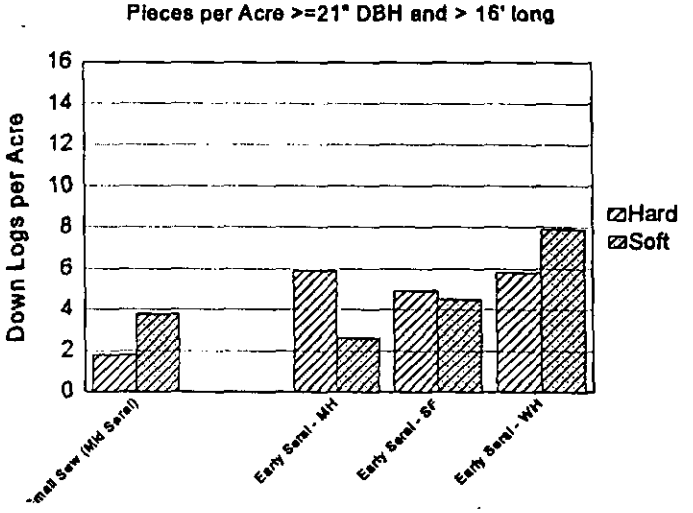


Figure 5-1. Downed Log Density - Managed Stands. Based on forest-wide managed stand survey (mid seral data) and 250 recently cut plantations measured in 1992 in Clackamas subbasin. Hard: decay classes 1, 2, and 3. Soft: decay classes 4 and 5. MH: Mountain hemlock series. SF: Silver fir series. WH: Western hemlock series.

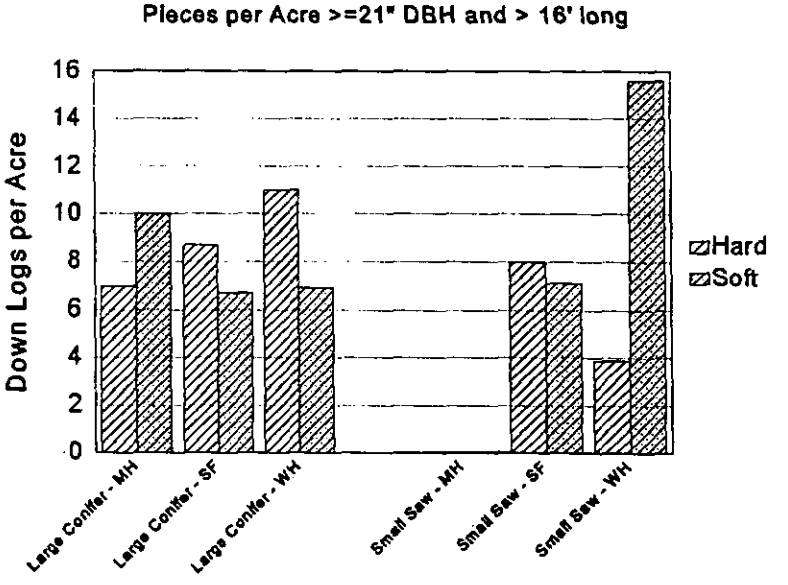


Figure 5-2. Downed Log Density - Unmanaged Stands. Based on Forest-wide data from natural stands in large and mid seral. MH: Mountain hemlock series. SF: Silver Fir series. WH: Western hemlock series. Hard: Includes decay classes 1,2, and 3. Soft: Includes decay classes 4 and 5.

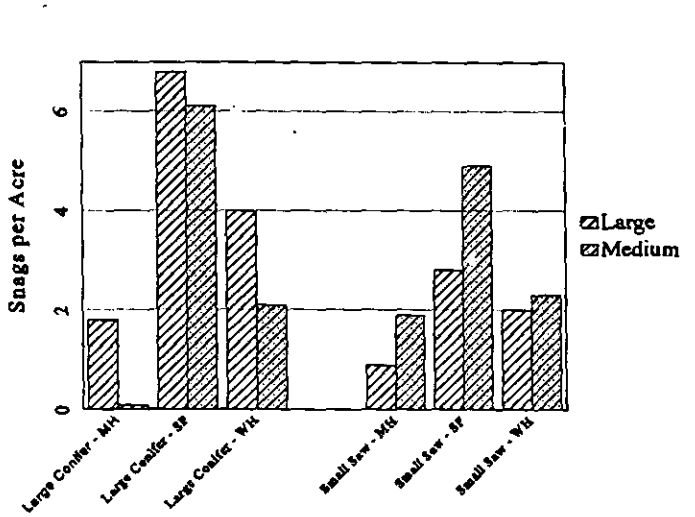


Figure 5-3. Snag Density - Unmanaged Stands. Based on Forest Inventory data gathered in 1986.. Large: >=21" DBH. Medium: 15-20.9" DBH. MH: Mountain hemlock zone. SF: Silver fir zone. WH: Western hemlock zone.

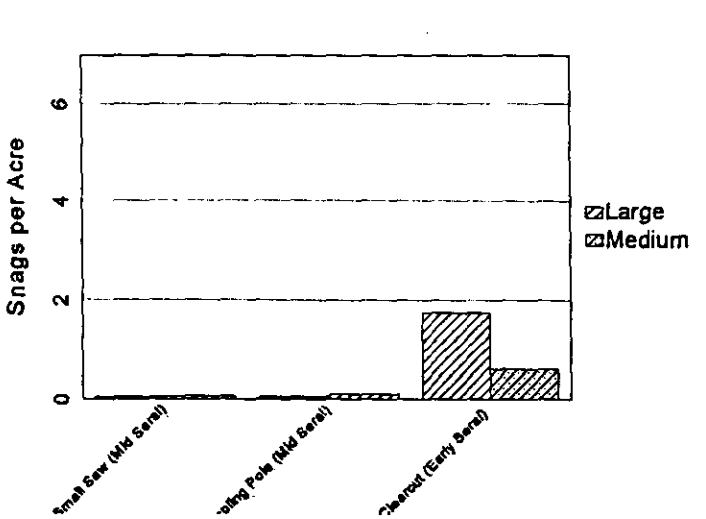


Figure 5-4. Snag Density - Managed Stands. Data based on Forest Inventory data (1992) and complete surveys of 100 early seral stands in Clackamas sub-basin (1992). Densities averaged over all vegetation series. Large: >=21" DBH. Medium: 15-20.9" DBH.

Many species in the Pacific Northwest evolved to use large snags and logs that were historically abundant in the landscape, even in early and mid-seral stands. The loss of snag and log density from managed stands affects biodiversity and potentially could cause a loss of critical function in the landscape such as control of forest insects. The recent outbreak of the Douglas-fir bark beetle suggests that some loss of function may have already taken place. Twenty-seven neotropical migratory bird species occurring within the watershed have significantly declined over the last two decades, based on Breeding Bird Survey data (Sharp, 1992). Of these 27 species, half are snag dependents and insectivorous or birds of prey feeding on forest birds. Some of these declining species were not evaluated for population viability in the FSEIS (USDA, et.al., 1994) because they are not closely associated with late seral habitats.

The quality and quantity of late successional habitat in the landscape fluctuated naturally under a natural disturbance regime. The present amount of late successional habitat is probably (on average, and across the subbasin) similar to historic levels. However, the pattern of the habitat was probably different. Large unevenly shaped openings were typical of the historic fire patterns. The late successional habitat was found in large stands, contiguous over thousands or tens of thousands of acres. Most late successional habitat probably bounded mid-seral stands. Little fragmentation and low quantities of early seral forests existed at any one time. These habitat conditions and patterns likely resulted in healthy populations of late-successional associated species, with few barriers to dispersal and population mixing.

B. Trends

Most mid seral stands in the watershed will not naturally develop spotted owl nesting habitat characteristics within the next 50 years, with the exception of a few stands in the lower elevations of the watershed based upon analysis completed in the FSEIS (1994) and the Upper Clackamas Watershed Analysis (1994). Without management within these areas to promote nesting habitat, late successional habitat and correspondingly, populations of late successional associates, will likely decline over the next several decades. The rate of population decline will depend on the location of harvest units, and the occurrence of fire, blowdown and other catastrophic events. Particularly for the owl, a slow rate of habitat loss would pose less risk to the population and would be best achieved by concentrating harvest outside known owl activity centers or within the territories that are already below take. These areas are available on the southern and eastern edges of the watershed.

Eventually, habitat recovery in LSRs, Riparian Reserves and other withdrawn lands should stabilize the owl populations across the region. Until that time, habitat loss and "take" will occur. Balancing the rate of loss against the rate of recovery would prevent further endangering the owl. An annual rate of take reasonable for the Mt. Hood National Forest or the Clackamas subbasin has not yet been established.

Depletion of downed wood through firewood cutting is likely to continue in the future. Future

harvest units may only temporarily meet the President's Forest Plan standards for down log retention.

C. Recommendations

General

Recommendations under the Vegetation Core Question include maintaining connectivity areas centered around the largest interior blocks. This strategy should maintain watershed level and drainage level connections. The key strategy for all late seral species is to maintain larger blocks of habitat with self-sustaining populations linked by effective dispersal pathways. They would be maintained in late seral or in mid seral "enhanced" by the presence of key late seral habitat components - e.g. down logs, large snags, large remnant trees in patches supporting wind-dispersed lichens, etc.

1. Implement Landscape Analysis and Design.

2. Minimize Rate of "take" of owls consistent with the NW Forest Plan.

Information Needs

No local data on owl dispersal within the area exists. Given that owls have large home ranges and high dispersal capabilities, owl dispersal could be occurring in all portions of the watershed through suitable dispersal habitat.

Accurate estimates of down woody debris component in early and mid seral plantations could help to prioritize for wood cutting opportunities while meeting NW Forest Plan Standards and Guidelines.

Core Topic Question - Species and Habitats

What other threatened, endangered or sensitive species exist in the watershed?

A. Current Condition as Compared to Reference Condition

Threatened, Endangered or Sensitive Species

Many of the TES species are highly associated with special habitats (Map 5-3).

Bald eagle

Thirty-one bald eagles sightings have occurred around Timothy Lake between 1975 and 1995. Forty bald eagles have been sighted at Clear Lake which is approximately 3 miles northeast of Timothy Lake. Another 5 bald eagles have been sighted in the general vicinity of both Timothy and Clear Lakes. No known nesting or roosting bald eagles exist in this area.

As part of the Forest planning process, the Mt. Hood National Forest designated management areas (A13 land allocations) based on the potential management zones identified in the Pacific Bald Eagle Recovery Plan (PBERP). The goal of the A13 areas is to "protect and manage bald eagle nesting ... areas in order to meet or exceed recovery levels established in the Pacific Bald Eagle Recovery Plan" (U.S. Department of Agriculture 1990, Four-201). Ten of these A13 land allocations are located around Timothy Lake (Map 5-2). Portions of other A13 areas exist along the west end of the watershed by the Clackamas River. These areas were not considered suitable nesting habitat because the small size of rivers would not provide an adequate prey base, and the closed canopies preclude access to the rivers (Frenzel, 1993).

Bald eagle foraging habitat around Timothy Lake probably did not exist prior to inundation of the area from the constructed dam. Foraging habitat may have been available in the system of meadows and streams.

Potential for a maximum of one nesting pair of bald eagles exists at Timothy Lake (Issacs 1987). This potential is based on: a) observed eagle activity and nesting osprey suggest adequate prey base; and b) a fairly uniform distribution of trees with adequate size and structure to support nests.

Vegetation component

Bald eagle nests are usually located in multi-storied stands with old growth components, near water bodies that support adequate prey base. Nest trees are usually large, open branching trees and are dominant on the landscape. In Oregon, bald eagles generally select forested stands with dense, high

basal areas in locations with minimal logging or other human disturbances (Anthony and Isaacs 1989).

All of the A13 areas surrounding Timothy Lake have late seral, closed large conifer structure. Closed large conifer refers to stands with canopy closure greater than or equal to 50% and greater than 21" average stand diameter. Average stand size is 35 acres with a total of 374 acres in A13 allocations in this area. A few of the A13 areas lack the large, open-branching tree structure necessary for nesting trees.

Potential bald eagle nesting habitat exists in 5517 acres of late-seral, large conifer stands within the one mile distance around Timothy Lake. A one mile distance was used because it encompasses the greatest distance from the lake of any A13 area (0.875 miles), even though bald eagles usually nest within a quarter mile of water in the Oregon Cascade mountains (US Department of Interior 1986).

Foraging Opportunities

Timothy Lake provides habitat for native and introduced fish species - prey items for bald eagles. Up to 12,000 catchable (6-8" in length) rainbow trout are stocked in Timothy Lake each year. The availability of fish species as forage for bald eagles depends on the productivity and temperature regime of the lake and consequent stratification of fish.

Waterfowl and other wildlife associated with the riparian areas in and around Timothy Lake contribute to the forage base for bald eagles. A paucity of information exists regarding the availability of forage during late winter/early spring.

Forage opportunities would not be expected to fluctuate due to changing lake levels since fluctuations in Timothy Lake are minimal and drawdown usually occurs in the fall.

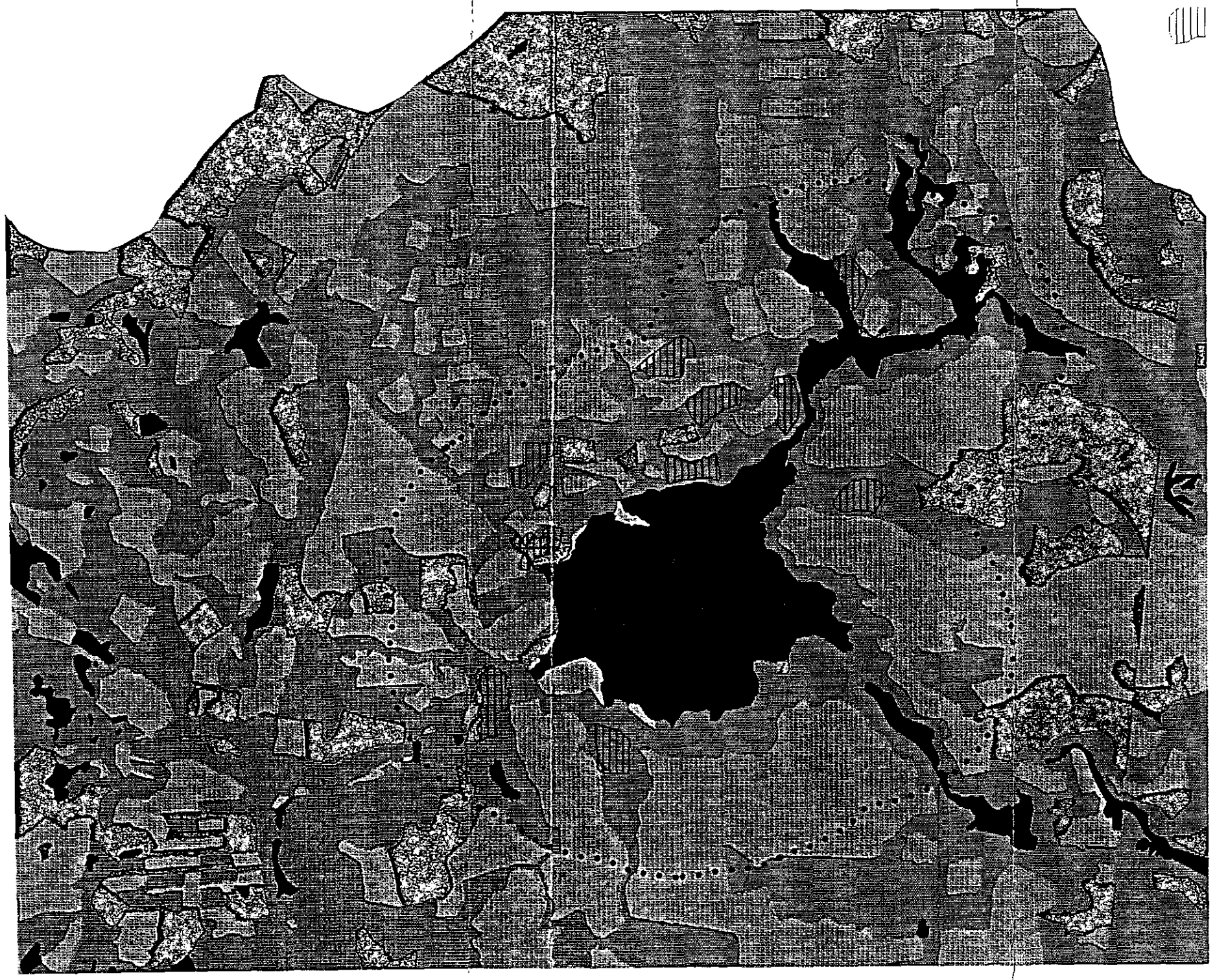
Recreation Conflicts

Timothy Lake receives high recreational use particularly during the summer months. Human activities, including recreation, can impact bald eagles either through permanent or temporary disruption of the eagle's environment (McGarigal et al., 1991). However, bald eagles may still attempt to nest at Timothy Lake primarily because nest building and egg laying occur in late winter/early spring, before the onset of heavy recreational use.

Peregrine Falcon

High Rock, a cliff site with high potential to support peregrine nesting, is located in the watershed. Other sites with some potential to support nesting include Mt. Mitchell cliffs (medium potential) and Pyramid Lake Rocks (low potential). Peregrine falcon presence has not been documented at any of the sites. Potential conflicts at any likely peregrine nesting site include rock climbing and any

Oak Grove Watershed
Bald Eagle Habitat Area With Seral Stage



- Early Seral
- Late Seral
- Mid Seral
- Non Forested
- Bald Eagle Habitat Area
- 1 Mile Boundary

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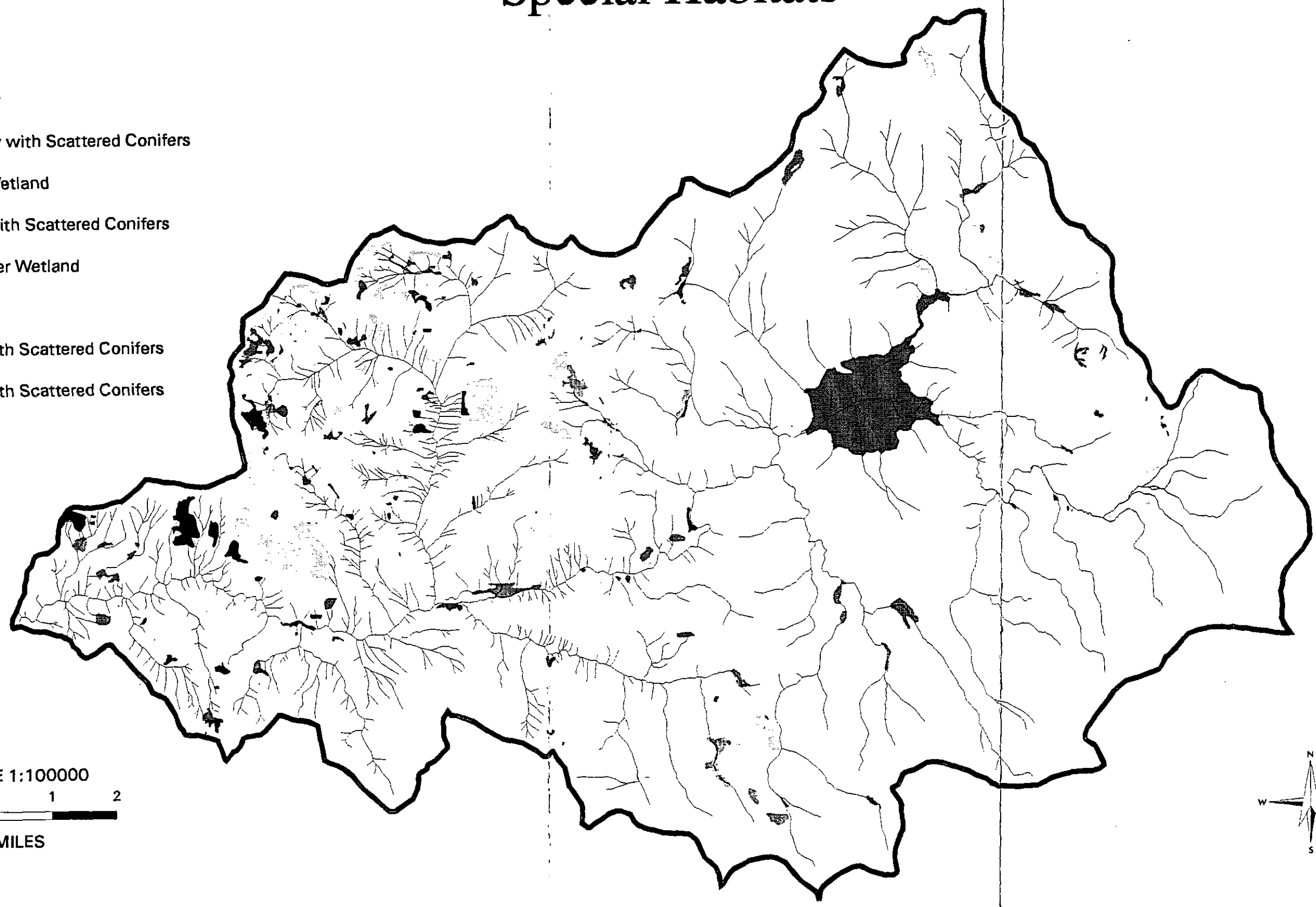
MAP 5-2

Oak Grove Watershed
Special Habitats

- Meadow
- Meadow with Scattered Conifers
- Shrub Wetland
- Shrub with Scattered Conifers
- Red Alder Wetland
- Rock
- Rock with Scattered Conifers
- Talus with Scattered Conifers
- Lakes



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MAP 5-3

unusual loud human disturbances, helicopter and fixed wing overflights, or nearby timber harvest. Perigrine existence in these areas historically is unknown although there is no reason to think they would not be present.

Townsend's Big Eared Bat

A winter hibernacula cluster for the Townsend's western big-eared bat (*Plecotus townsendii*) is present. This site is regionally significant, as it is one of only 26 hibernacula known for the state and one of only two in all of the northwest quadrant of Oregon.

Since the early 1980's, Townsend's big eared bats have been located near the Lake Harriet area. This locality contains a number of old shafts from abandoned mining claims and at least one currently patented claim. Mining activity has focused on cinnabar, though mercury and silver were sought after by at least a few prospectors. Many of the old adits (openings) are collapsed. Of those that remain open at least two locales have been verified as hibernacula: Quicksilver Falls Shaft (also known as the Ames/Bancroft mine) and Lower Oak Grove Shaft (also known as Nesbitt mine). In addition, several cabins in the vicinity and the Oak Grove barn support roosts both summer and winter.

Yearly winter counts of hibernating *Plecotus* bats in the Quicksilver Falls Shaft fluctuates from year to year, with a declining population trend (Figure 5-5).

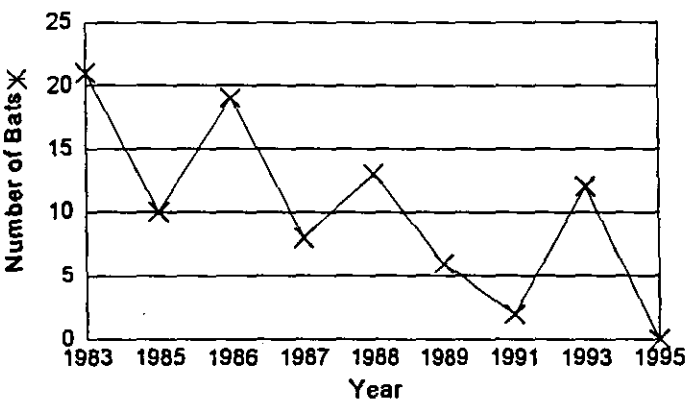


Figure 5-5. Winter counts of hibernating *Plecotus townsendii* at Quicksilver Falls Mineshaft.

Hibernating *Plecotus* were found (3 individuals) in 1988 although surveys had been conducted in two

other years. Summertime nursery roosts could not be located in 1994. A male that was radio tagged and followed for several days was observed foraging around meadows and streams in the Ripplebrook vicinity.

Condition of Hibernacular

Minor disturbances can impact hibernating bats in the winter. In 1992, closure devices were installed on the three open mine shafts accessing bat hibernacula. By the summer or fall of 1995, all of the closure devices had been vandalized. Gates on the access road are commonly breached. Recreational use in the area of the mine shafts is quite high. Vandalism and destruction of protection devices could be a recurring problem.

Bat boxes installed in several campgrounds in the Ripplebrook vicinity (including Lake Harriet campground, Ripplebrook campground and Rainbow campground) and in various clearcuts have been used infrequently.

Bats forage primarily over streams and wetlands and return to the forest to roost. They are the only group of species (with the exception of swifts and swallows) that exhibit such movement patterns. The daily cycle of bats play a potentially significant role in the transfer of nutrients from aquatic areas to upland habitats (Christy and West 1993). Foraging habitat is important even in wetlands smaller than an acre and experts consulted fro the FSEIS felt that the lack of buffer protection provided to small wetlands, under the interim riparian reserve boundaries could compromise viability for several bat species (USFS, et. al,, 1994).

The ROD provision of protection for caves, mines and abandoned wooden bridges and buildings that are used as roost sites for bats include development of management standards and guidelines for the area. Protection of this bat hibernacular could include 1) protection of the cabins, the Oak Grove Barn, and other buildings in the area providing bat habitat even though they are deteriorating (human safety concerns could be addressed by eliminating or discouraging visitors), 2) withdrawing the lands with the inactive mines from the mineral land base and 3) prohibiting timber harvest within 250 feet of the sites containing bats.

Harlequin Ducks

Harlequin Ducks were located once in the Oak Grove watershed on Shellrock Creek in 1991.

Pond Herptiles

The distribution of aquatic amphibians relative to stream gradient, temperature, shade or increased sedimentation is not well known or surveyed. Pacific giant salamanders or Cope's Salamanders have

been repeatedly located near the main stem of the Oak Grove Fork. Other aquatic amphibians presumed to exist in this watershed are the Dun's and Columbia Torrent Salamanders and the tailed frog. Aquatic TES species were probably more abundant, since the aquatic condition in the watershed is modified.

The watershed provides habitat (ponds and moist meadows) for two Forest Service Sensitive amphibians, the Red-legged and Cascade frogs. These species are both diminished in numbers across their range. Both species may be subject to predation by non-native fish. Dispersal between suitable habitats is a concern for amphibian populations. Important dispersal links would include areas between ponds and wetlands, especially those areas not linked by streams.

Neither Northwestern pond turtles nor Western painted turtles are known to inhabit the watershed, though they may have been present historically below 2000' . Western painted turtles persist in the Willamette valley though reproductive success there is extremely low. Reintroduction of these turtles at the low elevation ponds could buffer populations at risk elsewhere in the state.

Plant Species

Several sensitive vascular plant species exist in the Oak Grove watershed most of which are found in meadow or riparian habitats.

- *Agoseris elata*
- *Coptis trifolia*
- *Corydalis aquae-gelidae*
- *Lycopodium selago*
- *Scheuchzeria palustris* var. *americana*
- *Sisyrinchium sarmentosum*

B. Trends

Trend analysis for bald eagle nesting habitat in the Timothy Lake area is based upon implementation of the conceptual design and the recommendations identified below. Upon implementation, Timothy Lake may be capable of supporting up to one nesting pair of bald eagles thereby approaching recovery goals.

Bald eagle nesting habitat is expected to increase over time. The north arm of Timothy Lake will be managed for late seral conditions; thereby providing at least perching opportunities for foraging eagles. As the north arm is enhanced for wildlife, foraging opportunities will increase for bald eagles. If the recreational activities are modified to promote a watchable wildlife area, this decrease in human-associated disturbance may improve the suitability of the area as nesting habitat.

The area surrounding Timothy Lake - outside of the north arm - in which the majority of the A13 areas are located, will be managed as continuous forest. If this is not compatible with management to enhance bald eagle nesting habitat, those A13 areas within the continuous forest design will be managed to promote bald eagle nesting habitat.

If bald eagles nest in the A13 areas, or elsewhere in the vicinity of Timothy Lake, human disturbance will be managed to optimize nesting success. Although human disturbance has been documented as a significant disturbance to nesting bald eagles, this disturbance can be managed to ensure bald eagle nesting success (McGarigal et al. 1991, Garret et al. 1993, Anthony et al. 1995).

Disturbance will remain a potential concern for other TES species, especially peregrines and wolverines. Habitat conditions for other TES species should remain stable or improve with the exception of continued disturbance affecting perigrines and wolverines. Aquatic TES species may continue to be stresses by poor habitat conditions but should improve as riparian reserves function develops.

C. Recommendations

General

Bald Eagle

1. Re-allocate the four A13 allocations on the south and west end of the reservoir, if it is determined from field verification that recreation impacts may preclude bald eagle nesting.

2. Determine if both owl and eagle requirements could be met in the A13 that overlaps with the owl 100 LSR. Re-allocate that A13 if both species requirements can not be met.

3. Identify which stands could be managed to enhance existing and future nesting potential for Bald Eagle with silvicultural treatments.

4. Promote and encourage late seral conditions in the North Arm of Timothy Lake.

5. Cooperate w/ PGE to optimize water level fluctuations for wildlife habitat rehabilitation projects.

6. Maintain and/or increase amount and duration of surface forage for the Bald Eagle

7. Recommend to the State Marine Board to restrict boat use to minimize effects of wave action on shoreline and noise levels in North Arm of Timothy Lake.

Perigrine Falcon

Recommend aerial disturbance restrictions during the perigrine falcon nesting season near the High Rock and Mt. Mitchell Cliff areas.

Bats

1. Prohibit spraying pesticides and herbicides near or around Hibernacula.

2. Close access routes leading into bat hibernacula areas and discourage human visitation.

3. Utilize environmental education opportunities at front desk to raise awareness about the positive functions of bats in the ecosystem.

4. Withdraw mineral shafts from mineral land base.

5. Eliminate or discourage human visitors to deteriorating buildings used by bats. List these buildings on Historical Register where appropriate.

Monitoring

1. Monitor effectiveness of past and future wildlife habitat restoration projects.

2. Monitor for presence of bald eagles, particularly nesting bald eagles around Timothy Lake (at least during mid-late winter)

3. Monitor the effects of humans on nesting bald eagles, should they become established.

4. Monitor coridylas populations and other TES plants.

Information Needs

1. Effect of grazing on Sandhill Crane in Little Crater Meadow and other grazed meadows.

2. C3 species occurrence.

Core Topic Question - Species and Habitats

Are there any other species of concern? Does the amount, distribution and quality of habitat meet the specific requirements for breeding, feeding and shelter?

A. Current Condition as Compared to Reference Condition

Other Species of Concern

At least three elk herds utilize the Oak Grove Watershed: the Ripplebrook Herd, the Clackamas meadows Herd and the Camp Creek Herd (Map 3-1). The Ripplebrook Herd uses the Oak Grove Meadow for winter range and possibly for calving. The herd wanders into higher elevation areas during summer and fall, but seems to stay close to the Ripplebrook area.

The Big Meadows Herd (50-70 head) uses the Clackamas Meadows area (including Little Crater Meadows and other riparian habitats near Big Meadows) extensively during spring green-up and the calf rearing period March - July. The herd tends to move away from the meadows as human activity and grazing increases during summer, often choosing "clumpy" older clearcuts as alternative habitat. This herd winters on the Warm Springs Indian Reservation in the upper portions of the Warm Springs River or to Warm Springs Meadow (though in mild winters the herd may stay on the summer/fall range well into the winter). In the late summer and fall, rutting is concentrated around Buckskin Butte, West Butte, and Summit Butte.

The Camp Creek Herd wanders along the southern edge of the watershed between Summit Lake and Oak Grove Butte. Other elk utilize the watershed sporadically or as a travel corridor.

Most of the elk are considered native, although transplanted elk have been released into the watershed sporadically since the 1920's. Oak Grove Meadow has been a favorite release site.

Potential habitat for another native herd exists in the Upper Shellrock subwatershed, possibly centered around Black Wolf Meadows and Cottonwood Meadows.

Both Calvin et. al. (1995) and Fiedler and O'Connor (1992) documented an elk preference for riparian and meadow habitat throughout the year, especially areas of low road density and gentle terrain. Fielder reported that 70% of radio-collared elk observations occurred within 100 meters of a stream or wetland, while Calvin found all summertime observations on USFS lands within a quarter mile of a stream or water body. Calvin speculated that recreational users near major rivers and lakes may cause elk to avoid those areas. No major changes or movements in response to timber harvest were deduced during Calvin's study in the Oak Grove Watershed, although little was harvested during the study period (1991-1995).

Interspersion of thermal and hiding cover with forage openings is considered ideal for deer and elk. Thermal cover, especially in winter range, is sometimes considered a limiting factor for elk populations (see Mt. Hood LMP, 1990). Thermal cover is classified into four groups (Table 5-1). Some type of thermal cover is available in approximately 80% or the watershed, a suitable amount.

In the Calvin study, elk locations were compared with the distribution of thermal cover. Conclusions indicated that elk were not selecting for thermal cover above its proportion in the landscape, except in lightly forested winter range areas (ponderosa pine stands) of the Warm Springs Indian Reservation.

Elk were uncommon in the watershed historically. Transplants into the Cascades began as early as the 1920's. Habitat conditions for elk were probably excellent around meadows, but limited elsewhere. Modern hunting (with the emphasis on trophy bull elk) has probably changed the age structure of the elk and deer populations.

Table 5-1. Thermal cover in the Oak Grove Watershed.

Thermal Cover Type	Cover Type Definition	Watershed %
Optimal cover	Multistoried canopy with forage present	39
True thermal cover	Trees >40 feet tall with >70% crown canopy closure	
Near Thermal	Trees >40 feet tall with 60-70% canopy closure	25
Marginal Thermal Cover	Trees > 40 feet tall with 30-60% canopy closure	14

B. Trends

Elk populations will decline unless transplant and feeding programs continue to keep elk populations high. This is consistent with forest-wide trends.

C. Recommendations

General

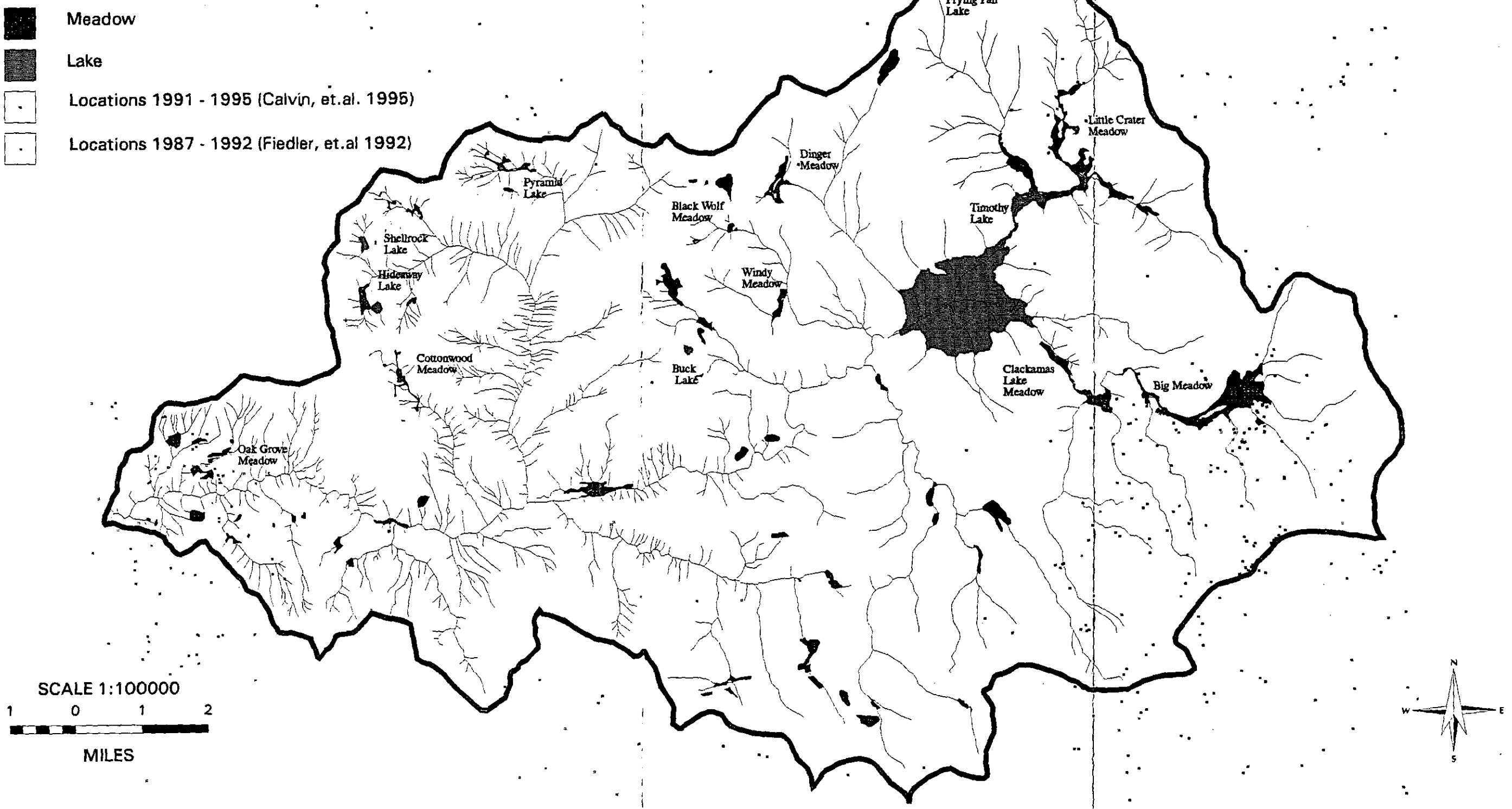
1. Limit human disturbance around key calving sites during the calving season.

2. Maintain areas with higher densities of trees and uneven spacing when pre-commercial thinning.

Information Needs

Investigate herd dynamics in the Upper Shellrock subwatershed.

Oak Grove Watershed
Radio Collared Elk Locations



MAP 5-4

Core Topic Question - Species and Habitats

Are introduced species affecting the distribution and abundance of native fish and other native aquatic species? What processes of habitat components are critical to the balance of supporting one or more native species while supporting other species desired for their recreational opportunities?

A. Current Condition as compared to Reference Condition

Introduction of non-native salmonids into the Timothy Lake Catchment began around the turn of the century. ODFW have stocked 15 lakes within the watershed. Presently, ODFW stocks seven lakes with rainbow trout (including catchable rainbows in Timothy Lake), three lakes with brook trout and two lakes with Westslope Cutthroat Trout (*Oncorhynchus clarki lewesii* from the Twin Lakes genetic stock in Washington). Brook trout are distributed throughout all perennial streams in the Timothy Lake Catchment. Rainbow trout also occur in the Upper Oak Grove Fork.

The stocking of rainbows in Timothy Lake does not appear to have negative effects to cutthroat populations although adequate monitoring is necessary for confirmation. The stocking of catchable rainbows in Timothy Lake provides an effective major recreational fishery within the watershed.

After the construction of the Timothy Lake Dam, kokanee (*Oncorhynchus nerka*) were introduced into Timothy Lake and a large reproducing population exists today.

Natural reproduction of the brook trout occur in five lakes. Six of the eight lakes with present brook trout populations have outlets which allow for escapement downstream, Dinger, Shellrock, Hideaway, Pyramid, Buck and Anvil.

No evidence exists that indicate natural reproduction of hatchery rainbow trout. A rare form of redband type rainbow trout may exist in the Oak Grove above Timothy Lake. Five of the seven lakes stocked with rainbow trout have outlets which allow for escapement. The native coastal cutthroat may hybridize with the rainbow trout or westslope trout which escape the lakes, with consequential reduction in genetic integrity of the native coastal cutthroat. Reduction of survival and fecundity of coastal cutthroat may also result from competition of the brook trout or rainbow trout. Gill net surveys in Dinger and Clackamas Lakes indicate that cutthroat populations were lower that brook trout populations.

B. Trends

Non-native gamefish are probably here to stay in the Oak Grove Fork Watershed. Brook Trout are especially widespread and have become naturalized (natural reproduction) in several streams and in stocked lakes that have suitable spawning habitat. Many of these brook trout populations started

from introductions as far back as the 1930's. Casual observation seems to suggest that most of these brook trout populations are now stable and no longer expanding into new habitat, although data on many of these populations is minimal. Many of the high lakes now with reproducing brook trout populations or those that are stocked semi-annually from the air were originally fishless. Introduced fish also prey on amphibians and native invertebrates in formerly fishless lakes. Non-native west slope cutthroat are also apparently being stocked in some high mountain lakes instead of the harder to raise coastal cutthroat trout. West slope cutthroat can hybridize with native coastal cutthroat when they come in contact with each other.

Cooper Creek, Crater Creek and the upper Oak Grove Fork above Timothy Lake have large populations of brook trout that have probably greatly depressed the native coastal cutthroat trout through competitive interactions. Other factors are possibly altered environmental conditions that brook trout are better adapted to. In the upper Oak Grove Fork above Timothy Lake there is also a small population of unusual appearing rainbow trout (O.mykiss) that may be of native redband stock (genetic testing is under way). In this stream initial observations seem to suggest that 80% of the fish population are now brook trout. It is not known if the presence of brook trout will continue to exert a downward pressure on this small population with possible extirpation. These conditions will continue into the future unless active manipulation of the brook trout populations is taken.

C. Recommendations

The brook trout is also a sought after game fish and its total removal from many streams and the watershed would not only be controversial but probably undesireable from a fisheries management viewpoint.

1. Manipulating or reducing some brook trout populations maybe desirable at certain locations such as the section of the Oak Grove Fork above Timothy Lake. The status of the native fish populations and the impacts from brook trout should be further explored. Native cutthroat trout and possibly redband trout at the above location are being swamped by the prolific brook trout.

2. Discussions should begin between the Forest Service and ODFW about best management practices and future policy for managing high mountain lake fisheries and careful use of exotic trout for stocking. Reproductive interactions between non-native cutthroat trout and native stocks should be prevented from occuring and need careful management. The very casual attitude about fish introductions and utilizing new stocks of fish for stocking high lakes and reservoirs 1. should become a thing of the past. Management is needed but joint management and good communication is a priority need for the future.

3. Presently fishless lakes should remain unstocked in the future to protect amphibian populations and other native invertebrates. Fish introductions into fishless lakes almost always results in dramatic

changes to the organisms inhabiting stillwater habitats with many native organisms being severly reduced or eliminated.

Chapter 6

Core Topic - Water Quality

Core Topic - Water Quality

Is Livestock Grazing Affecting Water Quality in the Upper Oak Grove Watershed?

A. Current Condition Compared to Reference Condition

Livestock grazing has occurred in the Upper Oak Grove watershed since the turn of the century. As many as 663 head of cattle grazed in the area in 1937. We have no baseline data to indicate the quality of water within the watershed prior to the advent of grazing. Currently there is one active allotment within the watershed.

The permit for the Wapinitia Allotment allows for 100 cow/calf pairs. The Clackamas Lake Allotment, which has been vacant since 1992, had a permit for 28 cow/calf pairs. The Warm Springs Reservation currently authorizes livestock grazing. Some livestock from the reservation drift into the USFS managed portion of Upper Oak Grove Fork. The Wapinitia Allotment covers 26,324 acres in both the Salmon River, White River and Oak Grove watersheds. Approximately 1/3 of the allotment area occurs within the Timothy Lake Area.

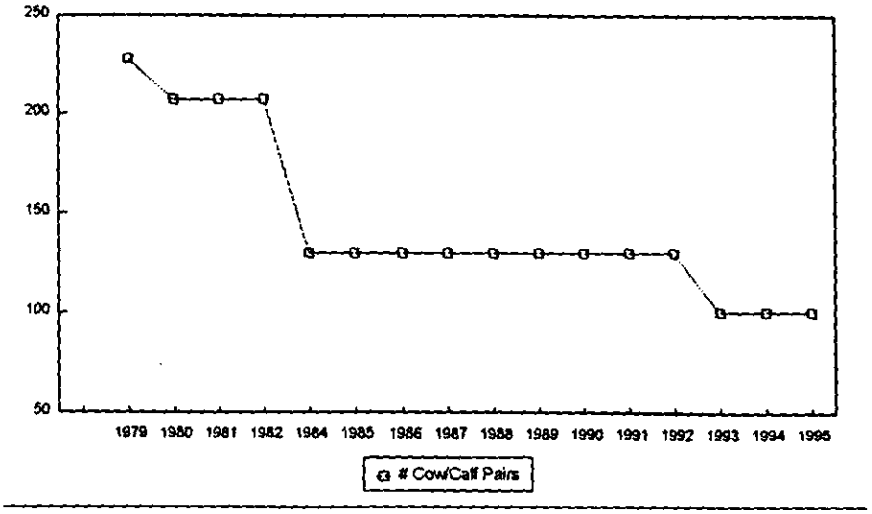


Figure 1. Number of cow/calf pairs in the Wapinitia Allotment. Data from 1983 is not included because the allotment was rested that year.

During 1993 the Wapinitia Grazing Allotment management plan was updated "to implement a resource protection strategy for sensitive areas". According to the plan, within the Oak Grove watershed, livestock were to be eliminated from Crater Creek, Cooper Creek wet area near road.

5890-230 and the North Arm of Timothy Lake. Grazing was to continue on a deferred rest-rotation system in the Little Crater Meadow complex, Dry Meadow, Stringer Meadow and Frying Pan Lake. Only one hundred cow/calf pairs (300 AUM's) would be allowed to graze on the allotment until all of the above mentioned areas were protected. Once these areas were protected the number of cow/calf pairs could be increased to 130. As of 1995, livestock exclosure fences have been constructed around 0.5 miles of Crater Creek and 0.5 miles of East Fork Crater Creek to control forage utilization. Current cow/calf pairs remains at 100.

High utilization levels (greater than 30%) occurred in the 1994 grazing season (Figure 2). This year had higher utilization levels due to a combination of factors: 1) cows spent more time in riparian areas during the dry, 1994 season and management strategies including fencing, or lack of, in some areas allowed concentrated utilization to occur. The Mt. Hood Forest Plan specifies utilization levels not to exceed 30-35% in riparian areas of all allotments.

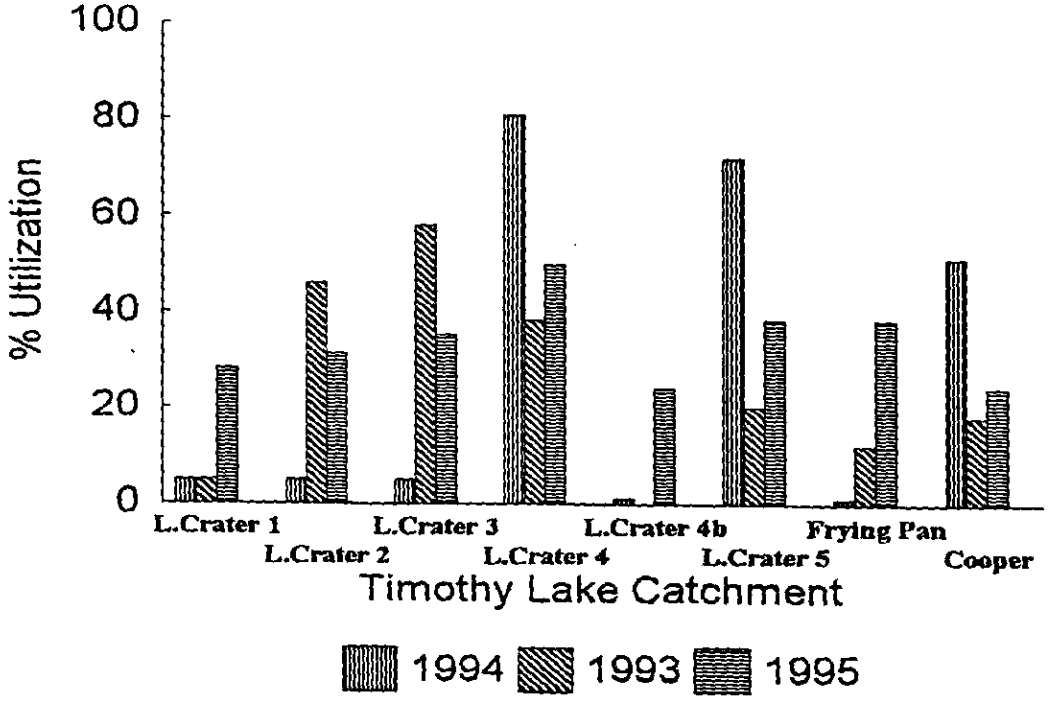


Figure 2. Range forage utilization at monitoring sites in the Little Crater Meadow Complex, Frying Pan Lake and Cooper Creek wet area, 1993-1995.

Three of eight sites (Little Crater sites 1, 2 and 4b) have been fenced at least ten years. Little Crater 3 was fenced during the 1993 grazing season. Little Crater 5 was fenced during 1995. Little Crater 4 is the only non-fenced portion of the meadow complex. The Wapinitia AMP identified fencing and grazing strategies, i.e. deferred rest-rotation grazing at Little Crater 1, 2, 3, 4b and 5, which were initiated in 1994 but have not been completed.

In general, improper range management practices may affect water quality in three ways: fine sediment introduction; increased water temperature; and increased bacterial concentrations through addition of animal wastes to the streams (Platts, 1981).

Sediment

When fine sediment levels are increased beyond the stream's ability to transport it downstream during bankfull flows, fine sediment may alter the substrate composition. This can be detrimental to the reproductive success of salmonids and eliminate habitat and diversity of macro invertebrates that require larger sized substrates for colonization (Waters, 1995). Elevated sediment input may also change the physical structure of stream channels by causing channel widening and pool filing. Primary sediment input resulting from riparian livestock over-grazing occurs from streambank sloughing due to removal of herbaceous riparian vegetation and stream crossings. E and C channel types are the most susceptible to over-grazing because they are dependent on root strength provided by riparian vegetation for stability. If the riparian vegetation is removed streambanks slough during bankfull flows (Rosgen, 1993).

Fine sediment level (cumulative particle size > 6 mm) greater than 20% is considered in exceedance of biologically significant levels (Bjornn and Reiser, 1991). Fine sediment levels in Upper Oak Grove Fork and Cooper Creek exceed the biologically significant levels (Table 6-1). Cooper Creek has the highest sediment levels which is attributable to stream bank sloughing along a short reach adjacent to the Cooper Creek wet area (river mile 0.9-1.2). This reach historically was a forested B channel but clear-cut timber harvesting, with no riparian buffer, created a frost pocket condition that has made reforestation difficult. Livestock continually graze upon grasses and forbes that attempt to propagate themselves along the streambanks within this reach. The result is massive streambank sloughing that is contributing large amounts of fine sediment to Cooper Creek. Past attempts to exclude livestock through fencing and replanting have been unsuccessful. The Wapinitia AMP recommends fencing the frost pocket area along Cooper Creek to exclude livestock but due to lack of funding the recommendation has yet to be implemented.

The Upper Oak Grove Fork is not within the Wapinitia Allotment. The stream does, however, originate inside of the Warm Springs Reservation and is within the Clackamas Lake Allotment. Cattle grazing effects within riparian areas adjacent to Upper Oak Grove Fork within USFS managed lands were not detected. Recreational livestock, however, may be contributing some sediment from Joe Graham horse camp and stream crossings. The extent of cattle grazing effects within the Warm Springs Reservation is unknown. How much, if any, sediment is being delivered from the

Reservation to Forest Service managed reaches in the Upper Oak Grove Fork is uncertain since the Upper Oak Grove Fork contains both transport and depositional reaches within the reservation.

Table 6-1. Sensitive stream reaches (C and E channels), miles protected from livestock grazing within the reach and % fine sediment less than < 6 mm, measured by Wolman pebble counts within the Timothy Lake Area.

Stream	River Miles	Channel Type	Miles Protected	% Fines < 6mm
Cooper	0.0-0.6	C4b	0	**49**
Crater	0.0-1.9	C6c-	0.5	15.9
Dinger	1.4-1.7	C4b	Outside of Allotments	19.7
	2.4-2.7	E4b	"	N.A.
East Fork Crater	0.0-0.4	C4b	0.3	16.8
	0.4-0.6	E4	0.2	N.A.
Upper Oak Grove	0.5-1.2	C4	0	**30**
	1.2-2.3	E4	0	**39.3**

Fine sediment levels in streams flowing through the Little Crater Meadow complex do not exceed biologically significant levels. This could be a result of the reduction cow/calf pairs and/or the exclosure fences around portions of the streams and the deferred rest-rotation grazing system. An interesting note is that measured particle size in a B reach of Crater Creek upstream of the meadow complex (river mile 1.64) was 84.9% and only 15.9% at the downstream end of the meadow. This indicates that fine sediment is settling out in the low gradient reaches flowing through the meadow. Thus the meadow complex may be acting as a sediment filtering mechanism.

Temperature

Water temperature is a major determinant of aquatic biological production. Removal of streamside vegetation along smaller streams increases stream temperatures during low flow periods in summer months and decrease winter temperatures. Stream temperatures, generally, are not excessively high within the Timothy Lake Catchment as Crater Creek, East Fork Crater, and Upper Oak Grove are well regulated, spring fed streams. Most of their flow originates in meadows not far upstream from Timothy Lake.

Cooper Creek has the highest stream temperatures within the Timothy Lake Catchment (Table 6-2). Much of the stream heating may be occurring within the frost pocket reach previously mentioned due to the lack of shade providing riparian vegetation. Suppression of herbaceous riparian vegetation is resulting from uncontrolled riparian livestock grazing.

Table 6-2. Stream temperatures within the Timothy Lake Catchment during 1995. *-Grab sample.

STREAM	# OF DAYS >14.4°C	7 DAY AVERAGE HIGH TEMP (°C)	MAXIMUM TEMPERATURE (°C)
Cooper	28	15.8	17.2
Dinger	14	15.4	16.8
Crater	0	NA	8*
East Fork Crater	0	NA	8*
Upper Oak Grove	0	NA	8*
Stone	NA	NA	NA

Bacterial Concentrations

Water pollution from livestock waste is determined by the numbers and kinds of bacteria present, particularly fecal coliform types (Clark and Gibbons, 1991). Fecal coliform data has not been collected from streams within the Upper Oak Grove watershed. However, nutrient data from Crater Creek was collected during 1993.

Table 6-3. Measured phosphorous, nitrates and ammonia levels at two sites in Crater Creek during the fall, 1993.

STREAM	TOTAL DISSOLVED PHOSPHOROUS (mg./l.)	NITRATES/NITRITES (mg./l.)	AMMONIA (mg./l.)
Crater Creek (meadows)	.033	.049	.04
Crater Creek (mouth)	.033	.006	.005

Nutrients were higher in Crater Creek within Little Crater Meadows than downstream of the meadows on one day in the fall of 1993. This difference between these two sites may be attributable to nutrient loading from livestock waste or could be within the range of natural variation for this meadow system. All these nutrient levels are well below the maximum limits established by the USEPA for drinking water .

Wastes from recreational livestock along trails paralleling Upper Oak Grove Fork and Joe Graham horse camp may be entering the stream.

B. Trends

The high sediment levels from stream bank sloughing and the high tempertures due to the lack of herbaceous vegetation in the frost pocket area along Cooper Creek will continue unless livestock is excluded from these areas. The Wapinitis AMP recommends fencing the frost pocket area.

Range condition and trend studies were established in 1980 and are repeated every five to ten years. The purpose of conducting range condition and trend studies is to evaluate livestock grazing impacts on vegetation and soil over the long term. If an area is in "fair" or "poor" condition, with a downward trend, livestock adjustments should be made to attain an upward trend in vegetation and soil conditions. If vegetation and soil are in "good" condition, livestock should be managed to prevent a downward trend. Data is available for Little Crater Meadows and Frying Pan Lake. Little Crater Meadows has a "fair" condition with a "stable" trend. Frying Pan Lake has "good" condition and with a "stable" trend.

Given that a majority of the riparian areas within the Crater Meadow Complex are managed under a deferred, rest-rotation grazing strategy and that the riparian forage utilization should not exceed 30-35%, sufficient riparian vegetation should be present to "buffer" cattle feces from entering Crater and East Fork Crater Creeks. However, the effectiveness of the riparian vegetation in preventing cattle waste from entering Crater Creek along the non-fenced portion is not verified.

C. Recommendations

<u>General</u>

The streams flowing through the Little Crater Meadow complex and the Upper Oak Grove Fork are very sensitive to increased sediment input. These streams are low gradient, depositional, spring fed systems. They do not show indications of seasonal peak flows capable of transporting large amounts of introduced fine sediment. Intensive livestock grazing regulation should continue to prevent cattle induced streambank sloughing and subsequent sediment delivery.

Improve riparian conditions within the frost pocket along Cooper Creek by 1) accomplishing objectives of the Wapinitia AMP of providing riparian exclusion fencing and 2) establishing shade providing vegetation.

Prohibit grazing outside of the allotment.

<u>Monitoring</u>

Monitor sediment and bacteria levels in the Upper Oak Grove Fork at the Reservation / USFS

boundary to assess potential effects from cattle grazing within the Reservation.

Monitor fecal coliform above and below the meadows along Crater Creek and above and below the Joe Grahm horse camp to estimate any excessive bacterial contribution to the stream by livestock waste.

Chapter 7

Core Topic - Stream Channel

Core Topic Question - Stream Channel

Have the basic morphological characteristics of streams changed? If so, what are the causes of these changes and have these changes affected any species dependent upon riparian and /or stream habitats?

A. Current Conditions as compared to Reference Conditions

Peak flows are critical to a watershed function as the relative frequent peak flows (2-25 year events) are the channel maintenance flows and the relative infrequent peak flows (50 and 100 year events) are floods which can change the channel and riparian vegetation. During peak flows, streambank and beds are scoured and large quantities of sediment is transported downstream. Increases in peak flows can cause excessive scour and or sediment transport and can result in risk of life and property.

Increased peak flows could result from excessive timber harvesting reducing amount of area in a hydrologically recovered condition or excessive road densities increasing overall drainage density and transporting water more rapidly than natural processes. Increased road densities increase the amount of water delivered to surface streams, affecting the timing and magnitude of peak flows.

The water available runoff model in the Standard Methodology for Conducting Watershed Analysis (1993) was used to assess changes in peak flows from the reduction of area in a hydrologically recovered condition. 'Unusual' in this model was estimated as unusually high air temperatures, high winds or greater than normal precipitation. In this model, a change of 10% or greater was considered a significant increase in peak flows. Percentage change in peak flows estimated by this model are available for each Oak Grove subwatershed in the Analysis File.

To assess the potential expansion of the channel network from road ditches the length of road ditch directly accessing the stream was added to the length of streams. Since the exact culvert spacing could not be determined for each subwatershed, a 'best case' scenario (200 feet spacing) was used. A 10% potential increase in channel network from road ditches was used to prioritize which subwatersheds could have the greater effects from channel network expansion and consequently be prioritzed for restoration.

Timothy Lake Catchment

Channel Condition

Timothy Lake Subwatershed was estimated with increased peak flows during average 2 year flow events (Table 7-1) and have a 14% increase in stream channel expansion due to roads (Table 7-2). The state of hydrologic recovery cannot be directly correlated with stream channel condition in this

subwatershed because it consists of smaller frontage drainages rather than drainages that exit the subwatershed at one point. Results from the model indicate that all the other subwatersheds in this catchment area had increased peak flows for at least one unusual channel forming event and greater than 10% increase in stream channel expansion due to roads.

Table 7-1. Increases in Peak Flow Events in the Oak Grove Watershed.

Catchment Basin Subwatershed	Average 2 Year Event	Unusual Year Event
Lower Oak Grove		
Lower Oak Grove	No	No
Lake Harriet		
Anvil	No	2, 5, 10, 25, 50
Cot	No	2, 5, 10, 25, 50
Lake Harriet	No	2, 5, 10, 25
Middle Oak Grove	No	2, 5, 10, 25
Shellrock & High Rock	No	2, 5, 10
Peavine	No	2, 5, 10
Kink	No	2, 5
Stone	No	2
Buck	No	2
Timothy Lake		
Timothy Lake	Yes	2, 5, 10, 25, 50, 100
Dinger	No	2, 5, 10
Upper Oak Grove	No	2, 5
Crater	No	2, 5
Cooper	No	2, 5

Large woody debris accumulation or removal from stream channels is the result of natural events, natural processes, and human activities. Natural events include flood, and landslides. Natural processes include such things as the passive contribution of LWD to the channel from the riparian area, and the natural tendency of LWD to gradually migrate downstream. Timber harvest, stream channel "cleanups," residential development, and road construction are human activities that affect the amount of LWD that is present in a stream channel. The presence or absence of large wood in a stream channel dramatically affect stream characteristics, i.e. shape, velocity, and temperature.

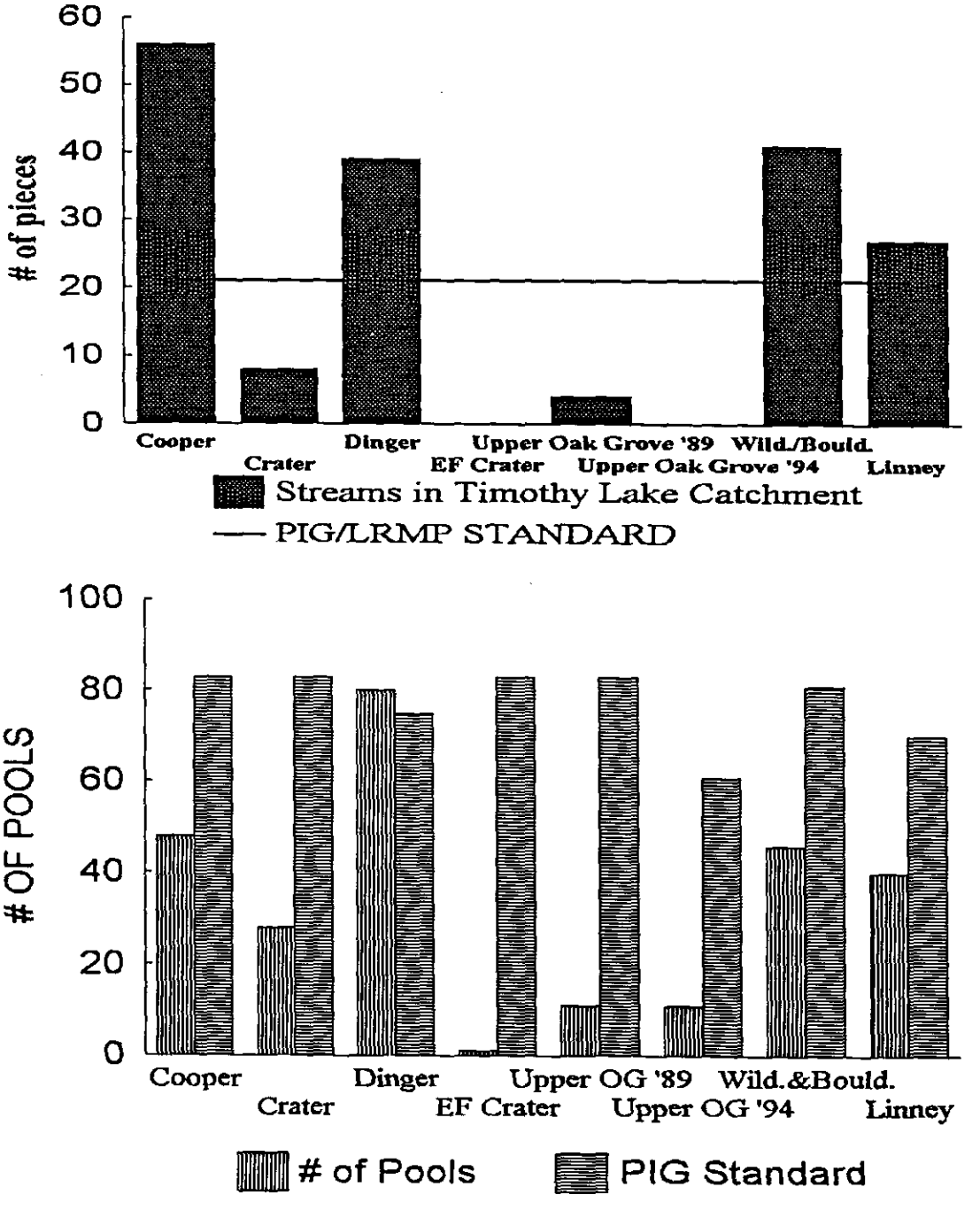
Table 7-2. Stream Crossings and Channel Network Expansion from Roads.

Subwatershed	Natural Stream miles	Stream Crossing #	Expanded Stream miles	Total Length miles	Change Percent
Lower Oak Grove	47.3	133	10.1	57.4	21
Lower Oak Grove Catchment	**47.3**	**133**	**10.1**	**57.4**	**21**
Shellrock & High Rock	79.4	152	11.5	91.0	14
Middle Oak Grove	30.5	53	4.0	34.5	13
Anvil	13.0	23	1.7	14.8	13
Stone	27.6	38	2.9	30.5	10
Lake Harriet	20.2	46	3.5	23.7	17
Peavine	28.3	37	2.8	31.1	10
Buck	6.7	21	1.6	8.3	24
Cot	10.6	7	0.5	11.1	5
Kink	13.1	26	2.0	15.1	15
Lake Harriet Catchment	**229**	**403**	**30.5**	**260.0**	**13**
Timothy Lake	22.2	42	3.2	25.4	14
Dinger	10.4	19	1.4	11.9	14
Crater	17.8	37	2.8	20.6	16
Cooper	13.7	23	1.7	15.5	13
Upper Oak Grove	32.4	40	3.0	35.4	9
Timothy Lake Catchment	**96.5**	**161.0**	**12.2**	**108.7**	**13**
Watershed Total	**373.3**	**697.0**	**52.8**	**426.1**	**14**

Instream large woody debris levels and number of pools in Dinger and Cooper are comparable to the Upper Boulder Creek and Linney Creek levels in the Badger Creek Wilderness Area (Figure 7-1).

The LWD levels in Dinger and Cooper Creeks meet the PIG standard (20 pieces/mile). The number of pools in Dinger Creek meet the PIG standard but the number of pools in Cooper Creek and the wilderness streams do not.

Figure 7-1. Large Woody Debris and Pool Levels in the Timothy Lake Catchment.



Dinger and Cooper Creek water temperatures were above state standards for an extended period in 1995 (Table 6-2). The annual maximum temperature in Cooper Creek (17.2oC) in 1995 was higher than ideal for cutthroat trout and may favor brook trout (Bjornn and Reiser 1993). Maximum temperatures in Dinger and Cooper Creeks were higher than Upper Boulder and Linney Creeks in the Badger Wilderness Area. The percentage early seral in Dinger (27%) and Cooper (22%) Subwatersheds were higher than the RNV (5-15%) established in REAP for the Clackamas River Basin (Map 7-1). The ability of riparian areas adjacent to ephemeral and intermittent channels to produce and deliver LWD to perennial channels has been compromised along Dinger and Cooper Creeks in some reaches due to harvest units in the riparian area.

The number of pools in the stream reaches surveyed in Crater Creek and Upper Oak Grove Subwatersheds are below the range of natural condition as defined in both the White River and Salmon River Watershed Analysis and do not meet PIG standards. In Crater Creek and Upper Oak Grove, these conclusions may be misleading because the Region 6 stream survey protocol does not include glides in the pool category. Glides are the dominant pool habitat form in E channel types which exist in Crater (35% of surveyed channels) and Upper Oak Grove Subwatersheds (65% of surveyed channels). Glides provide the same benefits to fish as pools but are physically different in that water is held in a glide by low gradient uniform bottom without a hydraulic control (Dore and Loitz, 1995).

Stream reaches in Crater and Upper Oak Grove Subwatershed consist of E and C channel types which do not depend upon LWD for channel roughness or habitat complexity . These channel types are dependent upon herbaceous and shrubby riparian vegetation for stream bank stability.

Increased fine sediment supply can detrimentally effect fish and other aquatic organisms by filling pools, covering spawning gravels, and physically changing channel shape, sinuosity and the pool to riffle ratio. All the fish bearing creeks in the Timothy Lake Catchment had greater than 20% surface fines (6mm diameter) with the exception of Dinger Creek. This can decrease the survival of resident salmonids embryos and alevins due to fine sediment blocking the flow of oxygenated water through the gravel to the embryos and embedding gravels preventing emergence (Bjornn and Reiser 1991).

Fish and Other Aquatic Species

The Timothy Lake Catchment is inhabited by non-anadromous salmonids in approximately 9.5 miles of perennial fish bearing streams. Coastal cutthroat trout, sculpin and possibly, the redband rainbow trout (genetic testing needed for confirmation) are endemic to this Catchment. Redband cutthroat, *Oncorhynchus mykiss spp.*, is listed as a sensitive species on the Mt. Hood National Forest. Long time anglers (Gardiner and Greene, 1994) reported catching rainbow appearing trout, as well as cutthroat trout in the Timothy Meadows area, years before the construction of Timothy Lake. They didn't recall catching rainbows below the meadows area.

Today hatchery stock catchable rainbow trout are stocked in large numbers annually at the campgrounds in Timothy Lake, Lake Harriet and the Lower Oak Grove Fork, as put and take fisheries. Most catchable hatchery rainbows are harvested or die before the end of one year. Hatchery rainbows are a valuable food source for resident osprey and bald eagles.

Bull trout (Salvelinus confluentus) may have occupied this area prior to the construction of the Timothy Lake Dam, however positively identified bull trout have not been documented. Timothy Lake supports a large population of small kokanee salmon, a favored food source of bull trout. This large reservoir also has cold water tributaries that may be suitable for spawning by bull trout. Habitat degradation and or the introduction of brook trout are possible causes for the absence of bull trout. Hybridization and competition with brook trout has depressed or caused extinction of several native bull trout populations in Oregon (Dambacher et al. 1992).

Lake Harriet Catchment

Channel Condition

Anvil Creek, Cot Creek, Middle Oak Grove, and Lake Harriet Subwatersheds have increased peak flows in all the unusual channel forming events (Table 7-1). All of the subwatersheds in the Lake Harriet Catchment have increased peak flows in at least one unusual event, the 2 year event. Anvil Creek and Cot Creek have increased peak flows for the unusual 50 year event also. All of the subwatersheds except Cot Creek had 10% or greater increase in channel network due to roads (Table 7-2). These increases in peak flow events can change the channel structure and riparian vegetation.

Although Lake Harriet Subwatersheds has increased peak flows for unusual channel forming flow events, this subwatershed consists of frontage sub-drainages into Lake Harriet so the hydrologic recovery condition can not be directly related to stream channel condition.

Large woody debris levels were below the LMP standard for reaches in Anvil, Middle Oak Grove and Shellrock / Highrock Subwatersheds (Figure 7-2). Pools per mile were below LMP standards in all the reaches surveyed in the Lake Harriet Catchment except the Middle Oak Grove Subwatershed.

In the three reaches that were surveyed, Anvil Creek had low small woody debris levels and one reach with low large woody debris levels compared to 3rd order wilderness streams (Analysis File). One reach in Peavine Creek also had low large woody debris levels compared to 3rd order streams. One reach in Shellrock Creek had low primary and total pools as compared to 5th order wilderness streams.

The increased percentage of early seral stands in the riparian areas compared to RNV (5-15%)

established in REAP for the Clackamas River Basin were highest in Anvil (28%), Kink (28%) and Stone (27 %) Subwatersheds of Lake Harriet Catchment (Map 7-1).

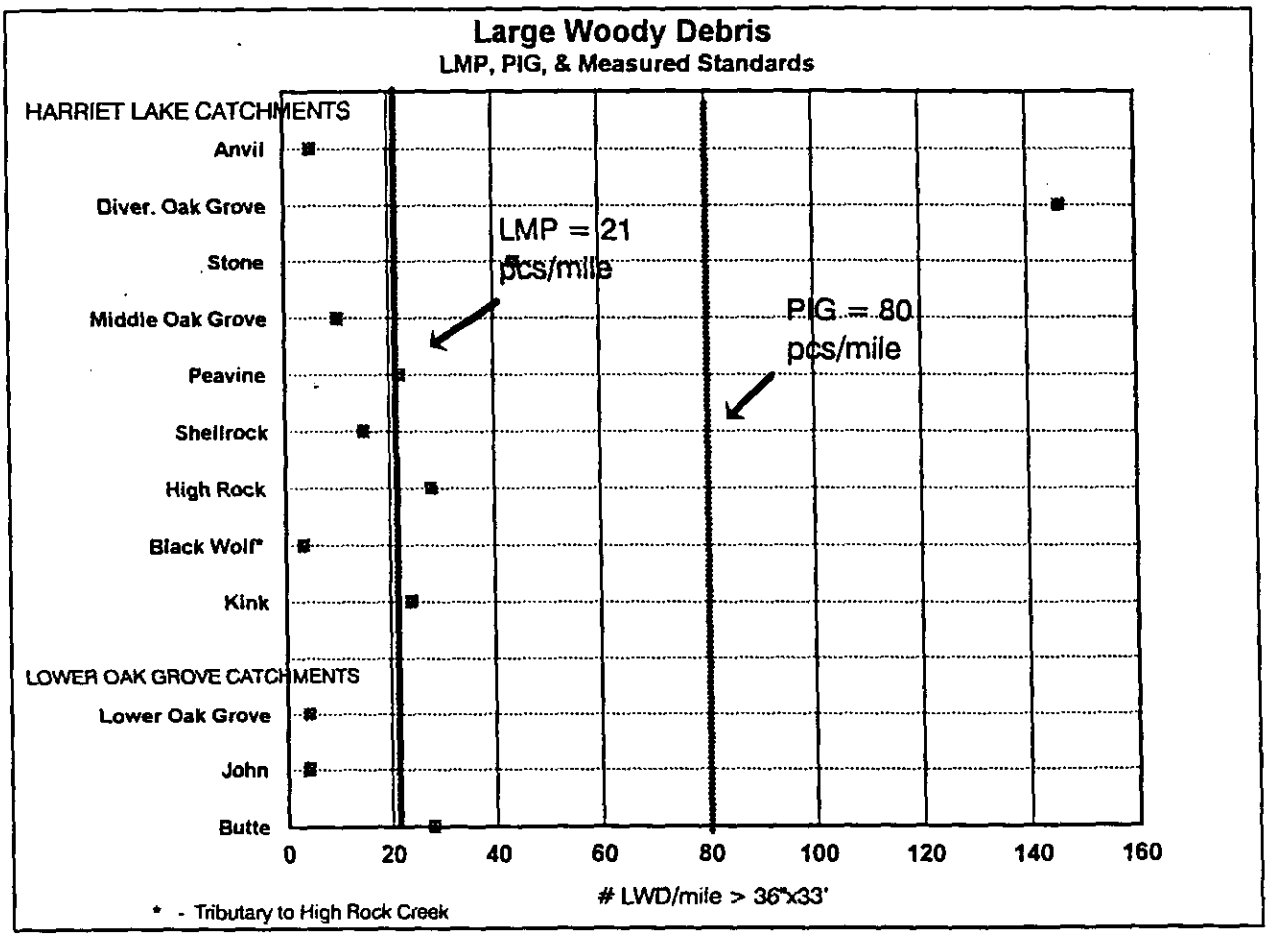


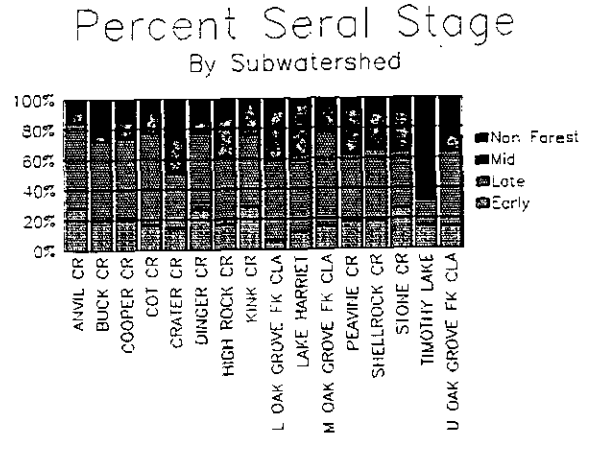
Figure 7-2. Large Woody Debris levels compared to LMP and PIG Standards in the Lake Harriet and Lower Oak Grove Catchments.

Fish and Other Aquatic Species

Degraded stream channel conditions are evident from this analysis with particular concern for Anvil Creek, Shellrock/High Rock, and Kink Creek due to three or more of the processes or structural components changed from a reference condition (Table 7-3). In Anvil, Shellrock/Highrock, Stone Creek and Kink Creek, afects to fish species populations have not been determined (Stream Surveys) Large populations of cutthroat exist in Shellrock Creek (USDA 1994) which supports a high quality fishery (USDA 1996, Gardiner and Greene, 1994).

These changes in structural components and processes in the Middle Oak Grove and Lake Harriet

Oak Grove Watershed
Riparian Reserves By Seral Stage



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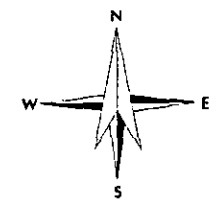


MAP 7-1

Subwatersheds and their effects to fish species were discusse in Chapter 1.

Table 7-3. Process changes in the Aquatic Ecosystem.

Subwatershed	Increased Peak Flows	Increased Road Network	Pools < LMP standards	Pools < wilderness streams	LWD < LMP standards	LWD < wilderness streams	Increased Early Seral Compared to RNV
Anvil	**High**	Low	**Yes**	No	**Yes**	**Yes**	**High**
Shellrock Highrock	Low	**High**	**Yes**	**Yes**	**Yes**	No	Low
Kink	Low	**High**	**Yes**	No	No	No	**High**
Lake Harriet	**High** effects comp-ensated	**High**	No	No	**Yes**	No	Low
Middle Oak Grove	**High** effects comp-ensated	Low	**Yes**	No	**Yes** except in diversion reach	No	Low
Peavine	Low	Low	**Yes**	No	No	**Yes**	Low
Stone	Low	Low	**Yes**	No	No	No	**High**
Buck	Low	**High**	Not Surveyed	Not Surveyed	Not Surveyed	Not Surveyed	Low
Cot	**High**	No	Not Surveyed	Not Surveyed	Not Surveyed	Not Surveyed	Low

Bold indicates changes of most concern.
Shaded subwatersheds have the most changes.

B. Trends

Timothy Lake Catchment

From the model results, all of the subwatersheds in the Timothy Lake Catchment had increased peak flows which will continue unless the rate of decreasing hydrologically recovered vegetative conditions is less than the rate that areas that are currently hydrologically unrecovered establish an adequate canopy cover. This is primarily a concern in the Timothy Lake Subwatershed. Decreasing roads in this catchment will also decrease the affects to peak flows.

The riparian condition of Dinger and Cooper Creeks may improve with time as areas in early seral condition grow into mid seral condition. The frost pocket area on Cooper Creek my never provide adequate shade or large woody debris. Increased fine sediment loading in Upper Oak Grove and Cooper Creek may continue unless grazing impacts are mitigated.

Brook trout appear to be dominating the Upper Oak Grove Fork above Timothy Lake and potentially could be reducing the scarce, redband appearing rainbow, as well as cutthroat trout populations. Few hatchery rainbows seam to be naturally reproducing before being harvested. Hatchery rainbows could continue to be stocked to supply high recreation demand at the hydroelectric reservoirs.

Lake Harriet Catchment

From the model results, all of the subwatersheds in the Lake Harriet Catchment had increased peak flows which will continue unless the rate of decreasing hydrologically recovered vegetative conditions is less than the rate that areas that are currently hydrologically unrecovered establish an adequate canopy cover. Decreasing roads in this catchment will also decrease the affects to peak flows. Anvil and Cot Subwatersheds are of primary concern for lack of areas in hydrologically recovered condition. Decreasing roads in this catchment will also decrease the affects to peak flows, with primary concern of eliminating roads in Shellroack/Highrock, Kink, Buck, and Lower Harriet Subwatersheds.

Since Anvil Creek has low CWD levels and a high percent of the riparian reserve is in eary seral stage, this channel will continue to lack CWD unless some is imported.

Cutthroat trout appear to be maintaining current populations in the Lake Harriet Catchment. Some long time anglers (Gardiner, 1995) report fewer fish over 12 inches and a very gradual reduction in the quality of the fishery from earlier decades. PGE's Oak Grove Project including Timothy Lake appears not to have diminished this population in several decades of project operation. Potentially the increase in local metro population may result in increased fishing pressure. The Stone Creek

Chapter 7 Core Topic - Stream Channel

Hydroelectric Project reduced existing habitat and may have reduced the carrying capacity for the cutthroat population in approximately the first mile of the Oak Grove Fork downstream of its diversion (USDA 1994 and USDA 1996). The remainder of the Stone Creek Hydro Project diversion reach is maintaining a strong population of cutthroat trout.

C. Recommendations

Reduce or maintain the amount of area not hydrologically recovered throughout the watershed with particular concern for the following subwatersheds: Timothy Lake, Middle Oak Grove, Cot Creek, Anvil Creek, and Lake Harriet.

Close roads to decrease the expansion of the channel network throughout the Oak Grove Watershed (See ATM).

Restore shade of Dinger and Cooper Creeks in the Timothy Lake Catchment.

Explore with ODFW, possibilities of reducing brook trout competition or numbers in the upper Oak Grove Fork above Timothy Lake to benefit native rainbow trout populations. A variety of options should be explored including use of local angling organizations to help limit brook trout impacts.

Open discussions with ODFW about cooperative trial project to establish bull trout in Timothy Lake. A weir and trap system would have to be established on spawning stream in order to keep brook trout separate and from spawning with bull trout. The Warm Springs Tribe has verbally expressed interest (Terry Luther, 1992) in providing Warm Springs bull trout breeding stock possibly, if a management strategy is developed with ODFW.

Implement fish habitat enhancement on the mainstem Oak Grove Fork in the uppermost two miles of the diversion reach of the Stone Creek Hydro Project.

Introduce wood into Anvil Creek and Peavine Creek as LWD levels are low and poor recruitment potential exists in these subwatersheds.

Manipulate new LWD jam upstream of the Shellrock Bridge so the water does not compromise the bridge integrity.

Replace Anvil Creek culverts at crossings with Road 5810 and 57 with structures suitable for 100 year events.

Replace deteriorating, undersized culverts on Road 4630 upstream of Lake Harriet.

Chapter 8

Core Topic Question - Erosion Processes

Core Topic Question - Erosion Processes

What are the major sediment delivery processes and where do they occur in the watershed? Do turbidity levels deteriorate water quality for present or future municipal water supply uses?

A. Current Condition as compared to Reference Condition

Landslides, roads, and recent harvest units were considered the major sediment delivery processes in the watershed.

Landslides

The landscape in the eastern portion of the watershed has been only slightly modified by erosion. In contrast erosional processes dominate the landscape in the western portion of the watershed due to weaker and older geological units which have resulted in deeply incised drainages and steep slopes. The weak materials and steep slopes contribute to many landslides in the western portion. The Lower Oak Grove channel is constricted by large ancient (Quarternary) landslide deposits, which could reactivate and encroach upon the river.

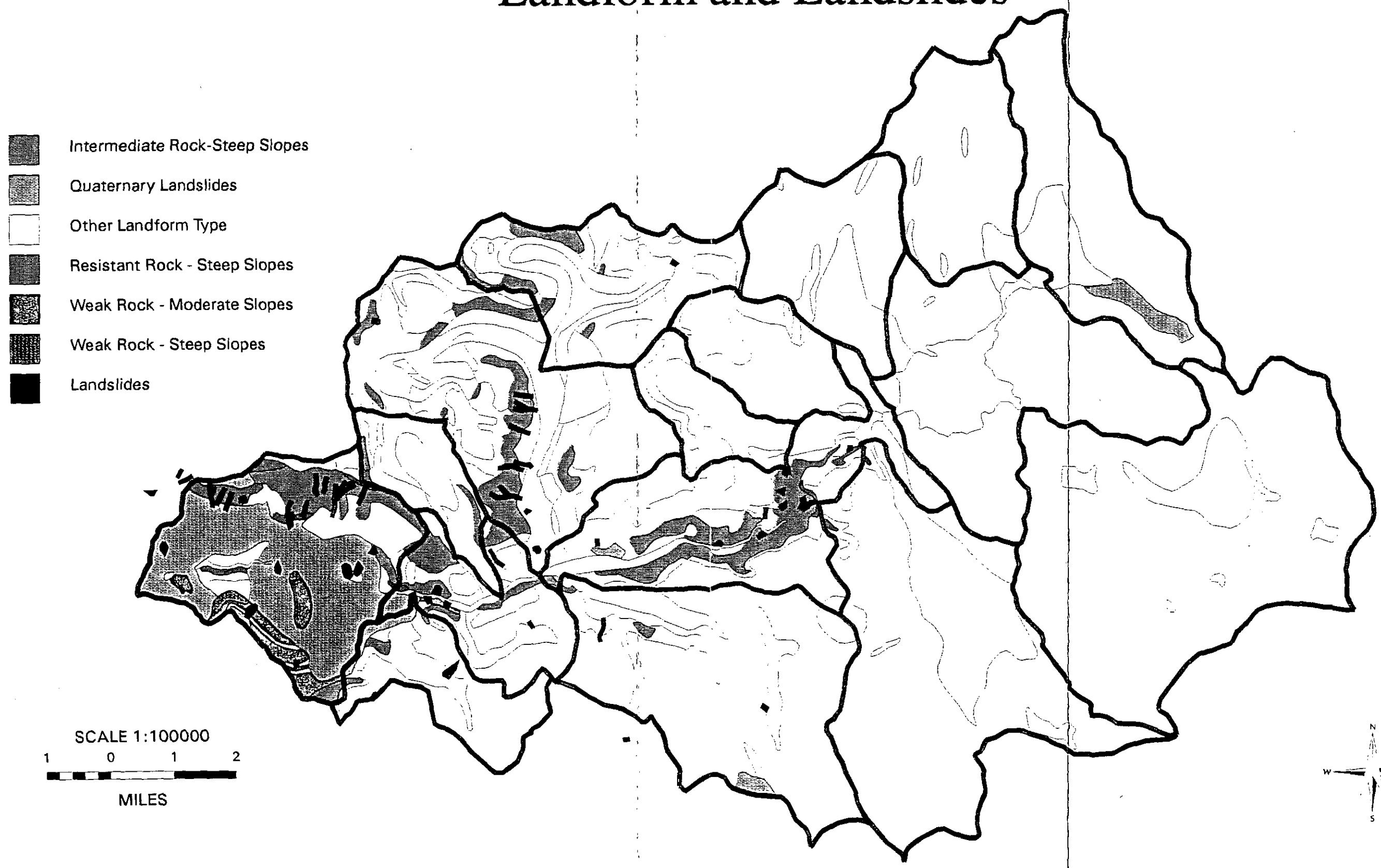
Most of the watershed falls within the rain-on-snow zone where rain-on-snow events produce peak flows, which may trigger debris torrents and sudden rapid landsliding.

The landslide inventory covered only the western portion of the watershed due to the predominance of weak geologic units and steep slopes. The eastern portion of the watershed is known to be less disposed to slope failures, primarily because it lacks steep slopes. As with many watersheds in the Cascade Mountains, the occurrence of landslides in the Oak Grove Fork Watershed is strongly dependent upon steep slopes, abundant precipitation, and the presence of weak rock formations.

Many of the inventoried landslides are associated with the vast Quarternary landslide deposits found in the Lower Oak Grove Subwatershed (Map 8-1). The landslides that produced these deposits were initiated under different climatic and hydrologic conditions from those that exist today but this arrangement of geologic units has been recognized elsewhere as being prone to large-scale slope failures.

Fifty-eight recent (within the last 50 years) landslides were identified in the landslide inventory (Map 8-1). Of these landslides, 30 are debris flows, 26 are debris slides and 2 are earthflows. Forty -nine of the 58 landslides delivered sediment to streams. Rates of sediment delivery were not calculated. Approximately half of the inventoried landslides are associated with land management activities (roads or harvest units). A causal relationship between land management activities and landslide occurrence could not be determined in this analysis. However, this causal relationship is well

Oak Grove Watershed
Landform and Landslides



MAP 8-1

documented in scientific literature (O'Loughlin 1974; Swanson and Dryness 1975; Gresswell et al. 1979; Ameranthus et al. 1985; Wolfe and Williams 1986; Neely and Rice 1990; Sidle 1992).

Natural rates of landslide occurrence were not determined. An assumption can be made that on steep slopes of the weak geologic units have always delivered sediment to streams. Sediment from landslides initiated or influenced by management activities can be considered an addition to the sediment load of the system.

Many stream bank failures or inner-gorge failures yet to be inventoried are believed to continuously delivering sediment to streams and probably account for a majority of the sediment delivered to streams by landslides.

The 1964 Flood does not appear to have affected mass wasting in this watershed as severely as it did in neighboring watersheds, particularly in the Salmon River Watershed to the north. One reason could be the regulated flow regime. Other reasons could be the amount of snow, the path of the storm, or the watershed was topographically isolated from the storm.

Roads and Recent Timber Harvest

Weak rock with steep or moderate slopes and resistant and intermediate rock on steep slopes have high sediment delivery potential (Map 8-1). The Quarternary landslide deposits landforms also has a high sediment delivery potential. The majority of these landforms are within the Lower Oak Grove, Lake Harriet, Middle Oak Grove and Shellrock / High Rock Subwatersheds. Roads and/or recent timber harvest near or adjacent to streams in these landforms will have higher sediment delivery rates than the other landforms.

Methodology for estimating sediment delivery to streams closely follows methods for evaluating surface erosion from hillslopes and roads described in the **Standard Methodology for Conducting Watershed Analysis** (1993). The objective of the methodology as applied to Oak Grove Watershed are to evaluate and document the relative potential for sediment delivery from roads and harvest units and to prioritize activities and locations for restoration.

Data limitation necessitated alternate analysis than described in the methodology and is described in the Analysis File. While this methodology is based on the current scientific understanding of forest management and watershed processes, its predicted outputs have not been evaluated on the Mt. Hood National Forest. Therefore, the results should not be considered as exacting measures of potential sediment yield but instead provide a framework for understanding relative effects of different management activities in the watershed and a comparison of sediment delivery rates among subwatersheds.

Natural or undisturbed rates of erosion for the landforms within the watershed are unknown. Swanson and Grant, 1982, estimated surface erosion rates for forested area as low, 0.007 tons/acre/year. Therefore surface erosion and sediment delivery estimated in this methodology could be considered an increase due to recent management activities. Total vegetative recovery is assumed after 5 years for harvest units and road revegetation and obliteration.

In the turn of the century few roads existed within this watershed so any sediment delivered from roads can be considered as an addition to the sediment loading of the system. Timber harvest and agricultural activity were also limited in the turn of the century although forest clearings due to wild or man-caused fires existed in large scale in the higher elevations of the western half of the watershed. Therefore the sediment produced from recent timber harvest may be similar to sediment delivery during periods when areas with large scale fires were vegetatively recovered but less during periods when there had been recent large scale fires.

The earliest road construction was the Abbott Butte road which is now known as Road 58 and the Skyline Road (4220) into and around Ollalie Lakes. These two road were built in the 1920's. Later in the 30's a portion of Road 58 was built from High Rock down Shellrock Creek over to Lake Harriet and then up Roads 5730/5720 which tied into Skyline Road (see map in analysis file).

The major road construction period was in the 60's and 70's along with major reconstruction program of converting aggregate surfaces to paved surfaces in the 70's. The last reconstruction project took place in 1980.

Table 8-1. Road Construction (miles) History in the Oak Grove Watershed.

DECADE		SURFACE TYPE		SYSTEM TOTALS
	NATIVE	AGGREGATE	ASPHALT	
Pre 1940	c 50.4	0.0	0.0	50.4
1940 - 1959	c 46.7	c 54.2	0.9	
Subtotals	97.1	54.2	0.9	152.2
1960 - 1979	c 74.4	c 118.5	c 5.6	
		r 17.2	r 32.7	
Subtotals	121.6	189.9	39.2	350.7
1980 - Present	c 11.1	c 67.3	c 0.0	
		r 11.8	r 0.0	
Subtotals	120.9	269.0	39.2	429.1

c = construction r = reconstruction

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

In this model, sediment delivery from roads was based on direct road ditch contribution and 10% of sediment transported from culvert out flow via overland flow less than 300 feet from a stream. Sediment delivery from harvest units was based on sediment transported via overland flow less than 300 feet from a stream

Twenty eight percent of the total sediment delivered to streams in the watershed from roads and recent harvest units were from within the Shellrock and Highrock Subwatersheds (Table 8-2). Approximately half of this sediment delivered was from roads (42.9 tons/year) and half from recent harvest units (55.0 tons/year).

Lower Oak Grove, Stone Creek, Peavine Creek and Crater Creek also had high levels of sediment delivery to streams from roads and recent harvest. Stone Creek, Peavine Creek and Crater Creek sediment delivery were predominately from recent harvest units. From the model results, All of the estimated sediment delivery from the model was from roads in Lower Oak Grove.

Within the Timothy Lake Catchment Basin, Timothy Lake, Dinger Creek and Crater Creek were the subwatersheds delivering the most sediment to streams from roads (Table 8-3). Within the Lake Harriet Catchment Basin, Shellrock/Highrock, Middle Oak Grove, Anvil and Stone Creek were the subwatersheds delivering the most sediment to streams from roads. Restoration to roads with high sediment delivery rates to streams would be most cost effective (Map 8-2).

The K-2 rock pit encompasses two perennial streams. Inadequate culverts exist on this area. Sediment is being delivered to the streams from the rock pit.

Turbidity data is not available for the Oak Grove Watershed. The streams appear clear except during storms when turbidity levels increase as expected due to natural processes of sediment movement during high flow events. Timothy Lake's clarity is good (secchi depth = 26 ft on September 14, 1993). The settling process which occur within Timothy Lake and to a lesser extent in Lake Harriet would tend to decrease turbidity levels during high flow events in this system. From the model used, the amount of estimated sediment delivered to streams from roads and harvest units were similar in this watershed compared to the Eagle Creek and North Fork Watersheds of the Clackamas River Basin.

Table 8-2. Total Sediment Delivery from Roads and Recent Timber Harvest.

Subwatershed	Sediment Delivery	
	Tons/year	%
Lower Oak Grove	36.4	10
Lower Oak Grove Catchment	**36.4**	**10**
Shellrock & High Rock	97.9	28
Stone	42.7	12
Peavine	27.9	8
Middle Oak Grove	18.6	5
Kink	17.9	5
Anvil	12.2	3
Harriet	11.9	3
Buck	8.7	2
Cot	4.1	1
Lake Harriet Catchment	**241.9**	**69**
Crater	27.1	8
Timothy Lake	17.7	5
Dinger	11.0	3
Upper Oak Grove	10.1	3
Cooper	6.9	2
Timothy Lake Catchment	**72.7**	**21**
Watershed Total	351.0	100

Table 8-3. Sediment Delivery Rates to Streams from Roads.

Subwatershed	Sediment Delivery		Road Length	
	Tons/year	%	Miles	%
Lower Oak Grove	36.4	17	21.3	17
Lower Oak Grove Catchment	**36.4**	**17**	**21.3**	**17**
Shellrock & High Rock	42.9	20	22.8	18
Middle Oak Grove	18.6	9	10.8	8
Stone	12.8	6	7.9	6
Anvil	12.2	6	4.8	4
Lake Harriet	11.9	5	8.8	7
Peavine	11.7	5	8.3	6
Buck	8.7	4	3.1	2
Cot	4.1	2	2.5	2
Kink	8.9	4	7.8	6
Lake Harriet Catchment	**131.9**	**61**	**76.8**	**60**
Timothy Lake	13.3	6	7.5	6
Dinger	11.0	5	5.9	5
Crater	10.7	5	7.0	5
Cooper	6.9	3	4.2	3
Upper Oak Grove	7.4	3	5.8	4
Timothy Lake Catchment	**49.3**	**23**	**30.4**	**24**
Watershed Total	217.6	100	128.4	100

Oak Grove Watershed
Road Sediment

High Sediment Rating

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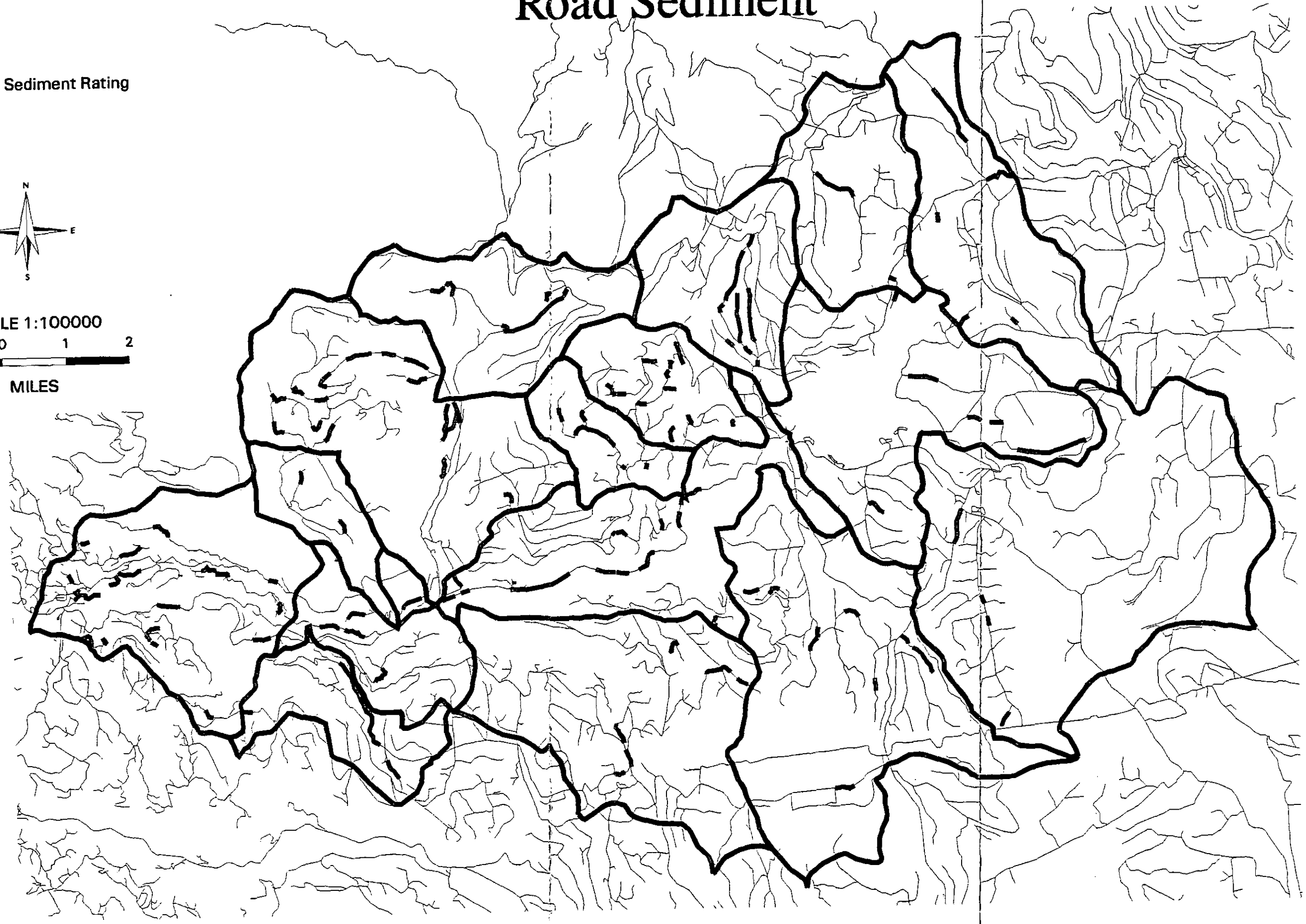


MAP 8-2

B. Trends

Landslides

Most of the Quarternary landslide deposits in the Lower Oak Grove Subwatershed are currently inactive although they continue to play an important role in a variety of sediment transport and delivery processes, due to their predisposition toward instability, . Those areas of the deposits that remain active (i.e. earthflows) are effectively transporting sediment to a position where it can be delivered to a stream via stream-bank failures, debris slides, or surface erosion. Unfortunately, the extent of active earthflows in this watershed is not entirely clear.

The stream bank failures or inner-gorge failures, yet to be inventoried will continue to deliver sediment to streams and probably account for a majority of the sediment delivered to streams by landslides.

Roads and Recent Timber Harvest

The LSR in this watershed includes over 50% of Shellrock/Highrock, Dinger, Anvil and Buck Creek Subwatersheds. Road use for silvicultural purposes will diminish in the LSR.

Increased sediment delivery over that of background levels in landforms of weak rock in steep or moderate slopes and resistant and intermediate rock on steep slopes will continue if harvest and/or road construction occur in these areas. The majority of these landforms are within the Lower Oak Grove Catchment, and the Lake Harriet Middle Oak Grove and Shellrock / High Rock Subwatersheds within the Lake Harriet Catchment. The landscape design objectives from the Landscape Analysis recommend over 70% of each of these subwatersheds be in patterns (Interim Connectivity and Late Seral) where minimal timber harvest and associated road construction would occur with the exception of Shellrock/Highrock Subwatershed. In Shellrock/Highrock subwatershed, approximately 15% of the area is in a aggregate pattern and 30% is in a Perforated Pattern. Silvicultural treatments could be located away from these more erosive landforms within these patterns.

District road maintenance priorities have necessitated the reduction in roads maintained. The resulting closure of road segments will decrease the sediment delivery from roads.

The K-2 rock pit will continue to deliver sediment to streams unless restoration improves this area.

Turbidity levels in the Oak Grove Watershed should remain the same with the impementation of the Northwest Forest Plan. Riparian reserve standards and guidelines will reduce the amount of earth

disturbing activities in the riparian areas and thus limit any managment related turbidity increases.

C. Recommendations

Close roads by eliminating access and assuring hydrologic stability for the following:

1. Non-paved roads in Late Successional Reserve

2. Roads which have high sediment delivery rates and are not needed for other District resource needs including primary hunter access roads (See ATM Map). Closure priority by Catchment should follow the order of magnitude of sediment delivery rates for each subwatershed (See Table 8-3).

Reduce sediment delivery from Road 57 by stabilizing cut and fill slopes, establishing adequate surface drainage and paving surface.

Reduce sediment delivery from Road 4630 (to Lake Harriet) by establishing adequate surface drainage and paving surface.

Check all recent timber harvest units (less than 5 years of age) to assure revegetation of any disturbed ground has been recovering adequately.

Close the K-2 Rock Pit by pulling culverts, re-establishing natural stream course, and stabilizing area with vegetation. Also close access road.

Chapter 9

Core Topic - Human Uses

Core Topic - Human Uses

What effect do roads have on big game habitat effectiveness and what are the social effects of closing roads?

Current Condition as compared to Reference Conditions

Road densities can have a significant effect on big game habitat effectiveness.
Calvin (1995) reported that no elk were observed in any areas on the USFS lands west of the Warm Springs boundary where open road density averaged higher than 2.8 miles per square mile, and most observations were recorded in areas of 2.0 miles per square mile or less. Some elk seemed to be more sensitive to human disturbance than others; one bull elk retreated annually into Roaring River Watershed, not to emerge until the rut. Another elk (the "Highway Cow") was notoriously difficult to spot, as she preferred to remain in extremely heavy hiding cover. Fiedler and O'Connor (1992) also reported that elk within or moving through areas of high open road densities moved longer distances (several miles per day was not uncommon).

Trends

Given the diminishing amounts of forage that will be present in the future as compared with the present due to reduced timber harvest, road closures will play a critical role in reducing the energetic demands upon the resident elk herds. Options to reduce open road densities especially in the locations identified as important to elk should be fully explored.

Roads in the watershed used for primary access to developed recreation sites like campgrounds, trailheads, and interpretive sites, as well as groomed snowmobile routes are priority roads to keep open. Repair and maintenance could be necessary for safety reasons and or to reduce hydrologic or habitat impacts. Effects to developed recreation and scenic driving should be minor from road closures.

The degree to which hunting access in the watershed could be affected by road closures will vary according to landform as well as type of road closure. Roads closures in the River Corridor Area and Shellrock Creek could limit hunting because of the steep terrain. In the Timothy Lake area, hunting use could shift to less vehicle based use but the gentle terrain facilitates pedestrian use. The type of road closure can also be a factor in changes in hunting access, ie. a gated road contrasted with an obliterated road. Increases in the deer and elk population due to lower road densities could also compensate for the changes in vehicle access.

Road closures in the Late Seral Reserves and Riparian Reserves could impact dispersed camping by creating more walk-in campsites and less vehicle access. These road closures could play an important role in the provision and retention of valued primitive and semi-primitive recreation settings particularly near rivers and creeks, back country lakes, and high elevation meadows.

Recommendations

1. Prioritize road closures near meadow complexes and near riparian areas in gentle terrain. Utilize CFR closures in sensitive areas.

Chapter 10

Landscape Analysis and Design

Landscape Analysis and Design

The Landscape Analysis and Design (LAD) process unites forest planning with the principles of landscape ecology and emphasizes the conscious design of vegetation patterns in the landscape based upon management objectives. The premise of the LAD process is that different landscape structures in the watershed can be arranged spatially according to the social expectations of the landscape plus the ecological potential. Information about the LAD process is described in detail in the publication Forest Landscape Analysis and Design (Diaz and Apostol, 1992). The goal of using the LAD process in the Oak Grove Watershed Analysis is to synthesize current management direction from the Northwest Forest Plan and the Mt. Hood National Forest Plan with the recommendations from the watershed analysis and form a spatial plan of vegetation patterns and forest structures. In addition, the LAD process was used was used in the watershed analysis as the synthesis step to coalesce individual resource analysis into comprehensive understanding of the landscape. The LAD process for the Oak Grove Watershed included an analysis of landscape structure, flow phenomena, disturbance regimes, endless discussion about management objectives, and opportunities and constraints which were developed into a Conceptual Landscape Design.

Opportunities and Constraints

A critical step to developing a Conceptual Design for the watershed began with mapping the opportunities and constraints for management activities and vegetation patterns. Social and landscape factors become constraints or opportunities based upon landscape management objectives. The opportunities and constraints identified (Map 10-1) were those located outside management areas with explicit objectives regarding the vegetation patterns or ecological processes such as the Late Seral Reserves and the recommended Riparian Reserves. To be considered, an opportunity or constraint had to drive a vegetation pattern particularly the size and distribution of created openings in the forest or targeted forest structure. Opportunities and Constraints in the Oak Grove watershed included:

- Unstable landforms with landslide and erosion potential (Map 8-1).
- Interim old-growth connectivity based on existing interior habitat (Map 4-5) and TLML (Map 4-4).
- Regeneration problems in Mt. Hemlock forest series (Map 4-3).
- Large areas of lodgepole forest.
- B2 Scenic Viewshed allocation from the Forest Plan.
- Trail viewsheds as specified in the Mt. Hood Forest Plan particularly the Pacific Crest Trail.
- Selected high elevation meadows and lakes outside the A9 Mt. Hood Forest Plan allocation.
- Timothy Lake subwatershed in an unrecovered hydrologic condition.
- A13 Bald Eagle Management Area allocations from the Mt. Hood Forest Plan.
- Owl circles below take (not displayed on Map 10-1).

Conceptual Landscape Design

The Conceptual Landscape Design (Map 10-2) graphically displays the vegetation patterns desired under the existing management direction found in the Northwest Forest Plan and the Mt. Hood National Forest Plan. Information during the watershed analysis regarding regeneration issues, hydrologic recovery, unstable landforms, rare and unique habitats, and recreation issues around Timothy Lake was also used to develop the spatial arrangement of vegetation patterns.
The Conceptual Landscape Design Key (Table 10-1) provides information specific to each pattern type, management objectives, derivation, and management recommendations.

Oak Grove Watershed
Conceptual Landscape Design

MAP 10-2

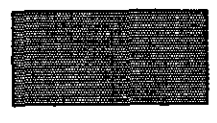
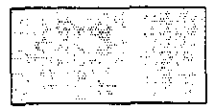
PATTERN TYPE	OBJECTIVES	INCLUDES	MANAGEMENT DIRECTION
Retain and Promote Late Seral Forest Structure 	• Habitat for late seral species • Protection of aquatic resources • Connectivity	• LSR • Recommended Riparian Reserves • 100-acre owl LSRs • LMP "A" Allocations: Roaring River Special Interest Area, Key Site Riparian and Bald Eagle Habitat Area	• Thin to promote late seral structure • Create or promote snags and LWD where lacking • Promote shade along streams • Fire suppression • Close unneeded roads • Salvage if this contributes to area objectives
Interim Connectivity 	• Retain connected mature forest dispersal habitat in watershed until LSR and Riparian Reserves function as planned. • Manage plantations for future timber production • Defer harvest of mature stands until other harvest possibilities are exhausted.	• Large blocks of interior late seral habitat outside LSR and Riparian Reserve • Highest quality TLML habitat • Late seral connections to neighboring watersheds • Foreground viewshed	• Limited timber production • $\leq$ 2 acre openings • $\geq$ 60% canopy closure • $\geq$ 40% canopy closure in plantations
Continuous Forest Cover (70%) with 2-5 acre perforations 	• Economical timber production • Minimize mass wasting and erosion • Meet scenic quality objectives • Contribute to mature forest connectivity • Maintain hyrologic function	• Matrix lands in Lower Oak Grove Fork subwatershed • Ancient (active and inactive) landslides • Middle ground viewshed	• Small regeneration harvest (2-5 acres) • Retain 70-80% of each design cell in closed canopy forest (mid or late seral) • Retain a minimum of 15% of harvested area in green trees • Maintain or promote adequate snags and LWD.
Continuous Forest Cover (> 60% Canopy Closure) with small perforations 	• Meet scenic quality objectives from Timothy Lake and Road 42 • Timber production	• Viewshed • Matrix • High Cascades area	• Maintain continuous forest cover with thinning and heavy shelterwoods • Small openings (0.5 -- 2 acres)
Rehabilitation - Shape Stands to create future addition to connectivity 	• Maintain or repair scenic integrity • Timber production	• Fragmented area of viewshed (B2) in Interim Connectivity Area	• Use timber harvest to feather and round edges of existing clearcuts to aggregate existing units togethe
Late Seral and Meadow Mosaic 	• Habitat for late seral, meadow and interface species • Aesthetics	• Area around Clackamas Meadows, Little Crater Meadows, and the North Arm of Timothy Lake • High quality bald eagle habitat	• Thin to promote late seral structure • Create or promote snags and LWD where lacking • Promote shade along streams

Table 10 - 1 Conceptual Landscape Design Key

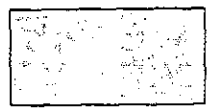
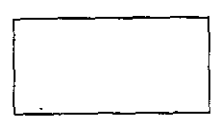
PATTERN TYPE	OBJECTIVES	INCLUDES	MANAGEMENT DIRECTION
Summit Lake - Thinning and Group Select 	• Aesthetics • Timber production	• Portion of viewshed around Summit Lake • Lodgepole forest type	• Group selection < 2 acres • Thinning for diversity
Aggregate (< 50 % late seral) 	• Timber production • Reduce degree of future fragmentation	• Portions of Matrix	• Focus on islands and peninsulas for regeneration harvest • Consider effect on interior habitat patches
Lodgepole / Fragmented 	• Retain lodgepole in watershed • Timber production	• Large area of lodgpole forest type	• 10-40 acre openings
Large perforations 	• Timber production • Maintain site conditions suitable for successful regeneration	• Mountain hemlock and other associations	• Regeneration harvest < 20 acres • Retention of shelterwood overstory
Uneven -age Management 	• Continue uneven-aged pattern • Continue long-term silvicultural trial of group selection in Western Cascades	• Matrix in Buck Lake area	• Openings < 2 acres • 100 year rotation

Table 10 -1 Conceptual Landscape Design Key

Oak Grove Watershed

Access Travel Management (ATM)

Obliteration or Vegetation Stabililization Priority

- First Priority
- Second Priority
- Third Priority

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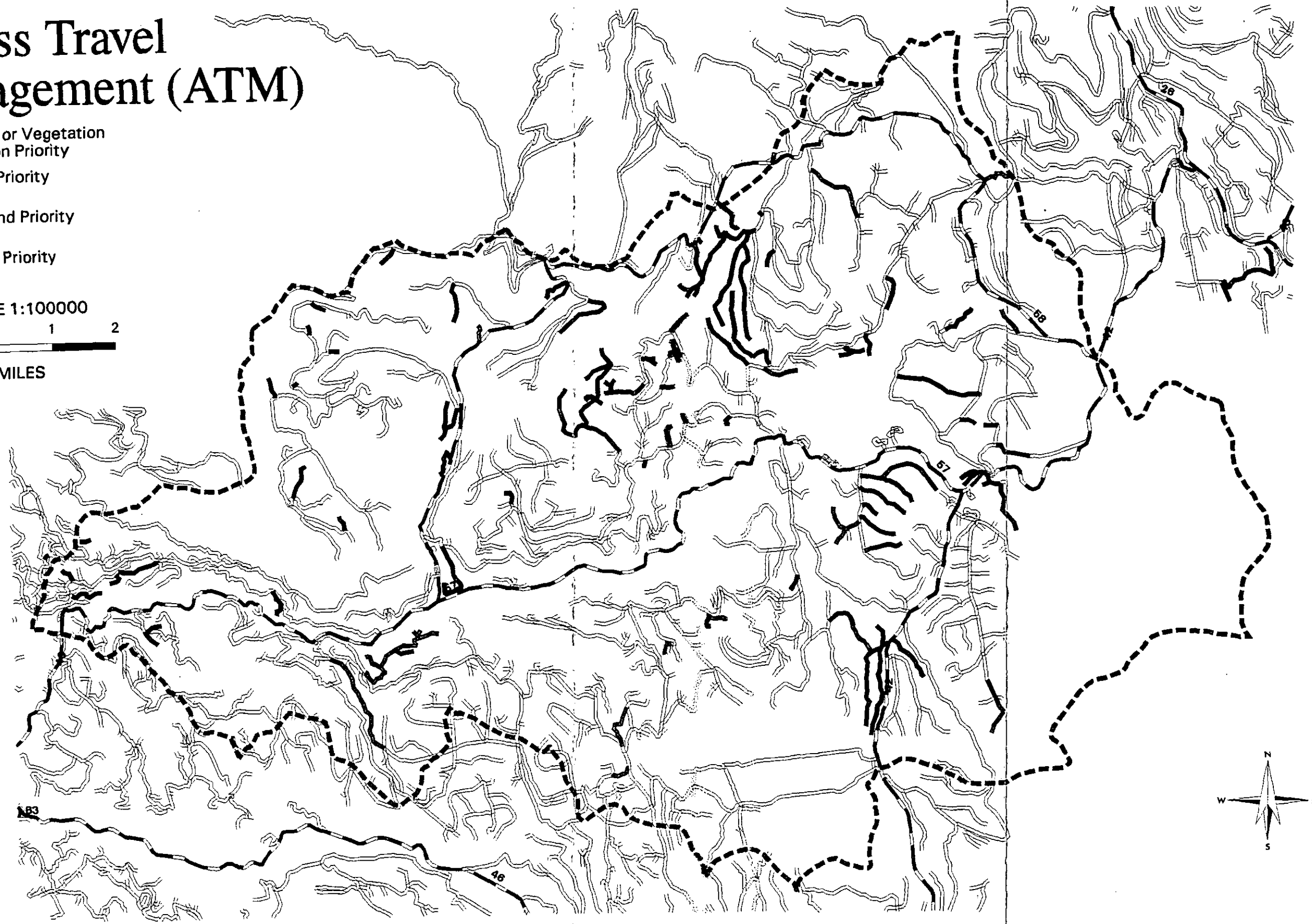

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MAP -

Chapter 11

Summary

Recommendations

Watershed wide

- Develop a flow regime that includes channel maintenance flows below Lake Harriet.
- Negotiate for minimum flows from Lake Harriet Dam to increase productivity for the naturally produced coho and other anadromous species currently using the lower Oak Grove Fork. Improving flows and biological viability is a desired future condition under the Northwest Forest Plan and the Clackamas River Wild and Scenic River Management Plan.
- Coordinate with PGE and EWAB to achieve consistency in operating conditions for the Oak Grove Hydroelectric Project and Stone Creek projects.
- Explore merit and possibilities with ODFW, PGE, and other involved agencies of implementing ODFW's draft plan for emergency hatchery intervention for the late run coho, weak year class in late 1996.
- Pave Road 57 for user comfort, safety, and to reduce sedimentation.
- Rehabilitate, relocate if possible or necessary and/or modify dispersed recreation sites in Riparian Reserves.
- Promote mid and late-seral habitat within 1,000 feet of high elevation meadows. If A9 allocation exists around these meadows, the A9 allocation is considered adequate, with the exception of the Clackamas Lake Meadow in which case the 1,000 foot vegetation retention zone is preferred.
- Develop plans to manage people use in popular meadows. Little Crater Meadows and North Arm of Timothy should be highest priority.
- Implement Conceptual Landscape Design.
- Conduct preference testing related to the B2 Viewshed.
- Explore opportunities for decreasing safety risks on Road 42 east of junction with 5810.
- Retain the following B5 (Pileated Woodpecker / Pine Marten) areas: 2101M, 2041W. In the remainder of the watershed, retention of Late Seral and Interim Connectivity design cells is believed to be sufficient for late seral connectivity for pileated woodpecker and pine marten.
- Restrict further final overstory removal in shelterwoods.
- Minimize rate of "take" of owl, consistent with the Northwest Forest Plan.
- Try to limit human disturbance around key calving sites during calving season.
- When pre-commercial thinning, consider the "clumpy" features that elk prefer in these types of plantations and aim for uneven spacing.
- Implement Access and Travel Management (ATM) Plan

Timothy Lake Area

- Expand developed recreation facilities around Timothy Lake Area.
- Complete Master Plan for the Timothy Lake recreation area.
- Emphasize wildlife viewing opportunities in the North Arm of Timothy Lake.
- Recommend to the State Marine Board to restrict boat use to minimize effects of wave action on shoreline and noise levels in North Arm of Timothy Lake.
- Relocate Road 5890-12 further from the North Arm of Timothy Lake.
- Assure that sanitary facilities adequately meet level of human use.
- Limit camping to a minimum in the North Arm to reduce disturbance.
- Prohibit grazing outside of the grazing allotment.
- If field verification warrants, re-allocate the four A13 allocations on the south and west end of the reservoir, if it is determined that recreation impacts may preclude bald eagle nesting.
- Determine if both owl and eagle requirements could be met in the A13 that overlaps with the owl 100 LSR. Re-allocate that A13 if both species requirements can not be met.
- Identify which stands could be managed to enhance existing and future nesting potential for Bald Eagle with silvicultural treatments.
- Maintain and/or increase amount and duration of surface forage for the Bald Eagle.
- Promote and encourage late seral conditions in the North Arm of Timothy Lake.
- Cooperate w/ PGE to optimize water level fluctuations for wildlife habitat rehabilitation projects.
- Improve riparian conditions within the frost pocket along Cooper Creek by 1) accomplishing objectives of the Wapinitia AMP of providing riparian exclusion fencing and 2) establishing shade providing vegetation.
- Explore and plan with ODFW and interested publics the means for reducing brook trout competition with native trout in Timothy Lake streams especially near Clackamas Lake.
- Open discussions with ODFW about cooperative trial project to establish bull trout in Timothy Lake. A weir and trap system would have to be established on spawning streams in order to keep brook trout separate from spawning with bull trout.
- Restore shade to Dinger and Cooper Creeks.
- Reduce or maintain the area not hydrologically recovered in the Timothy Lake Subwatershed.

Lake Harriet Catchment Area

- Decrease safety risk on Road 4630 from road 57 to Lake Harriet Campground.
- Maintain or reduce the amount of area not hydrologically recovered in Anvil , Cot , Middle Oak Grove and Lake Harriet subwatersheds.
- Implement fish habitat enhancement on the mainstem Oak Grove Fork in the uppermost two miles of the diversion reach of the Stone Creek Hydroelectic Project.
- Introduce wood into Anvil and Peavine Creeks as LWD levels are low and poor recruitment potential exist in these subwatersheds.
- Manipulate new LWD jam upstream of the Shellrock Bridge so the water does not

compromise the bridge integrity.

- Replace Road 5810 and 57 culverts at crossings with Anvil Creek with structures suitable for 100 year events.
- Replace deteriorating, undersized culverts on Road 4630 upstream of Harriet Lake.
- Replace Road 5830 culvert at crossing with High Rock Creek.
- Check all recent timber harvest units (less than 5 years of age) to assure revegetation of any disturbed ground has been recovering adequately.
- Close the K-2 Rock Pit by pulling culverts, re-establishing natural stream course, and stabilizing area with vegetation. Also close access road.

Lower Oak Grove Area

- Explore opportunities to replace missing gravel inputs depleted by Lake Harriet dam in the Lower Oak Grove Subwatershed.
- Close access routes leading into bat hibernacualr areas and discourage human visitation.
- Prohibit spraying pesticides and herbicides near or around Townsend's western big-eared bat hibernacula.
- Utilize environmental education opportunities at front desk to raise awareness about the positive functions of bats in the ecosystem.
- Withdraw bat hibernacula from mineral land base.
- List buildings on Historical Register where appropriate.

Table 11.1 Restoration Opportunities.

Altered Process	Restoration Objective	Restoration Projects	Emphasis Area
Riparian processes	Maintain health of riparian system	Rehabilitate, relocate if possible or necessary and / or modify dispersed recreation sites in Riparian Reserves.	Mainstem corridor and around lakes and meadows
		Replace culverts with structures suitable for 100 year flood events	High Rock Creek at 5830 Anvil Creek at 5810 and 57 Oak Grove Fork upstream of Lake Harriet on 4630 road.
		Relocate Road 5890-12 further from the North Arm of Timothy Lake	North Arm Timothy Lake
Changed flow regime	Restore flow regime	Develop a flow regime that includes channel maintenance flows and minimum flows. Negotiate for these flow requirements during Hydroelectric Projects reliscensing.	Mainstem of Oak Grove below Timothy Lake Dam to confluence with the Clackamas River.
Increased peak flows	Maintain peak flows	Reduce road crossings by road obliteration	Accomplished in ATM
		Minimize harvest units until more stands become hydrologically recovered	Subwatersheds: Timothy Lake Anvil Cot Lake Hariet Middle Oak Grove

Sedimentation originating from roads and harvest	Reduce or eliminate management induced sedimentation	Stabilize cut and fill slopes, establish adequate surface drainage and pave surface. Rehab K2 rock pit by pulling culverts, reestablishing natural stream course, and stabilizing area with vegetation. Close access road. Obliterate roads with high sediment delivery potential	Road 57 Road 4635 K2 pit area Accomplished in ATM
Reduced large tree component in plantations	Increase proportion of large standing and downed trees	Pre-commercial thin for clumpiness, diversity, and tree diameter growth	Early seral plantations within the LSR and Riparian Reserve
Disturbance to wildlife habitats	Minimize human disturbance in key areas	Limit camping to a minimum. Close access routes and discourage human visitation. Develop a strategy to reduce human access at key times	North Arm of Timothy Lake Bat hibernacula Key calving areas especially around Little Crater Meadows
Native Fish Declines	Improve aquatic conditions for native fish	Manage for bull trout. Establish a weir and trap system on spawning streams to keep brook trout separate from the bull trout.	Cold water tributaries of Timothy Lake.
Degraded habitats	Improve habitats for fish, wildlife and plants	Restore shade and bank stability. Increase LWD	Frost Pockets along Cooper Creek Anvil Creek Peavine Creek

Table 11.2 Monitoring Recommendations.

Process	Monitoring Objective	Monitoring Parameter	Emphasis Area
Recreation Impacts to Resources	Compliance with State Standards, Aquatic Conservation Strategy and LMP guidelines	Dispersed recreation use levels Bacteria levels	Near highly visited areas Timothy Lake during high use periods
Visual quality	Assure LMP guidelines are met	Establish photo points	B-2 land allocation
Effect of grazing on Water Quality	Compliance with State Standards, Aquatic Conservation Strategy, and LMP Objectives	Sediment levels (Wolman pebble count) Fecal coliform levels	Upper Oak Grove Fork at boundary with Reservation boundary Above and below meadows along Crater Creek and above and below the Joe Graham horse camp
Fish species distribution	Meeting fish sustainability goals of LMP	Cutthroat trout movement and spawning Presence of adult and juvenile resident and anadromous fish	Timothy Lake and feeder streams All fish bearing streams
Stream ecological processes	Effect of hydroelectric development	Corydalis populations -Fish populations -Harlequin duck distribution -Stream amphibians - Water temperature - LWD / fish habitat Spawning gravel budget	Mainstem Oak Grove Fork Mainstem Oak Grove Fork between Timothy Lake and Lake Harriet Middle Oak Grove Fork and Lower Oak Grove Fork Anadromous reaches

Information Needs

- User demographics
- The amount of money generated by Timothy Lake recreation.
- Recreation User Preference Survey.
- Recreational use affects to wildlife species and habitat around Timothy Lake (especially in North Arm)
- Species preference for distance of forested cover around meadows.
- Verify Vegetation Layer on the Bear Springs District.
- Data on owl dispersal within the watershed.
- C3 species occurrence information.
- Investigate herd dynamics in the Upper Shellrock sub-watershed.
- Angler Survey on the mainstem Oak Grove between Timothy Lake and Lake Harriet.
- Historic fire occurrence within the meadows.
- Effect of grazing on sandhill crane in Little Crater Meadow and other grazed meadows.
- Estimates of down woody debris component in early and mid seral plantations to locate preferable wood cutting areas.

ATM STRATEGY

The ATM strategy devised by the team is based on the premise that roaded access to the watershed will decline over the next decade. The decline will be due in large part to the reduction of road maintenance funds. The second premise is that some restoration funds will be available to the districts for use in this watershed. Restoration projects should be planned using these lists.

Given the question of which roads to close and which to maintain, we decided that all Level 3 and 4 roads would remain open except in cases of a congruence of overriding factors. Analysis tools used to determine the priority of road closure or "obliteration" included:

- The known or modeled potential of a road segment to deliver sediment into a stream
- The modeled quantity of sediment entering streams from roads (rated by subwatershed in tons/year)
- Open road density (rated by subwatershed as high, medium, or low)
- Sensitive areas (e.g. LSR, or areas with known use by disturbance-sensitive wildlife species)
- The district "need" for a road based on timber harvest likelihood over the next decade District/steward observations and recommendations

Road closures were prioritized by consideration of these factors together. Where funding opportunities (e.g. KV) are available, roads should be closed from the list regardless of priority..

First priority for road closure (nearly all of these are "obliteration" or some type of treatment to make the road hydrological stable):

a) Roads that are already EA approved and have funding (not mapped or listed in Table 11.3).

b) Level 1 roads that have a high potential for sediment introduction into streams and are located:

- in subwatersheds with where the sediment model predicted > 12 tons/year sediment delivered from roads to streams or
- in the LSR or adjacent to areas heavily used by sensitive wildlife, or
- in subwatersheds with high open road density, or
- recommended for obliteration under Bear Springs ATM plan
- not needed for timber harvest in the foreseeable future

Second priority for road closure (all of these are "obliteration" or some type of treatment to make road hydrological stable):

a) Level 1 roads that have a high potential for sediment introduction into streams and are located:

- in subwatersheds where the sediment model predicted > 12 tons/year sediment delivered from roads to streams, or
  Level 1 or Level 2 roads that:
- are wet at least part of the year
- not needed for timber harvest in the foreseeable future

Third priority for road closure (unless closed for hydrological reason, guardrails, gates or berms would be sufficient):

- Roads impacted from over-use by recreationists, or
- Roads in the LSR or elsewhere that are not needed in the next decade for timber harvest, or
- Level 2 or 3 roads that have a high potential or sediment introduction into streams (not mapped or listed in Table 11.5), or
- Additional roads to close with guardrails to reduce overall road density to near or below 2.0 miles/square mile (not mapped or listed in Table 11.5).
- not needed for timber harvest in the foreseeable future

Table 11.3 First Priority Road Closures

(obliteration or vegetative stabilization in most cases)

* Roads that may be closed with guardrail or gate; not necessarily in need of vegetative stabilization.

Road Number		Road Number		Road Number	
4200	-013	5700	-013	5820	-020
	-014	5730	-049		-021
	-018*	5740	-250		-022
	-020*	5800	-023		-023
	-021*		-024		-024
	-027		-150		-140
	-028		-180		-160*
	-030		-310	5830	-013
	-270		-311		-014
	-530*		-320		-unnamed road
4280	-011		-330		-016
	-013	5810	-018		-020
	-014		-036		-250
	-017*		-037		-270
	-232		-038	5860	-019
	-240		-130 (portion)		-020
	-270		-039		-021
4630	-017		-040		-022
	-024*		-043		-222
	-025*		-045		-230
	-026		-210(from jct. with		-240*
4631	-segment by		rd 230)		-241
	meadow*		-230		-242
	-018		-240	5880	-019
	-150	5820	-017		-241
	-246		-018	5890	-012
5700	-012		-019		-240

Table 11.4 Second Priority Road Closure

(Obliteration or vegetative stabilization in most cases)

Road Number		Road Number		Road Number	
4200	-030	5730	-130	5800	-017
4270	-019		-131		-138
5730	-014		-160 (portion)	5870	-011
	-015	5732	-011		-connector between
	-041	5740	-unnamed spur		-221 and -222
	-050	5750	-240	5880	-260
	-120		-242		

Table 11.5 Third Priority Road Closure

(Guardrails or gates sufficient in many cases. Many potential closures are not listed; see explanatory text above.)

Road Number		Road Number		Road Number	
4200	-029	5750	-014	5830	-145
4610	-048		-220	5890	-014
5730	-013		-250		-015
	-130	5800	-170		-016
5750	-011	5830	-017		-260
	-012		-018		
	-013		-other spurs		